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NATIONAL ENERGY SOFTWARE CENTER: COMPILATION OF PROGRAM ABSTRACTS

by

**J. M. Brown, M. K. Butler, M. M. De Bruler,
F. K. Degges, H. S. Edwards, L. R. Eyberger,
C. E. Hughes, P. L. Johnson, M. Legan,
J. Mockler, L. L. Reed, and A. J. Strecok**

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Applied Mathematics Division

May 1979

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<p><i>For convenience the abstract collection is listed here in alphabetic order by program name. In Section VI the abstracts appear in ascending order by program accession number. Pages are numbered by appending a page identifier to the program accession number. The program accession number serves as the basis of the page numbering system. Letters, such as R, G, or S, preceding the page number indicate that distribution of the program is limited in some manner.</i></p>	
ACCEL(MOD2), DESIGN OF PRINTED-CIRCUIT BOARDS	SLA 6600 F+COM RS P T T 681
ACCEL(MOD2), DESIGN OF PRINTED-CIRCUIT BOARDS	SLA 1108 F+BAL RSBP T T 681
ADEP, 1-D & 2-D FEW-GROUP SPACE-TIME KINETICS	BCL 6400 F4 RS P T F 494
AEC-ALO FAU, RADIO FREQUENCY MANAGEMENT SYSTEM	ALOO 360 COBOL RS P M 587
AILMOE, X-SECTION CALC ELASTIC SCAT RESONANCES	AI 360 F4 RS PLX T B 147
AIM6, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	OSUC 370 F4 RS PL CT C 29
AIREK3, SPACE-INDEPENDENT KINETICS W/FEEDBACK	AEB 360 F4 RS P E 121
AIROS2A, SIMULATION OF REACTOR DYNAMICS	AI 360 F+BAL RS P T E 326
AISITE2, PARAMETRIC SITE REQUIREMENT STUDY	AI 360 F4 RS P T G 172
ALPHA-M, RESOLUTION OF GAMMA-RAY SPECTRA	ORNL 360 F4 RS P O 413
ALVIN, DIFFERENTIAL-INTEGRAL DATA CONSISTENCY	LASL 7600 F4 RS P CT A 815
AMDLIBAE, ARGONNE SUBROUTINE LIBRARY CAT. A-E	ANL 360B F+P+A RS T P 562
AMDLIBF, ARGONNE SUBROUTINE LIBRARY CAT. F	ANL 360B F+BAL RS T P 563
AMDLIBGZ, ARGONNE SUBROUTINE LIBRARY CAT. G-Z	ANL 360B F+P+A RS T P 564
ANCON, SPACE-INDEPENDENT REACTOR KINETICS CODE	LASL 6600 F4 RS P T E 486
ANCON, SPACE-INDEPENDENT REACTOR KINETICS CODE	ANL 360 F4 RS P T E 486
ANOVA, THREE FACTOR ANALYSIS OF VARIANCE	EKC 6600 F4 RS P P 819
ANVENT, LOCA ANALYSIS DUKE POWER MCGUIRE UNITS	DUCO 635 F4 RS G 529
APRFX1, 99-GP DLC-2B LIBRARY GROUP-COLLAPSING	APG 6600 F4 RS B 466
ARC-DIF1D, 1-D MULTI-GP DIFFUSION & INVENTORY	ANL 360 F4 RSBP CT C 626
ARC-NUI002, BCD INPUT DATA PROCESSING MODULE	ANL 360 F4 RSBP CT L 533
ARC-SYSTEM, SYSTEM SUBPROGRAMS AND MODULES	ANL 360 F+BAL RSBP CT M 522
ARC-XSEC1, MICROSCOPIC X-SECTION MANIPULATION	ANL 360 F4 RSBPL CT L 594
ARSTEC, NONLINEAR MIXED INTEGER OPTIMIZATION	EG&G 360 F4 RS P P 738
ASPI, GAMMA-RAY SOURCE BUILDUP FACTOR CALC	BAPL 6600 F+ASC RS P T J R429
ASTEM, THERMODYNAMIC PROPERTIES WATER & STEAM	EG-D 360B F4 RS P X T H 580
ASTEM, THERMODYNAMIC PROPERTIES WATER & STEAM	BCAC 6600 F4 RS P T H 580
ATHENA4, INELASTIC SCATTERING FORM FACTORS	ORNL 360 F4 RS P T A 417
ATM, ATMOSPHERIC TRANSPORT & DIFFUSION MODEL	ORNL 360 F+BAL RS P T R 787
AVERAGE, UNRESOLVED REGION AVERAGE X-SEC CALC	BNL 6600 F4 RS P A 376
AVOID, ANNULAR VOID X-SECTION CALCULATION	GEC 625 F4 RS P B 276
AXICRP, FINITE ELEMENT CODE FOR CREEP ANALYSIS	HEDL 6600 F4 RS P CT I 785
BASIC2 INTERPRETER, MINIMAL BASIC LANGUAGE	LLL 8080 ASM RS P T P 803
BEACON/MOD2A, CONTAINMENT SYSTEM FLUID FLOW	EG&G 7600 F+COM RS P CT G 767
BEAMCRP, FINITE-ELEMENT BEAM CREEP ANALYSIS	HEDL 6600 F4 RS P T I R701
BECOM, AEC DP PURCHASE VERSUS LEASE ANALYSIS	SLA 360 COBOL RSBP CT M R589

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COMQC, QUALITY CONTROL DATA ANALYSIS ROUTINES	BKC	360	F4	RS P	P	649
COMRADEX4, ACCIDENT RELEASED RADIOLOGICAL DOSE	AI	370	F4	RS P	T G	663
CONCEPT3, POWER PLANT CONCEPTUAL COST ESTIMATE	GGA	1108	F4	RS P	XCT D	498
CONCEPT5, POWER PLANT CONCEPTUAL COST ESTIMATE	ORNL	360	F+BAL	RS P	X T D	498
CONDYN, POLYA MODEL SECONDARY ELECTRON SPECTRA	KAPL	6600	F4	RS P	W	786
CONTEMPT-LT/026, PRESSURE-TEMPERATURE RESPONSE	EG&G	360B	F+BAL	RSBPLXCT	G	433
CONTEMPT4/MOD2, MULTICOMPARTMENT CONTAINMENT	EG&G	7600B	F+COM	RS	PLXCT G	818
CONTEMPT4/MOD2, MULTICOMPARTMENT CONTAINMENT	EG&G	7600	F+COM	RSBPLXCT	G	818
COPYCAT, IBM OS SYSTEM CATALOG UTILITY ROUTINE	ANL	360D	BAL	RS	X T P	646
COREL, RASE4, DAMG2, ION IMPLANTATION DEPOSITION	SLA	6600	F4	RS P	T Q	758
CORGAM, UNFOLDING OF COMPLEX GAMMA-RAY SPECTRA	KSUN	360	F4	RS P	O	390
COROPT, OPTIMIZING LMFBR MIXED-OXIDE CORES	FBRD	6000	F4	RS P	T D	S752
CORRAL2, RADIONUCLIDE CONTAINMENT AFTER LOCA	BCL	6400	F4	RS P	T G	745
CORTES, THERMAL & MECHANICAL ANALYSIS OF TEES	ORNL	360B	F4	RS P	CT I	759
COVE1, CREEP COLLAPSE FOR OVAL FUEL PIN TUBE	BNW	6000	F4	RS P	T I	817
CRAC, CALC OF REACTOR ACCIDENT CONSEQUENCES	NRC	370	F4	RS	PLX T G	722
CRECT, CHECKER, ENDF/B V2 PROCESSING CODES	ANL	360	F4	RS P	T M	475
CRECT, CHECKER, RIGEL, PLOTFB, ... ENDF/B V2 PROC	BNL	6600B	F4	RS	T M	475
CREEP-PLAST, 2-D INELASTIC STRUCTURAL ANALYSIS	ORNL	360B	F+BAL	RS P	X T I	R707
CREEP-PLAST2, 2D INELASTIC STRUCTURAL ANALYSIS	ORNL	360	F+BAL	RS P	XCT I	R810
CURFIT, CURVE FITTING EXPERIMENTAL DATA POINTS	KAPL	6600	F+ASC	RS P	T P	R 43
CURIE, FISSION PRODUCT INVENTORY DECAY HISTORY	ANL	370	F4	RS	PL C G	196
CURT2, CURVED TUBES OR ELBOWS & ATTACHED PIPES	ORNL	360	F+BAL	RS P	XCT I	R750
CYGR02, STRESS ANALYSIS CYL FUEL ELEMENT	BAPL	6600	F4	RS	T I	R266
CYGR03, OXIDE FUEL ROD STRESS & DEFORMATION	BAPL	6600	F4	RS P	T I	R449
CYGR03, OXIDE FUEL ROD STRESS & DEFORMATION	AN-T	360B	F4	RSBP	CT I	R449
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DAFT1, LEAST SQUARES FIT FISSION NUCLEIDE DATA	BAPL	6600	F4	RS P	P	R327
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DATATRAN2, MODULAR PROGRAMMING AND DATA SYSTEM	KAPL	7600C	F+COM	RS P	T M	386
DATATRAN2, RADI GEOMETRY MODULES 2-D INPUT GEN	KAPL	6600B	F+C	RS P	T L	406
DATATRAN2, UTILITY PLOT MODULES F(X) & F(X,Y)	KAPL	6600B	F+COM	RS P	T P	407
DBUFIT1, LEAST SQUARES TRANSMUTATION ANALYSIS	BNW	1108	F5	RS P	T D	456
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DISPER1, AEROSOL PARTICLE TRANSPORT STUDY	ANL	370	F4	RS P	G	554
DOE2.0, BUILDING ENERGY CONSUMPTION ANALYSIS	BKY	7600	F+COM	RS	PLXCT T	782
DOGGY, DESK CALCULATOR FORM SHEET DP PACKAGE	KAPL	6600	F+ASC	RS P	T P	R428
DOPSEL, SELF-SHIELDING IN THE RESONANCE REGION	RRC	370	F4	RS P	T A	805
DOS, NEUTRON FLUX-DOSIMETER ACTIVITY RELATION	GEC	635	F4	RSBP	D	423
DOT2DB, 2-D MULTIGROUP DIFFUSION & SN THEORY	NED	635	F4	RS P	T C	459
DPOLE, HELMHOLTZ EQUATION ON GENERAL 3D REGION	NYU	6600	F4	RS P	T P	816
DRAFTMAN, DRAW FIGURES & GRAPHS WITH DISSPLA	ANL	360	F4	RS P	CT P	748
DSMP, DYNAMIC SIMULATION NUCLEAR POWER PLANTS	ANL	370	F4	RS P	X T K	784
DTF4, 1-D MULTI-GP DISCRETE ORDINATE PROGRAM	BC	625	F+MAP	RS P	T C	209
DTF4, 1-D MULTI-GP DISCRETE ORDINATE PROGRAM	LASL	6600	F4	RS P	T C	209
DTF4, 1-D MULTI-GP DISCRETE ORDINATE PROGRAM	ANL	360	F+BAL	RS P	T C	209
DUMP, USER-ORIENTED MEMORY DUMP UTILITY	BKY	7600	F+COM	RS P	T P	698
DUZ2, 2-D AXISYMMETRIC & PLANE ELASTIC-PLASTIC	BAPL	6600	F+COM	RS P	T I	R503
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EDITOR, ENDF/B TAPE PROCESSING AND EDITING	ORNL	6600	F4	RS PL	T M	502
EGAD, CALC OF EXTERNAL GAMMA DOSE INTEGRALS	DP	360	F4	RS P	G	600
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EISPACK2, MATRIX EIGENVALUE/VECTOR PACKAGE	ANL	360B	F4	RSBP	XCT P	534
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ELBOW-ORNL, PIPE STRESS & FLEXIBILITY CALC	ORNL	360	F+BAL	RS P	I	650
EMERALD REV. 1, PWR ACCIDENT ACTIVITY RELEASE	PGE	360	F4	RS P	T G	546
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GENRD, FREE-FORMAT CARD INPUT PROCESSOR	LASL	360	F4	RS P L	530
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IMPAC2, B SHIPPING CONTAINER IMPACT ANALYSIS	LASL	7600	F4	RS P I	715
IMPORTANCE, FTA BASIC EVENT & CUT SET RANKING	ANL	370	F4	RS P T G	779
INCITE, THERMAL SPECTRA & MULTI-GP CONSTANTS	EG&G	360	F4	RS PL CT B	565
INDX, XRAY DIFFRACTION POWDER PATTERN INDEXING	LASL	6600	F+COM	RS P Q	609
INTEG,INSPEC, MARKOV SIMULATION OF REACTOR OPN	DP	360	F4	RS P G	590
IISOGEN, RADIONUCLIDE GENERATION AND DECAY	BNW	1108	F5	RSBPPL T D	367
IISOSEARCH, ISOTOPE PRODUCTION FLUX, X-SEC CALC	ORNL	360	F+BAL	RS P D	322
ISOTAB, PU POWER OUTPUT FROM MIXED ISOTOPES	MLMO	360B	F4	RS P C Q	R619
ISOTOPES, MAXIMUM YIELD FROM REACTION OR DECAY	LMSC	1100	F5	RS P D	179

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JITER, FLUCTUATION EXPERIMENT ANALYSIS	BAPL	6600	F4	RS P		O		R394
JOURNAL CONTROL, LIBRARY JOURNAL MANAGEMENT	ORNL	360	C+BAL	RS PL CT	M			660
JP1XR, COUPLD-CHANNEL SCATTERING X-SEC CALC	KAPL	6600	F4	RS P T A				R506
JUPIITORI, COUPLED CHANNEL X-SEC EVALUATION	ENEA	360	F4	RS P CT A				308
K-FIX, TRANSIENT 2-DIMENSIONAL 2-FLUID FLOW	LASL	7600	F4	RS P X T H				727
KAPLPLOT, KAPL CALCOMP PLOTTING ROUTINES	KAPL	6600	F+COM	RS	T P			R496
KEELE, LINEARLY-CONSTRAINED OPTIMIZATION	ORNL	360	F4	RS P		P		556
KEFF,MGBS,TGAN, NUCLEAR CRITICALITY SAFETY	DP	360	F4	RS P T C				617
KENO2, MONTE CARLO MULTIGROUP CRITICALITY CODE	RFD	6600B	F+COM	RS PLX T C				450
KENO2, MONTE CARLO MULTIGROUP CRITICALITY CODE	DP	360B	F+BAL	RSBP CT C				450
KENO4, MONTE CARLO MULTIGROUP CRITICALITY CODE	ORNL	360C	F+BAL	RSBPLXCT C				450
LARCA, FLUX-WEIGHTING OF DTF4 CROSS SECTIONS	LASL	6600	F4	RS P		N		409
LASER, SPECTRUM CALC WITH BURNUP CYL LATTICE	TVA	360B	F4	RSBPLXCT B				249
LASIP3, CCC STANDARD INTERFACE FILE PROCESSOR	LASL	360	F4	RS P CT M				691
LASL XSEC SETS, SN 18- 24- AND 25-GROUP SETS	LASL	6600	BCD	R LX T Z				532
LASLIB, LOS ALAMOS SUBROUTINE LIBRARY ROUTINES	LASL	6600C	F+COM	RS	T P			633
LATIN SQ, NXN LATIN SQUARE EXPERIMENTAL DESIGN	MLMO	360	F4	RSBP C P				630
LENSEDES, NONLINEAR LEAST SQ LENS DESIGN SYSTEM	LASL	6600	F+COM	RS P T P				602
LEOPARD,SPOTS, SPECTRUM CALC WITH DEPLETION	WAPD	360C	F4	RS PLXCT B				279
LEOPARD,SPOTS, SPECTRUM CALC WITH DEPLETION	JNC	1108B	F5	RS PLX T B				279
LIFE3, MIXED-OXIDE FUEL ELEMENT PERFORMANCE	ANL	7600	F4	RS P T I				R460
LIFE3, MIXED-OXIDE FUEL ELEMENT PERFORMANCE	ANL	370	F4	RS P CT I				R460
LINDA, EVALUATION OF STRAIN-GAGE DATA	ORNL	360	F+BAL	RS P T I				657
LINEAR,SIGMA1, LINEARIZE & BROADEN ENDF/B DATA	LLL	7600	F4	RS P T B				747
LINPACK, SIMULTANEOUS LINEAR ALGEBRAIC EQUATNS	ANL	370	F4	RS P X T P				800
LION4, 3-D TEMPERATURE DISTRIBUTION PROGRAM	FW	360	F4	RS P CT H				R299
LION4, 3-D TEMPERATURE DISTRIBUTION PROGRAM	KAPL	6600B	F+ASC	RS P T H				R299
LION4, 3-D TEMPERATURE DISTRIBUTION PROGRAM	CHI	1108A	F4	RS P T H				R299
LION4, 3-D TEMPERATURE DISTRIBUTION PROGRAM	FW	1108B	F4	RS P T H				R299
LIZARD, NONLINEAR DIFFERENTIAL EQNS. SOLUTION	KAPL	6600	F+ASC	RS P T P				R445
LOCK, FEW-CHANNEL COOLANT-FLOW BLOCKAGE STUDY	PNC	360	F4	RS P T H				732
LUGS, STRESS FOR INTEGRAL ATTACHMENTS TO PIPE	ORNL	360	F4	RS P		I		648
MACH1, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	MTS	360	F4	RSBPLXCT C				262
MACH1, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	PURD	6500	F4	RS PLX T C				262
MAGS LATTICE VIBRATION NEUTRON SCATTERING CODES	EG&G	360	F4	RS P CT W				574
MANE1, RECTANGULAR MAGNETIC NETWORK SOLUTION	BAPL	6600B	F4	RS P		I		R412
MANTA, STEADY-STATE THERMAL-HYDRAULIC ANALYSIS	NED	635	F4	RS P T H				256
MANTA, STEADY-STATE THERMAL-HYDRAULIC ANALYSIS	WARD	6600	F4	RS P T H				256
MAPPER, PREDICTING MANUFACTURING REQUIREMENTS	GEP1	GETS	BASIC R			M		595
MARGE/SLUMP, MAXIMUM TEMPERATURE LMFBF FUELPIN	ANL	360	F4	RS P		H		677
MARLOWE, BINARY COLLISION CASCADE SIMULATION	ORNL	360C	F+BAL	RS P X T Q				680
MARLOWE, BINARY COLLISION CASCADE SIMULATION	ORNL	7600	F+BAL	RS P X T Q				680
MATHLIB, SANDIA MATHEMATICAL SUBROUTINES	SLA	6600C	F+COM	RS P X T P				654
MATUS, 3-D FINITE-ELEMENT ELASTIC ANALYSIS	BAPL	6600	F+COM	RS P X T I				R597
MC**2-2, FAST NEUTRON SPECTRA & MULTIGP X-SECS	ANL	370	F+BAL	RSBPL CT B				355
MC**2-2, FAST NEUTRON SPECTRA & MULTIGP X-SECS	ANL	7600	F+COM	RS PLXCT B				355
MELT3, FAST REACTOR TRANSIENT OVERPOWER STUDY	HEDL	6600	F4	RS P CT F				700
METRICATION, CONVERSION TO OR FROM SI UNITS	RDYN	370B	F4	RS P T P				G668
MICHRO, MICROHARDNESS MEASUREMENT ANALYSIS	GEC	635	F4	RSBP		O		421
MIRAB,MIRAP, CONTAINMENT SYSTEM IODINE REMOVAL	BCL	6400B	F4	RS P X T G				499
MMM3, COORDINATE ANALYSES SEMI-RIGID MOLECULES	EG&G	360	F4	RS P		W		632
MOBY, MOBILE HOME HEATING & COOLING ENERGY USE	ORNL	360	F4	RS P X R				724
MOCUS, MINIMAL SETS FROM FAULT TREES	EG&G	360	F4	RSBP CT G				653
MODEL, MODIFIED BETTIS ENVIRNMNTL LIB SCOPE2.0	CEND	7600B	F4	RS		T P		478
MODEL, MODIFIED BETTIS ENVIRNMNTL LIB SCOPE3.3	CDC	6600D	F+COM	RS		T P		478
MOD5, STOCHASTIC MODEL OF NEUTRON SLOWING-DOWN	NGPS	360	F4	RS P X T E				491
MONA, 1-D MULTIGROUP DIFFUSION SLAB, CYL, SPH	EG&G	360	F4	RSBP CT C				582

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PDQ8, 1, 2 OR 3-D FEW-GP DIFFUSION DEPLETION	BAPL	7600B	F+COM	RS P	T	D				R275
PELEN, FUEL PELLET TEMPERATURE & DEFORMATION	BAPL	6600	F4	RS P	T	I				R598
PERT, 1-D PERTURBATION FOR AIM AND FOG CODES	BHSC	360	F4	RS P		C				30
PERT4, 2-D PERTURBATION XY RZ RTHETA GEOMETRY	BNW	1108	F4	RS P		C				304
PHASER, PHASE SHIFT X-SEC & POLARIZATION CALC	KAPL	6600	F4	RS P		A				R507
PHENIX, 2-D DIFFUSION BURNUP/REFUELING HISTORY	LASL	6600	F4	RS P	T	D				454
PHROG, MULTI-GP CONSTANT & FAST SPECTRA CALC	EG&G	360	F4	RS	PLXCT	B				520
PIRAX2, SIMPLIFIED INELASTIC PIPING ANALYSIS	BCL	6400	F4	RS P	T	I				R725
PLACRE, FEM INELASTIC STRUCTURAL ANALYSIS	ORNL	360	F4	RS P	CT	I				R740
PLENUM, FLOW DIST. IN CYL COOLANT INLET PLENUM	DP	360	F4	RS P		H				586
PLETHS, ISOPLETH-AREA CALC FROM SINGLE SOURCE	ANL	GETS	F			R				591
PLOT-3D, 3-D PLOTS ON IBN2280 OR CALCOMP780	ANL	360	F4	RS P	T	N				544
PLOT2, 2-D CONTOUR PLOTS & AREA CALCULATION	SLA	6600	F4	RS P		P				R578
PMS1, FAST NEUTRON POLARIZATION EXPERIMENT	UCND	360B	F+BAL	RS P		O				469
POLLA, CONVERTS R-MATRIX RESONANCE PARAMETERS	ORNL	360	F4	RS P		A				639
POLUTE, FOREST AIR POLLUTANT UPTAKE MODEL	DP	360	CSMP	RS		R				774
POWERCO, NUCLEAR STATION ELECTRICITY COSTS	UEC	6600	F4	RS P		D				340
PREP,KITT, SYSTEM FAULT TREE EVALUATION CODES	EG&G	360	F4	RSBP	CT	G				528
PREP,KITT, SYSTEM FAULT TREE EVALUATION CODES	EG&G	1108	F4	RS P	T	G				528
PROGLOOK, USER PROGRAM PERFORMANCE MONITOR	SLAC	360B	F+BAL	RSB	CT	P				642
PROSA1, PROBABILISTIC RESPONSE SURFACE CODE	ANL	370	F+BAL	RS P	T	G				R778
PRP, PRODUCT PRICE CALCULATED BY DCF METHOD	ORNL	360	F4	RS P		D				739
PRPLOT, LINE PRINTER PLOT SUBROUTINE PACKAGE	ACRC	370	F4	RS P	CT	N				773
PSA2, STRESS ANALYSIS MULTIANCHOR PIPE SYSTEM	A1	360	F4	RS P	C	I				542
PSEUDO, STATISTICAL RESONANCE PARAMETER CALC	GGA	1108	F4	RS P						292
PSEUDO, STATISTICAL RESONANCE PARAMETER CALC	ENEA	360	F4	RS P						292
PTAC11, 2-PASS ASSEMBLER FOR THE PDP-11 ON 360	EG&G	360	PL1	RS P	T	P				516
PTA1, PIPE SYSTEM PRESSURE ANALYSIS	ANL	370	F4	RS P	T	G				R761
PUN1, UNRESOLVED RESONANCE INTEGRALS X-SECS	BAPL	6600	F4	RS P	T	A				R359
PWCOST, REACTOR FUEL CYCLE COST CALCULATION	GGA	1108	F4	RS P	T	D				441
PWR-PPM, BORATION-DILUTION TABLES FOR PWR OPN	OPPD	6400	F4	S	P	H				552
QMESH.RENUM, SELF-ORGANIZING MESH GENERATION	ANL	360	F4	RS P	CT	L				612
QMESH.RENUM, SELF-ORGANIZING MESH GENERATION	SLA	6600	F4	RS P	T	L				612
QX1, QUASISTATIC SPATIAL REACTOR KINETICS CODE	ANL	360	F4	RS	PL CT	F				474
RAFFLE, 1ST FLIGHT COLLISION PROBABILITIES MC	ORNL	360B	F+BAL	RS P	T	B				392
RAFFLE2/MOD2, MONTE CARLO NEUTRON TRANSPORT	EG&G	360	F+BAL	RSBP	CT	B				631
RAHAB, JOSHUA SYSTEM LATTICE PHYSICS MODULES	DP	360	F+BAL	S	X T	B				536
RALCRTPH, RESOURCE ALLOCATION PROJECT PLANNING	MLMO	360	F+C+R	RSBP	T	M				G603
RAMP1, REICH-MOORE RESOLVED REGION X-SECTIONS	BNL	6600	F4	RS P		A				492
RANDOM SAMPLING TABLE, FOR NON-BIAS ORDERING	MLMO	360	F+COB	RSBP	XC	M				679
RAPFU, FUEL CYCLE PARAMETERS FAST BREEDERS	NED	635	F4	RS P		D				372

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TRIPLET, 2-D TRIANGULAR MESH TRANSPORT PROGRAM	LASL	7600	F4	RS P	T C	608
TRIPLET, 2-D TRIANGULAR MESH TRANSPORT PROGRAM	LASL	360	F4	RSBP	CT C	608
TRITMOD, ADVECTION MODEL OF TRITIUM DISPERSION	DP	360		CSMP	S	811
TROUT, MUG MULTIGROUP XSEC LIBRARY MAINTENANCE	NED	635	F4	RS P	T M	493
TROUT, MUG MULTIGROUP XSEC LIBRARY MAINTENANCE	NED	1108	F5	RS P	T M	493
TRUMP, TRANSIENT & S-STATE TEMPERATURE DIST	ORNL	360	F+BAL	RS PLXCT	II	771
TSN, SPATIALLY-DEPENDENT REACTOR KINETICS	AI	360	F4	RS P	T F	309
TUBE, U-TUBE HEAT EXCHANGER STRESS ANALYSIS	KAPL	6600	F4	RS P	I	R378
TVENT, VENTILATION SYSTEM TRANSIENT ANALYSIS	LASL	7600	F4	RS P	T H	809
TWIGGLE, 2-D 2-GP SPACE-TIME DIFFUSION	ANL	360	F4	RS P	T F	R338
TWIGL, 2-D 2-GP SPACE-TIME DIFFUSION FEEDBACK	BAPL	6600	F4	RS P	T F	R338
TWOTRAN-PNVW, 2-D PARTICLE TRANSPORT XY RZ RTH	LASL	7600	F4	RS P	T C	573
TWOTRAN2, 2-D MULTI-GP TRANSPORT XY RZ RTHETA	LASL	7600D	F4	RS P	T C	358
TWOTRAN2, 2-D MULTI-GP TRANSPORT XY RZ RTHETA	LASL	6600D	F4	RS P	T C	358
TWOTRAN2, 2-D MULTI-GP TRANSPORT XY RZ RTHETA	LASL	360D	F4	RSBP	CT C	358
U3R, UNRESOL RESONANCE XSEC PROBABILITY TABLES	AI	360	F+BAL	RS P	CT A	553
VARI-QUIR, TIME-DEP 2-D MULTI-GP DIFFUSION	UMCC	360	F4	RS P	T C	212
VARI-QUIR, TIME-DEP 2-D MULTI-GP DIFFUSION	WANL	6600	F4	RS P	T C	212
VARI-1D, 1-D VARIATIONAL SENSITIVITY	ANL	360	F4	RSBPL	CT C	625
VARR2, CRBRP 2-D TRANSIENT FLUID FLOW ANALYSIS	WARD	7600	F+COM	RS P	XCT H	755
VELVET2, TURBULENT FLOW IN LMFBR ROD BUNDLE	NED	635	F4	RS P	T H	458
VENTURE, 1, 2, OR 3-D MULTIGROUP DIFFUSION	ORNL	360	F+BAL	RSBP	CT C	686
VENUS, 2-D LMFBR POWER EXCURSION DISASSEMBLY	ANL	360	F4	RS P	XCT F	511
VIEWPIN, VIEW FACTOR CALC FOR CYLINDRICAL PINS	EG&G	360	F4	RSBP	CT J	569
VIMI, MONTE CARLO CRITICAL ASSEMBLY ANALYSIS	AI	7600	F4	RS	PLX T C	510
VIMIX, MONTE CARLO CRITICAL ASSEMBLY ANALYSIS	AI-A	360	F4	RSBPLXCT	C	510
WAMPUM, FUEL CYCLE COSTS PERFORMANCE STUDY	UEC	6600	F4	RS P	D	224
WASP2, WATER PROPERTIES FOR SAFETY ANALYSIS	BAPL	7600	F4	RS P	T H	R396
WATER, STEAM TABLES 14.5-14.500PSIA 32-472DEGF	BAPL	6600	F4	RS	H	R267
WELWING, MATERIAL BUCKLING CYL FUEL ELEMENTS	AEB	360	F4	RS P	B	362
WFLLL2B, WIRE CONFIGURATION FREQUENCY DOMAIN	LLL	7600	F4	RS P	T T	721
WHAM6, LIQUID-FILLED PIPING SYSTEM ANALYSIS	EG&G	360B	F+BAL	RS P	T G	278
WHAM6, LIQUID-FILLED PIPING SYSTEM ANALYSIS	ANL	7600B	F4	RS P	T G	278
WHTM, WISCONSIN HYDROLOGIC TRANSPORT MODEL	ORNL	360	F+BAL	RS P	CT R	808
WIGL2, 1-D 2-GP SPACE-TIME DIFFUSION 3-GEOM	UFCC	370	F4	RS P	T F	R274
WIGL2, 1-D 2-GP SPACE-TIME DIFFUSION 3-GEOM	GGA	1108	F4	RS P	T F	R274
WIGL2, 1-D 2-GP SPACE-TIME DIFFUSION 3-GEOM	BAPL	6600	F4	RS P	T F	R274
WIGL3, 1-D SPACE-TIME DIFFUSION W/FEEDBACK	BAPL	6600	F4	RS P	T F	R708
WREM-TOODEE2/MOD3, 2D TIME-DEP FUEL ELEM STUDY	NRC	370	F4	RSBP	CT G	712
WSP-HASP/DOS, DOS-MFT REMOTE WORKSTATION PKG	ANL	360B	F+ASM	RSB	CT P	541
XDTRAP, HYDROGEN PERMEATION WITH TRAPPING	DP	360	F4	RSBP	Q	655
ZONE, 2-D FINITE ELEMENT MESH GENERATOR	LLL	7600	F	RS P	T N	765
ZPR-III ASSEMBLY 48 GAFFAR ENDF/B DATA TAPES	GGA	1108	BIN	R	L T Z	356
1DX, 1-D DIFFUSION FAST X-SECTION GENERATION	ANL	360	F+BAL	RSBP	XCT B	374
1DX, 1-D DIFFUSION FAST X-SECTION GENERATION	BNW	1108	F4	RS P	X T B	374
2DB, 2-D MULTIGROUP DIFFUSION AND DEPLETION	BNW	1108	F4	RS P	T D	325
2DB, 2-D MULTIGROUP DIFFUSION AND DEPLETION	LASL	6600	F4	RS P	T D	325
2DEPEP, ELLIPTIC PARABOLIC & EIGENVALUE SOLNS.	PURD	6500	F4	RS P	CT P	806
2DF, 2-D MULTI-GP DISCRETE ORDINATE CODE	GGA	1108	F5	RS P	T C	173
3DB, 3-D MULTIGROUP DIFFUSION BURNUP ANALYSIS	ANL	360	F4	RS P	CT D	567
3DB, 3-D MULTIGROUP DIFFUSION BURNUP ANALYSIS	HEDL	1108	F4	RS P	T D	567
3DDT, 3-D MULTIGROUP DIFFUSION XYZ R-THETA-Z	LASL	6600	F4	RS P	T D	463
3DXT, DEP3, 3-D XENON TRANSIENT & DEPLETION	KAPL	6600	F4	RS P	T D	R477
6KILER, CORE HEATUP CODE FOR BWR/6 ANALYSIS	EI	360	F-BAL	RS P	CT H	636

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1. NAME OR DESIGNATION OF PROGRAM - EGAD
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360/195
3. DESCRIPTION OF PROBLEM OR FUNCTION - EGAD calculates gamma dose integrals to a ground level receptor, for incremental values of the vertical dispersion parameter σ_z , as a function of gamma energy and spatial distribution of the radioactive material. The dose integrals are representative of sector averages since the distribution of material is assumed to be Gaussian in the vertical, homogeneous in the horizontal, and bounded between ground level and an inversion lid. Calculated dose integrals are independent of radioactive decay, transport velocity, downwind distance, and sector width. Space attenuation and buildup are taken into account.
4. METHOD OF SOLUTION - The plume of radioactive material is assumed to remain constant in shape and size during passage over a receptor point. The space distribution of material is then represented as parallel line sources. The line contributions are integrated analytically by transforming to Bessel and related functions, reducing the spatial distribution to a vertical plane at the receptor point. Plane integrations are then performed by Gaussian quadratures.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - Running time to evaluate integrals is typically less than 30 msec for each energy and receptor point.
7. UNUSUAL FEATURES OF THE PROGRAM - EGAD provides an efficient means of compiling tabular data of dose integrals as a function of incremental values of energy and the vertical dispersion parameter. These data may then be interpolated for specific values of the variables resulting in large computational savings if large amounts of meteorology data are to be processed.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1973.
IBM360 version submitted May 1973, sample problem executed by NESC.
10. REFERENCE - R. E. Cooper, A Computer Program to Compute Dose Integrals from External Gamma Emitters, DP-1304, September 1972.
11. MACHINE REQUIREMENTS - 40K bytes of core storage
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
R. E. Cooper
Savannah River Laboratory
E. I. duPont de Nemours and Company, Inc.
Aiken, South Carolina 29801
16. MATERIAL AVAILABLE -
Source deck (222 cards)
Sample problem (6 cards)
Sample problem output (1 page)
Reference report
17. CATEGORY - G
KEYWORDS - dose rates, gamma radiation, radioactivity

NESC ABSTRACT 600

12/73

18. SPONSOR -

600.2

1. NAME OR DESIGNATION OF PROGRAM - ERF/ERFC
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - ERF and ERFC are used to compute values of the error function and complementary error function for any real number. They may be used to compute other related functions such as the normal probability integrals.
4. METHOD OF SOLUTION - The error function and complementary error function are approximated by rational functions. Three such rational approximations are used depending on whether -
 $|x|$.LT.0.46875,
 0.46875.LE. $|x|$.LT.4.0, or
 $|x|$.GE.4.0.
In the first region the error function is computed directly and the complementary error function is computed via the identity $\text{erfc}(x)=1.0-\text{erf}(x)$. In the other two regions the complementary error function is computed directly and the error function is computed from the identity $\text{erf}(x)=1.0-\text{erfc}(x)$. The error function and complementary error function are real-valued functions of any real argument. The range of the error function is $(-1,1)$. The range of the complementary error function is $(0,2)$.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The user is cautioned against using ERF to compute the complementary error function by using the identity $\text{erfc}(x)=1.0-\text{erf}(x)$. This subtraction may cause partial or total loss of significance for certain values of x .
6. TYPICAL RUNNING TIME - Running time depends on the argument value and will vary between 70 and 110 microseconds.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - This package is a modification of ALO-00241 transferred from the ALO-COSMIC collection.
9. STATUS - Abstract first distributed December 1973.
 CDC6600 version submitted May 1973.
10. REFERENCE - J. E. Vogel, ERF and ERFC: Mathematical Routines for Computing the Error Function and Complementary Error Function, SC-M-70-275, May 1970.
11. MACHINE REQUIREMENTS - ERF and ERFC each require about 260 (octal) locations.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
 J. E. Vogel
 Sandia Laboratories
 P. O. Box 5800
 Albuquerque, New Mexico 87115
16. MATERIAL AVAILABLE -
 Source deck (129 cards)
 Sample problem (48 cards)
 Sample problem output (1 page)
 Reference report
17. CATEGORY - P
 KEYWORDS - data processing, error function, probability

NESC ABSTRACT 601

05/79

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM - LENSDES**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC7600,6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** LENSDES analyzes the performance of optical lenses by computing the image errors found when bundles of skew rays are traced from object points to the image surface. Lens performance is optimized by varying selected lens parameters under direction of the nonlinear least squares program, OPTIMIZ.
4. **METHOD OF SOLUTION -** Lens design is treated as an application of nonlinear least squares optimization of a continuous n-parameter system.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** All optical surfaces must be centered.
6. **TYPICAL RUNNING TIME -** One minute is required on the CDC7600.
7. **UNUSUAL FEATURES OF THE PROGRAM -** Rapidly and steadily decreasing error function.
8. **RELATED AND AUXILIARY PROGRAMS -** This program is a later version of ALO-00010, an IBM7090 program in the ALO-COSMIC collection. LASL-1962 and JPL FOLPD-1967 lens design codes are earlier versions developed at LASL.
9. **STATUS -** Abstract first distributed December 1973.
CDC7600 version submitted May 1973.
10. **REFERENCES -** T. C. Doyle, Nonlinear Least Squares Optimization of a Continuous N-Parameter System, LA-DC-72-1018, 1972.
T. C. Doyle, Automatic Lens Design by Nonlinear Least Squares Optimization of a Continuous N-Parameter System, LA-UR-73-518, 1973.
B. Brixner, Faster LASL Lens Design Program, Applied Optics reprint, Vol. 12, pp. 2703-2708, 1973.
LASL Special System Subroutines Used to Access Extended Core Storage, LASL Note, 1973.
Thomas C. Doyle, Automatic Lens Design by Nonlinear Least Squares Optimization of a Continuous N-Parameter System, LASL Memo T4AB, April 1, 1973.
Thomas C. Doyle, Nonlinear Least Squares Optimization of a Continuous N-Parameter System, LASL Memo E4AA, April 1, 1973.
11. **MACHINE REQUIREMENTS -** 32K words of memory, but very large problems may require extended core storage (ECS) on the CDC6600 or large core memory (LCM) on the CDC7600.
12. **PROGRAMMING LANGUAGES USED -** FORTRAN IV and COMPASS
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** Operable under CDC SCOPE 3.1 on the CDC6600 or under the LASL-developed CROS system on the CDC7600.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -**
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
B. Brixner and T. C. Doyle
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87544
16. **MATERIAL AVAILABLE -** Magnetic Tape Transmittal
Source decks (3768 cards)
Sample problems (335 cards)
Sample problem output (PHIGRAD(V) 35 selected pages, PHIGRAD(U) 38 selected pages)
Reference reports, Reprint, Note, and Memoranda

NESC ABSTRACT 602

04/79

17. CATEGORY - P

KEYWORDS - least square fit, optimization, nonlinear problems, lenses, design, performance

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM - RALCRTPH**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360**
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** RALCRTPH is a resource allocation system used to provide the project planner with a tool to help him schedule resources involved in a project. Information on which jobs are critical and the resources available is necessary for project scheduling. This system is oriented toward the user who is planning a plant shutdown. However, it also has applications in other areas.
4. **METHOD OF SOLUTION -** The resource allocation system performs two basic functions -
 - (1) calculates the critical path, and
 - (2) levels resources and schedules activities.If only a critical path report is required, the system edits the input data for looping and syntactical errors and prints the critical path report. The system can then proceed to schedule a project within user-specified resource limitations. After scheduling a project, a series of reports can be printed. This series includes the resource utilization summary, activity listing for all resources, activity listing for specified resources, activity bar graph for all resources, activity bar graph for specified resources, a work schedule for all resources, and a work schedule for specified resources.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** The size of the arrow diagram that can be read into the edit and critical path programs in the form of activity cards is determined by the memory available in the computer. The present limitation is 3000. The limitations on node numbers are also controlled in the critical path program. The present range of acceptable numbers is 1 to 3000. The upper limit may be increased. However, 0 or negative node numbers are unacceptable. The present queue sizes in the resource allocation program are 300 each for the process and the wait queues. The limitations on resources per activity (4) and the total number of resources (51) are also controlled by the resource allocation program.
6. **TYPICAL RUNNING TIME -**
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -**
9. **STATUS -** Abstract first distributed January 1974.
IBM360 version submitted August 1973, sample problem executed by NESC.
10. **REFERENCE -** C. T. Sigler, Resource Allocation User's Guide, Monsanto Management Information and Systems Department Final Report, September 1, 1967.
11. **MACHINE REQUIREMENTS -** 128K bytes of memory, card reader, printer, 3 tapes or disk drives
12. **PROGRAMMING LANGUAGES USED -** FORTRAN IV(H), COBOL, and RPG
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS 11, Level 8.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -**
15. **NAME AND ESTABLISHMENT OF AUTHOR -**
C. T. Sigler
Monsanto Corporation
Texas City, Texas 77590
16. **MATERIAL AVAILABLE -** Restricted to Use on Government Contracts
Magnetic Tape Transmittal
Source decks (FORTRAN 5089 cards, COBOL 1202 cards, RPG 58 cards)
Sample problems (542 cards)
Load module RALLIB (487 blocks)

NESC ABSTRACT 603

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Sample problem output (part1 41 pages, part2 46 pages)
Reference report

17. **CATEGORY** - M
KEYWORDS - PERT method, planning, information systems
18. **SPONSOR** -

NESC ABSTRACT 604

02/74

- 1. NAME OR DESIGNATION OF PROGRAM - TCB01**
- 2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600**
- 3. DESCRIPTION OF PROBLEM OR FUNCTION -** A tube under external pressure, at elevated temperature, and initially out-of-round will creep, becoming more out-of-round and eventually will collapse. TCB01 attempts to predict the time of collapse.
- 4. METHOD OF SOLUTION -** Using the solution at the previous time-point and the time increment, stress and strains are calculated at radial stations which lie on the radius through the point of minimum radius of curvature. When the change in external moment calculated from the change in strain cannot be balanced by the change in internal moment due to stress, the tube has collapsed. The strain hardening rule may be used with either the Tresca or von Mises criterion. The temperature may vary with time.
- 5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** It is assumed that plane sections remain plane, the radial stress is zero, the temperature across the thickness is constant, the initial out-of-roundness follows a cosine law, and the tube is fixed axially. The program analyzes a simple tube of a single material. At the present time zircaloy is the only material available.
- 6. TYPICAL RUNNING TIME -** The sample problem requires less than a minute.
- 7. UNUSUAL FEATURES OF THE PROGRAM -**
- 8. RELATED AND AUXILIARY PROGRAMS -**
- 9. STATUS -** Abstract first distributed January 1974.
CDC6600 version submitted November 1973.
- 10. REFERENCES -** W. K. Wilson, A Method of Analysis for the Creep-buckling of Tubes Under External Pressure, WAPD-TM-956, September 1970.
- 11. MACHINE REQUIREMENTS -**
- 12. PROGRAMMING LANGUAGE USED - FORTRAN IV**
- 13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.1.5.**
- 14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -**
- 15. NAME AND ESTABLISHMENT OF AUTHOR -**
W. K. Wilson
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
- 16. MATERIAL AVAILABLE -** Restricted Distribution
Source deck (873 cards)
Sample problem (10 cards)
Reference report
- 17. CATEGORY - I**
KEYWORDS - buckling, tubes, pressure, LWBR reactors
- 18. SPONSOR -**

1. **NAME OR DESIGNATION OF PROGRAM - GAUSS5**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360/75
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** GAUSS5 is used to determine gamma-ray energies and intensities from spectra obtained with a Ge(Li) detector and a multichannel pulse-height analysis system.
4. **METHOD OF SOLUTION -** The spectrum analysis is generally carried out in the following steps:
 - (a) The peaks are located automatically by means of an auto-correlation routine. Manual peak selection is also available.
 - (b) Each peak is fitted with a Gaussian function plus a linear function representing the spectral background. Normally, only the three Gaussian parameters (height, width and position) are allowed to vary. Also, the program uses only the data points above about the half-height in the fit, unless the user specifies other limits.
 - (c) If the user supplies the gamma-ray energies of some calibration lines, a linear and/or quadratic energy vs. channel function is determined. This calculation includes corrections for the previously measured nonlinearity of the electronic system. The energies of all lines are then computed along with the uncertainties.
 - (d) If a detector efficiency table is available, the gamma-ray intensities are computed.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** GAUSS5 will handle spectra of up to 4096 channels with up to 300 peaks and 50 energy calibration lines.
6. **TYPICAL RUNNING TIME -** Typical spectra can be analyzed at a rate of about 5 per minute.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -** GAUSS5 supersedes GAUSS3 which has been described in Nuclear Instruments and Methods 57, Vol. 46, 1967. The program LCTAPE is used to transfer the nonlinearity correction and efficiency tables to disk.
9. **STATUS -** Abstract first distributed January 1974
IBM360 version submitted September 1973, sample problem executed by NESC.
10. **REFERENCE -** R. G. Helmer and M. H. Putnam, GAUSS V, A Computer Program for the Analysis of Gamma-ray Spectra from Ge(Li) Spectrometers, ANCR-1043, January 1972.
11. **MACHINE REQUIREMENTS -** One 9-track tape for spectral library and four disks, a printer and card punch
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/360 MVT.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -**
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
R. G. Helmer and M. H. Putnam
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401
16. **MATERIAL AVAILABLE -** Magnetic Tape Transmittal
Source decks (GAUSS5 3639 cards, LCTAPE 164 cards)

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Sample problems (GAUSS5 424 cards, LCTAPE 24 cards)
Control information (GAUSS5 25 cards, LCTAPE 10 cards)
Load module GSS5 (133 blocks)
Punched output (GAUSS5 104 cards)
Sample problem output (GAUSS5 15 pages, LCTAPE 3 pages)
Reference report

17. CATEGORY - U

KEYWORDS - gamma spectra, Gauss function, Li-drifted Ge detectors, LCTAPE codes, GAUSS3 codes

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - GAPER1D
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - UNIVAC1108
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - Reactivity coefficients are computed using first-order transport perturbation theory for one-dimensional multi-region reactor assemblies. The number of spatial mesh-points and energy groups is arbitrary. An elementary synthesis scheme is employed for treatment of two- and three-dimensional problems. The contributions to the change in inverse multiplication factor, $\delta(1/k)$, from perturbations in the individual capture, net fission, total scattering, $(n,2n)$, inelastic scattering, and leakage cross sections are computed. A multi-dimensional prompt neutron lifetime calculation is also available.
4. **METHOD OF SOLUTION** - Broad group cross sections for the core and perturbing or sample materials are required as input. Scalar neutron fluxes and currents, as computed by SN transport calculations, are then utilized to solve the first-order transport perturbation theory equations. A synthesis scheme is used, along with independent SN calculations in two or three dimensions, to treat a multi-dimensional assembly. Spherical harmonics expansions of the angular fluxes and scattering source terms are used with leakage and anisotropic scattering treated in a P1 approximation. The angular integrations in the perturbation theory equations are performed analytically. Various reactivity coefficients and material worths are then easily computed at specified positions in the assembly.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The formulation of the synthesis scheme used for two- and three-dimensional problems assumes that the fluxes and currents were computed by the DTF4 code (NESC Abstract 209). Therefore, fluxes and currents from two- or three-dimensional transport or diffusion theory codes cannot be used.
6. **TYPICAL RUNNING TIME** - A three-dimensional, 11-group series of eight problems with eight regions defined for a 9x9x9 interval mesh requires 12 seconds. A one-dimensional, 20-group series of 6 problems with 5 regions defined for a 50-interval mesh requires 22 seconds.
7. **UNUSUAL FEATURES OF THE PROGRAM** - Problems involving calculations for different assemblies can be run consecutively, if desired.
8. **RELATED AND AUXILIARY PROGRAMS** - GAPER and GAPER2D (NESC Abstract 471). GAPER1D is an updated version of the GAPER code.
9. **STATUS** - Abstract first distributed December 1973.
UNIVAC1108 version submitted July 1973.
10. **REFERENCES** - D. A. Sargis, GAPER - A Transport Perturbation Theory Program, GA-8667, April 26, 1968.
K. Lathrop, DTF-IV, A FORTRAN IV Program for Solving the Multigroup Transport Equation with Anisotropic Scattering, LA-3373, July 15, 1965.
R. J. Archibald and D. A. Sargis, GAPER-2D, A Two-dimensional Transport Perturbation Theory Program, GA-10103, April 29, 1970.
GAPER-1D Sample Problem Description, Gulf Note, 1973.
P. Koch, GAPER-1D Description, Gulf Internal Memorandum, July 11, 1973.
11. **MACHINE REQUIREMENTS** - One I/O device for reading input and printing results and one tape drive to read the code from tape. Core storage requirements are variable.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - EXEC8.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - GAPER1D is core-contained. Parameter statements are used to set dimension limits on the arrays.

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04/79

15. NAME AND ESTABLISHMENT OF AUTHOR -

P. K. Koch
General Atomic Company
P. O. Box 81608
San Diego, California 92138

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (GAPER1D 2036 cards, DTF4 modifications 46 cards)
Sample problem (642 cards)
Control information (11 cards)
Sample problem output (40 pages)
Reference report; GA-8667, Gulf Note, and Internal Memorandum

17. CATEGORY - C

KEYWORDS - reactivity, perturbation theory, one-dimensional, discrete ordinate method, DTF4 codes, GAPER codes

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM - SPIRAL**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
UNIVAC1108
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** The general ability of SPIRAL is building, perhaps gradually, a machine-readable encyclopedia of information items that are or may become important to a particular project, and then later, recalling bits of information as required. The information content of a collection can range from cryptic comments (as occur in some test and inspection records) to more lengthy entries (such as technical abstracts and management briefs) as well as full text of documents.
4. **METHOD OF SOLUTION -** The indexing phase includes elimination of exclusion words, suffix truncation, and has coding of words. The resulting codes are inserted into a multilevel index file structure. Using this structure, the retrieval system applies a combination of binary and sequential search operations to find documents and paragraphs within documents that are pertinent to an inquiry.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Input documents must contain less than 4096 paragraphs, and paragraphs must contain less than 4096 words. For processing efficiency, a given accumulation of documents should not exceed approximately 1000 documents or approximately a million words. Otherwise, a given collection is limited to available on-line storage for containing the data base. The retrieval system is limited to processing no more than 100 inquiries simultaneously.
6. **TYPICAL RUNNING TIME -** The indexing and storage system operates at between 5000 and 20,000 words per minute. Primarily, the variation is due to the length of documents, the length of paragraphs, and the number of documents being input during a given processing cycle. In the retrieval process, run time per inquiry is governed by the complexity of inquiries, the number of inquiries being processed simultaneously, and the amount of relevant information contained in the data base. Because of these factors, run time per inquiry may vary from a few seconds to a few minutes.
7. **UNUSUAL FEATURES OF THE PROGRAM -** Among the perhaps novel features of the system are -
 - (a) the method of data compression (hash coding) used in building the corpus index and in constructing inquiries,
 - (b) the method of machine-compiling the inquiries such that many can be processed simultaneously,
 - (c) the method for coding and comparison of phrases, and
 - (d) a method to detect vocabulary similarity between paragraphs.
8. **RELATED AND AUXILIARY PROGRAMS -**
9. **STATUS -** Abstract first distributed December 1973.
UNIVAC1108 version submitted September 1973.
10. **REFERENCES -** L. E. West, SPIRAL Revisited, SC-M-72 0175, March 1972.
Leslie E. West, SPIRAL (Sandia's Program for Information Retrieval and Listing), Proceedings of the American Society for Information Science, Annual Meeting, 1969.
11. **MACHINE REQUIREMENTS -** UNIVAC1108 FASTRAND II drum, FH-432 drum, card reader, printer, and tape drive
12. **PROGRAMMING LANGUAGES USED -** FORTRAN V and Assembly language
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** EXEC8.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** SPIRAL uses the UNIVAC1108 SORT/MERGE and NTRAN I/O packages. User programming may be required to reformat existing machine-readable text to SPIRAL's text input format.

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15. NAME AND ESTABLISHMENT OF AUTHOR -

L. E. West
Division 2644
Sandia Laboratories
P. O. Box 5800
Albuquerque, New Mexico 87115

16. MATERIAL AVAILABLE - Restricted Distribution

Magnetic Tape Transmittal
Source deck (8636 cards)
Sample problem (1037 cards)
Element file (980 variable-length binary records)
Reference report, SC-M-72 0175, and Proceedings Reprint

17. CATEGORY - M

KEYWORDS - data processing, information retrieval, sorting, indexes, abstracts

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM -** TRIPLET
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC7600, 6600, IBM360
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** TRIPLET solves the two-dimensional multigroup transport equation in planar geometries using a regular triangular mesh. Regular and adjoint, inhomogeneous and homogeneous (keff and eigenvalue searches) problems subject to vacuum, reflective or source boundary conditions are solved. General anisotropic scattering is allowed and anisotropic distributed sources are permitted.
4. **METHOD OF SOLUTION -** The discrete ordinates approximation is used for the angular variables. A finite element method in which the angular flux is assumed to be given by a low-order polynomial in each triangle is used to solve the discrete ordinates equations. Angular fluxes are allowed to be discontinuous across triangle boundaries, and the order of the polynomial is input data to the code. Both inner (within-group) and outer iteration cycles are accelerated by either system or fine mesh rebalance.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Variable dimensioning is used so that any combination of problem parameters leading to a container array less than MAXLEN can be accommodated. On CDC machines MAXLEN can be about 40,000 words and peripheral storage is used for most group-dependent data. On IBM machines TRIPLET will execute in single-precision (4 bytes per word) so that MAXLEN can be several hundred thousand and most problems can be core-contained.
6. **TYPICAL RUNNING TIME -** A six-group, S2, 1700 triangle, keff calculation of an EBR-II core requires about 4.4 minutes of CDC7600 time. Running times vary almost linearly with the total number of unknowns.
7. **UNUSUAL FEATURES OF THE PROGRAM -** Sources, fluxes, SN constants, and cross sections may be input from standard interface files. Creation of standard interface output files for SN constants and scalar and angular fluxes is optional. All binary data transfers are localized in subroutines called REED and RITE. Flexible edit options, including dumps and restart capability, are provided.
8. **RELATED AND AUXILIARY PROGRAMS -** TRIPLET is based in large part on the two-dimensional orthogonal mesh code TWOTRAN2 (NESC Abstract 358), which is an improved version of the TWOTRAN program.
9. **STATUS -** Abstract first distributed December 1973.
CDC7600 version submitted August 1973, replaced by revised edition February 1974.
CDC6600 version submitted August 1973, replaced by revised edition February 1974.
IBM360 version submitted August 1973, replaced by revised edition February 1974,
sample problem executed by NESC.
10. **REFERENCES -** Wm. H. Reed, T. R. Hill, F. W. Brinkley, and K. D. Lathrop, TRIPLET: A Two-dimensional, Multigroup, Triangular Mesh, Planar Geometry, Explicit Transport Code, LA-5428-MS, October 1973.
11. **MACHINE REQUIREMENTS -** Six output (scratch) units and two system I/O units are required. Use of five interface units is optional. On the CDC machines a large bulk memory is required.
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -**
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** The code is written to read the case input data from FSET10 (7600) or TAPE10 (6600) and to write the output information on FSET9 (7600) or TAPE9 (6600), which are not equivalent to the system input and output units.

15. NAME AND ESTABLISHMENT OF AUTHOR -

T. R. Hill
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87544

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (7600-8261 cards, 6600-8262 cards, 360-8646 cards)
Sample problems (7600-361 cards, 6600-661 cards, 360-661 cards)
Control information (JCL 360-31 cards)
IBM 2314 load module TRIPLET (360-306 blocks)
Sample problem output (7600, 6600-50 selected pages, 360-45 selected pages)
Reference report

17. CATEGORY - C

KEYWORDS - two-dimensional, multigroup, transport theory, triangular configuration, anisotropic scattering, finite element method, discrete ordinate method, TWOTRAN2 codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - INDX
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - INDX provides a means for rapidly defining and testing trial unit cells as an aid to indexing powder patterns of crystal structures of unknown symmetry.
4. METHOD OF SOLUTION - INDX attempts to index x-ray diffraction powder patterns by finding a reduced triclinic cell whose calculated q values ($q=1/(d^2+2)$) match a desired percentage of the observed q values within a given limit of error. If a reduced triclinic cell is found, the cell constants may be used to form a rectangular array (i.e., a Niggli matrix). Reference to published tables of general and special Niggli matrices reveals whether or not the specific triclinic cell may be transformed to a cell of higher symmetry. The results of this program are the real space cell constants of each individual trial cell and the position of the cell in the possible cells list.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The number of observed q values cannot exceed 100. The maximum value of $q=2.0$.
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - This program is the ALO-00154 program transferred from the ALO-COSMIC collection.
9. STATUS - Abstract first distributed December 1973.
CDC6600 version submitted July 1973.
10. REFERENCES - R. B. Roof, Jr., INDX, A Computer Program to Aid in the Indexing of X-Ray Powder Patterns of Crystal Structures of Unknown Symmetry, LA-3920, July 1968.
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and COMPASS
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
R. B. Roof, Jr.
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87544
16. MATERIAL AVAILABLE -
Source deck (746 cards)
Sample problem (63 cards)
Reference report
17. CATEGORY - Q
KEYWORDS - x-ray diffraction, crystal lattices, spectra, testing
18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - FUNPACK Release 2
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** -
IBM360,370, CDC6000-7000, UNIVAC1108,1110
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - FUNPACK is a collection of FORTRAN subroutines to evaluate certain special functions. The individual subroutines are -

IDENTIFICATION	DESCRIPTION
NATSIO	F2IO Bessel function I-sub-0
NATSII	F2II Bessel function I-sub-1
NATSJO	F2JO Bessel function J-sub-0
NATSJI	F2JI Bessel function J-sub-1
NATSKO	F2KO Bessel function K-sub-0
NATSKI	F2KI Bessel function K-sub-1
NATSBESY	F2BY Bessel function Y-sub-nu
DAW	F1DW Dawson's integral
DELIPK	F1EK Complete elliptic integral of the first kind
DELIPE	F1EE Complete elliptic integral of the second kind
DEI	F1EI Exponential integrals
NATSPSI	F2PS Psi (logarithmic derivative of gamma function)
MONERR	F1MO Error monitoring package
4. **METHOD OF SOLUTION** - FUNPACK uses evaluation of minimax approximations.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** -
6. **TYPICAL RUNNING TIME** -
7. **UNUSUAL FEATURES OF THE PROGRAM** - These routines have been certified under the NATS project for the machines and operating systems indicated in item 13 and for the compilers indicated in item 12. Extensive testing on these machines has shown no evidence of performance difficulties. Exceptions follow -

CDC versions of these subroutines are tuned to perform best using the rounded arithmetic option on CDC compilers.

The accuracy of the subroutines for the elementary functions (EXP, ALOG, etc.) can affect the accuracy of FUNPACK subroutines.

The IBM version of this package assumes the IBM-supplied traceback subroutine ERRTRA is available.

The NATS project fully supports certified routines in the sense that reports of poor or incorrect performance on at least the machines and operating systems listed will be examined and necessary corrections made. This assurance of support applies only when the software is obtained directly from the National Energy Software Center and has not been modified.
8. **RELATED AND AUXILIARY PROGRAMS** - FUNPACK Release 2 replaces FUNPACK, an earlier package submitted in July 1973 and distributed by the Center as NESC No. 610 prior to this release. Subroutines identified as F1xx in item 3 above are unmodified from the previous release, with the possible exception of the test material for the IBM machines.
9. **STATUS** - Abstract first distributed July 1973.

IBM360,370 version of FUNPACK submitted August 1973, replaced by FUNPACK Release 2 September 1976, replaced by revised Edition B July 1977, sample problems executed by NESC September 1976 on an IBM370/195.

CDC6000-7000 version of FUNPACK submitted August 1973, replaced by FUNPACK Release 2 September 1976, replaced by revised Edition B July 1977, sample problems executed by NESC October 1976.

UNIVAC1108 version of FUNPACK submitted August 1973, replaced by UNIVAC1108,1110 version of FUNPACK Release 2 September 1976, replaced by revised Edition B July 1977.

10. REFERENCES - J. M. Blair and C. A. Edwards, Stable Rational Minimax Approximations to the Modified Bessel Functions $I_0(x)$ and $I_1(x)$, AECL-4928, 1974.
 J. M. Blair and A. E. Russon, Rational Minimax Approximations for the Bessel Functions $K_0(x)$ and $K_1(x)$, AECL-3461, 1969.
 W. J. Cody, Chebyshev Approximations for the Complete Elliptic Integrals K and E, Mathematics of Computation, Vol. 19, pp. 105-112, 1965.
 W. J. Cody, R. M. Motley, and L. W. Fullerton, The Computation of Real Fractional Order Bessel Functions of the Second Kind, Applied Mathematics Division Technical Memorandum No. 291, Argonne National Laboratory, 1976.
 W. J. Cody, K. A. Paciorek, and H. C. Thacher, Jr., Chebyshev Approximations for Dawson's Integral, Mathematics of Computation, Vol. 24, pp. 171-178, 1970.
 W. J. Cody, A. J. Strecok, and Henry C. Thacher, Jr., Chebyshev Approximations for the Psi Function, Mathematics of Computation, Vol. 27, pp. 123-127, 1973.
 W. J. Cody and Henry C. Thacher, Jr., Rational Chebyshev Approximations for the Exponential Integral $E_1(x)$, Mathematics of Computation, Vol. 22, pp. 641-649, 1968.
 W. J. Cody and Henry C. Thacher, Jr., Rational Chebyshev Approximations for the Exponential Integral $E_i(x)$, Mathematics of Computation, Vol. 23, pp. 289-303, 1969.

11. MACHINE REQUIREMENTS -

12. PROGRAMMING LANGUAGES USED -

FORTRAN IV(G)	IBM360/75, 195, IBM370/165, 195
FORTRAN IV(G 21)	IBM360/65, 75, 91, IBM370/158
FORTRAN IV(G1)	IBM360/75, 195
FORTRAN IV(H)	IBM360/65, 67, 75, 195, IBM370/165
FORTRAN IV(H 20.1)	IBM360/65, 75, 195, AMDAHL470V/6
FORTRAN IV(H 21.6)	IBM360/75, 91
FORTRAN IV(H 21.7)	IBM360/75
FORTRAN IV(H 21.8)	IBM360/65
FORTRAN IV(H Extended)	IBM370/195
FORTRAN IV(H Extended 2.1)	IBM360/75, 91, IBM370/168, 168-II
FORTRAN IV(WATFIV)	IBM360/67
FORTRAN IV(WATFIV 1.4)	IBM370/158
FTN	CDC6400, 6500
FTN(4.642)	CDC6600, CY173, 175
FTN(3.0)	CDC6400
RUN	CDC6400, 6500, 6600-6400, 7600
RUN(2.3)	CDC6400
FUN	CDC6400-6500, 6600, 6700
FTN V	UNIVAC1108
FTN V(S10A-0)	UNIVAC1108
FTN V(MACC 1.175)	UNIVAC1110

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -

OS/360	IBM360/67
OS/360(19.6)	IBM360/65
OS/360(20.1)	IBM370/165
OS/360(20.7)	IBM360/75, 195
OS/360(21.0)	IBM360/75, 91
OS/360(21.7)	IBM360/75, 370/195
OS/360(21.8)	IBM360/75
OS/MVT(21.7)	IBM370/165-II
OS/MVT(21.8)	IBM360/65, 91, IBM370/158
OS/VS2(1.6)	IBM370/168
MTS	IBM360/67, AMDAHL470V/6
Stanford University	IBM360/67
Purdue University	CDC6500, 6400-6500
Lawrence Berkeley Laboratory	CDC6600, 7600
Lawrence Livermore Laboratory	CDC6600, 7600
NCAR	CDC6600, 7600
SCOPE(3.3)	CDC6400
SCOPE(3.4)	CDC6600
UT2D	CDC6600-6400

EXEC 8	UNIVAC1108
EXEC 31.244E	UNIVAC1108
EXEC MACC 31.66	UNIVAC1110

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

Locations and machines used for FUNPACK testing were -

Machine	Test Site
IBM360/65, IBM370/158	Ames Laboratory, Iowa State University
IBM360/75, 195, 370/195	Argonne National Laboratory
IBM360/75, 91	Oak Ridge National Laboratory
IBM360/67, 91, 370/168	Stanford University
IBM360/75	Stockholm Data Center
IBM360/65	The University of Chicago
IBM360/75	University of Illinois at Urbana-Champaign
IBM360/67, AMDAHL470V/6	The University of Michigan
IBM360/67	The University of New Mexico
IBM370/165, 165-II	University of Toronto
CDC6600	Kirtland Air Force Base/AFWL
CY173, 175	ICASE/NASA Langley Research Center
CDC6600, 7600	Lawrence Berkeley Laboratory
CDC6600, 7600	Lawrence Livermore Laboratory
CDC6600, 7600	National Center for Atmospheric Research
CDC6400	Northwestern University
CDC6400-8500	Purdue University
CDC6600-6400	The University of Texas at Austin
UNIVAC1108	Illinois Institute of Technology
UNIVAC1108	Jet Propulsion Laboratory
UNIVAC1108, 1110	University of Wisconsin

15. NAME AND ESTABLISHMENT OF AUTHOR -

Author W. J. Cody

Contact Burton S. Garbow
Applied Mathematics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (370-3902 cards, 7600-3983 cards, 1110-4115 cards)
Demonstration program source decks (370-2083 cards, 7600-2151 cards, 1110-2211 cards)
Demonstration output (370-61 pages, 7600-58 pages, 1110-44 pages)
Machine-readable documentation (370-4532 cards, 7600-4518 cards, 1110-4518 cards)

17. CATEGORY - P

KEYWORDS - special functions, integrals, errors, Bessel functions, gamma function

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - CHILES
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - CHILES is a finite element computer program that calculates the strength of singularities in linear elastic bodies. Plane stress, plane strain, and axisymmetric conditions are treated. Crack tip singularity problems are solved by this version of the code, but any type of integrable singularity may be properly modeled by modifying selected subroutines in the program.
4. METHOD OF SOLUTION - A generalized, quadrilateral finite element that includes a singular point at a corner node is incorporated in the code. The displacement formulation is used and inter-element compatibility is maintained so that monotone convergence is preserved.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - CHILES allows three singular points to be modeled in the body being analyzed and each singular point may have coupled Mode I and II deformations. 1000 nodal points may be used.
6. TYPICAL RUNNING TIME - Less than 2 minutes is required for a typical problem.
7. UNUSUAL FEATURES OF THE PROGRAM - A pre-created mesh may be read from an external file and computed results are written on an external file for plotting.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed April 1974.
CDC6600 version submitted January 1974.
10. REFERENCES - S. E. Benzley and Z. E. Beisinger, CHILES - A Finite Element Computer Program that Calculates the Intensities of Linear Elastic Singularities, SLA-73-0894, September 1973.
S. E. Benzley, Representation of Singularities with Isoparametric Finite Elements, International Journal for Numerical Methods in Engineering, (to be published).
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN (FORTRAN Extended)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.3.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
S. E. Benzley and Z. E. Beisinger
Analytical Development Division 1541
Sandia Laboratories
P. O. Box 5800
Albuquerque, New Mexico 87115
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (1688 cards)
Sample problem (218 cards)
Reference report, SLA-73-0894
17. CATEGORY - I
KEYWORDS - two-dimensional, elasticity, finite element method, numerical solution, solids, stresses, strains, fracture properties
18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - QMESH/RENUM
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC6600, IBM360,370/195
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - QMESH generates meshes having quadrilateral elements on arbitrarily shaped two-dimensional (planar or axisymmetric) bodies. The main intended application is in finite element analysis. A flexible hierarchical input scheme is used to describe bodies to QMESH as collections of regions. A mesh for each region is developed independently, with the final assembly and bandwidth minimization performed by the separate program, RENUM.
4. **METHOD OF SOLUTION** - The mesh generating process for each individual region begins with the installation of an initial mesh which is a transformation of a regular grid on the unit square. The dimensions and orientation of the initial mesh may be defined by the user or, optionally, may be chosen by QMESH. Various smoothing algorithms (some of which are new) may be applied to the initial mesh if desired. Then, the mesh may be "restructured" using an iterative scheme involving "element pair restructuring", "acute element deletion", and smoothing. In element pair restructuring, the interface side between two elements is removed and replaced between two different nodes belonging to the pair of elements, provided that the change produces an overall improvement in the shapes of the two elements. In acute element deletion, an element having one diagonal much shorter than the other is deleted by collapsing the short diagonal to zero length. The exact order in which restructuring, element deletion, and smoothing are performed may be controlled by use of a "scheme" input card. The scheme card also allows the user to control plotting and printing. The resulting mesh descriptions for individual regions are melded into an integrated mesh by the companion program, RENUM, which also performs bandwidth minimization using a modified Cuthill-McKee algorithm. The resulting tape file is complete with flags for use in applying boundary conditions.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - QMESH can process up to 25 regions, each having as many as 600 nodes. The maximum number of regions may easily be increased with little increase in program size, but increasing the maximum number of nodes per region is more costly. RENUM can process meshes having up to 2000 elements.
6. **TYPICAL RUNNING TIME** - Meshes of up to several hundred elements which do not require restructuring are handled by QMESH in a few seconds. Large meshes involving much restructuring and smoothing may require several minutes of execution time. RENUM requires a few seconds at most.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The hierarchical input system used in QMESH is quite natural and allows inclusion of such structures as cracks and sliding interfaces. A variety of mesh-smoothing techniques, some new, are available in QMESH. The application of restructuring techniques to automatically improve the shapes of the elements is a powerful new capability. An unusual degree of user control over the program operation is made possible by the use of the scheme card.
8. **RELATED AND AUXILIARY PROGRAMS** - QMESH is a stand-alone mesh generation program intended for use with a variety of two-dimensional finite element analysis programs.
9. **STATUS** - Abstract first distributed December 1974.
CDC6600 version submitted August 1974.
IBM360 version submitted August 1975, sample problem executed by NESC August 1975 on an IBM370/195.
10. **REFERENCES** - R. E. Jones, QMESH: A Self-organizing Mesh Generation Program, SLA-73-1088, July 1974.
R. E. Jones, User's Manual for QMESH, A Self Organizing Mesh Generation Program, SLA-74-0239, July 1974.
R. E. Jones, Comments on Converting QMESH and RENUM to Various Computer Systems, August 1974.
ACC Programming Note 75-15, December 1974.

ACC Programming Note 75-26, February 17, 1975. Revised September 24, 1975.

11. **MACHINE REQUIREMENTS** - 42,000 (decimal) words and an SD4020 plotter (CDC6600), 280K bytes and a CalComp 936 plotter (IBM360).
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 3.3 (CDC6600), OS/360,370 (IBM360,370).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - For the CDC6600 version, the SCORS plotting package is assumed to be available. ENCODE and DECODE statements are used in QMESH, but they can be eliminated if necessary. Suggestions to aid in conversion to other systems are supplied with the program. The IBM360 version uses standard CalComp plotter routines. The test problem for the CDC6600 version was not executed by NESC because the SCORS package was not available.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
6600 R. E. Jones, Division 2642
Sandia Laboratories
P. O. Box 5600
Albuquerque, New Mexico 87115

360 H. E. Edwards
National Energy Software Center
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (QMESH 6600-5610 cards, 360-5908 cards; RENUM 6600-994 cards, 360-1010 cards)
Sample problem (QMESH 33 cards)
Control information (JCL 360-98 cards)
Sample problem output (7 pages and 5 plots)
Reference reports and Notes
17. **CATEGORY** - L
KEYWORDS - mesh generation, finite element method, bandwidth minimization
18. **SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - NRTS ENVIRONMENTAL SUBROUTINES

2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
IBM360, 370

3. DESCRIPTION OF PROBLEM OR FUNCTION - The NRTS ENVIRONMENTAL SUBROUTINES are a collection of routines designed to aid the programmer by providing extensions to the FORTRAN language, data management services, and programming aids.

ASTEM evaluates the 1967 ASME equations of state for water/steam and derivatives of these equations.

DOUT extracts decks from a file and writes each deck as a separate file so that they can be processed by the assembler which can handle only one deck per step.

UMRG is used to merge parts of update tapes.

UPD is used to update source decks.

STHG generates water thermodynamic property tables.

AND, IAND, DAND, OR, IOR, and DOR give the logical product (and) and logical sum (or) for 4 and 8-byte words.

CVI converts EBCDIC information to binary information.

COMPAR compares a character string beginning at location a(i) with another character string beginning at location b(j). The comparison is made one character at a time and terminated after all requested characters are tested or after the first inequality is found.

DATE converts the Julian date maintained by the OS operating system into the form mm/dd/yy where mm is the month, dd the day, and yy the year.

FABEND causes an abnormal termination of the job step, and a core dump is printed if a SYSUDUMP or SYSABEND DD card is included in the job step JCL.

The FETCH function returns the value of the variable whose address is specified as the argument.

The extended IBCOM# routine provides automatic page control, and optionally, permits from one to three lines to be inserted as page headings in the output to a specified sysout unit.

The INP set of subroutines, a data input package for use with FORTRAN programs, is a conversion of the INPF FORTRAN package written by Bettis for the CDC6600 and can be used in the conversion of Bettis programs that use INPF.

INFILQ is an incore read and write subroutine that modifies IBCOM# in such a way that the next read or write request causes information in the user's list to be placed in a core buffer.

JSIDZZ returns the name of the job entered on the name field of the job card.

JULIAN returns a 5-byte numeric Julian date in EBCDIC characters from the OS operating system.

LOCFCN returns the absolute core address of the variable specified as the argument.

MAINS and MAIND are matrix inversion subroutines in single- and double-precision, respectively.

MOVE transfers data assumed to be in character, full-word, or double-word form from one array to a second array.

RUNOUT can be used to obtain a second copy of the printed output.

ISL, ISR, ISRL, SL, SR, SRL, DSL, DSR, and DSRL are arithmetic and logical shift functions for 4 and 8-byte words.

The interval TIME routine provides the user with the means of determining the elapsed time of his task.

TYME will return the time of day as the second argument.

VOLSER provides the volume serial number(s), data set name, and creation date of data sets residing on peripheral devices (disk or tape units).

ZEROUT sets to zero an arbitrary length of sequential 8-byte words beginning on a double-word boundary.

The FTB package is a set of subroutines for controlling dynamic storage allocation in fast core, bulk core, four disk data sets, and one drum data set and performing the I/O operations to disk and drum storage.

Subroutine FLINK allows access to the LINK macro.

The FIOSET routine is used to override the FORTRAN convention for naming DD cards.

REMTYM gives the user access to his unused CPU time.

The standard CalComp plotter subroutines are also part of the package.

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The Integrated Graphics System (IGS) used at the Rand Corporation to support an SC4060 stored-program recording system is also included.

- 4. METHOD OF SOLUTION -**
- 5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** In Edition B of the STH20 water property package a pressure restriction has been removed and pressure-enthalpy (STH205) and pressure-internal energy (STH206) subroutines are included.
- 6. TYPICAL RUNNING TIME -**
- 7. UNUSUAL FEATURES OF THE PROGRAM -**
- 8. RELATED AND AUXILIARY PROGRAMS -**
- 9. STATUS -** Abstract first distributed November 1974.
IBM360 version submitted August 1974, replaced by Edition B February 1975.
- 10. REFERENCES -** NRTS Environmental Subroutine Manual, December 1972.
R. J. Wagner, L. C. Richardson, and N. H. Marshall, FORTRAN Callable Subroutines that Facilitate Modular Programming, ANCR Note, March 1973.
G. J. Moore, Time Remaining (RENTYM), ANCR Note, February 1973.
A. J. Smith, Standard Package Description, CalComp Plotter Subroutines (S0010.0), Appendix D, January 1971.
G. D. Brown, C. H. Bush, and R. A. Berman, The Integrated Graphics System for the SC-4060: I. User's Manual, Memorandum RM-5660-PR, December 1968.
W. H. Rettig, R. C. Young, and N. H. Marshall, UPD - A Program of Update Source Decks, P01751, and Addendum.
K. V. Moore, ASTEM - A Collection of FORTRAN Subroutines to Evaluate the 1967 ASME Equations of State for Water/Steam and Derivatives of These Equations, ANCR-1026, October 1971.
NRTS ENVIRONMENTAL SUBROUTINES, ACC Programming Note 75-6, November 1974.
R. J. Wagner, STH20, A Subroutine Package to Compute the Thermodynamic Properties of Water, ANCR Note, 1975.
- 11. MACHINE REQUIREMENTS -**
- 12. PROGRAMMING LANGUAGES USED -** FORTRAN IV and Assembly language
- 13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/360,370.
- 14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** Because several of the routines in the environmental package have the same name as similar routines in the automatic call library, care must be taken in the link-edit step to ensure that the correct routine is loaded.
- 15. NAME AND ESTABLISHMENT OF AUTHOR -**
R. J. Wagner
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401
- 16. MATERIAL AVAILABLE -** Magnetic Tape Transmittal
Source deck (22,103 cards)
Load modules (2314 and 3330 ENVIR 559 blocks)
Reference reports, Notes, and Memorandum
- 17. CATEGORY - P**
KEYWORDS - data processing, thermodynamic properties, matrices, utility routines
- 18. SPONSOR -**

1. NAME OR DESIGNATION OF PROGRAM - HISTOGRAMS
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
IBM360,370/195
3. DESCRIPTION OF PROBLEM OR FUNCTION - HISTOGRAMS provides graphical representation of lot sample characteristics in the form of histogram bars. On large lot samples, if a histogram bar should exceed fifty units, the entire histogram plot is automatically scaled by the smallest integer that will cause the largest frequency to fall within the maximum plot of fifty units. The number of cells in the histogram can vary from 3 to 22. The equal intervals are determined by the difference of the upper and lower boundaries divided by the number of cells less two. In addition to the plot, the program provides statistical characteristics in the form of: the mean, standard deviation, skewness, kurtosis, range, number of standard deviations between the mean and the two specification limits, and up to nineteen values falling outside the boundary limits.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - A maximum of 22 cells can be plotted.
6. TYPICAL RUNNING TIME - Less than 1 second is required for a typical problem.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - This program is the ALO-00187 program transferred from the ALO-COSMIC collection.
9. STATUS - Abstract first distributed October 1974.
IBM360 program submitted September 1974, sample problem executed by NESC on IBM370/195.
10. REFERENCES - Analysis of Data - HISTOGRAMS, Bendix Corporation Computer Program Report QC6A, July 25, 1966.
11. MACHINE REQUIREMENTS - 18K bytes for program, 27K bytes for load module
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360,370.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
L. A. Elrod and G. C. Hynes
Kansas City Division
Bendix Corporation
P. O. Box 1159
Kansas City, Missouri 64141
16. MATERIAL AVAILABLE -
Source deck (235 cards)
Object deck (78 cards)
Sample problem (85 cards)
Sample problem output (8 pages)
Reference report
17. CATEGORY - P
KEYWORDS - statistics, computer graphics, quality control
18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - REXCO-H (Release 2)
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360/195
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - REXCO-H calculates the two-dimensional hydrodynamic response of primary reactor containment to a high-energy excursion.
4. **METHOD OF SOLUTION** - The equations of hydrodynamics and the equations of state of reactor materials are expressed in Lagrangian form and set into finite difference equations. Shock discontinuities are eliminated by the use of the von Neumann-Richtmyer pseudoviscosity factor, q . Propagation of shock waves, loads imposed on different parts of the reactor components and the resulting damage are determined at every time-step, until the vessel ruptures or the force acting on the shield plug exceeds the strength of the plug holddown device. Calculated displacements and pressures at all spatial points at any instant of time also are given in pictorial form.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Maxima of -
 - 3000 grid zones
 - 1000 cycles if CalComp display is required
 - 20 materials
 - 20 sections
 - 10 reactor vessels
 - 50 points for stress-strain table for reactor material
6. **TYPICAL RUNNING TIME** - About 1 minute is required for 200 cycles for the sample problem.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The reactor vessels in this program are treated as thin shell structures.
8. **RELATED AND AUXILIARY PROGRAMS** - PLOT3D (NESC Abstract 544) and REXCO-H, Release 1 (NESC Abstract 550). Release 2 is an improved version of REXCO-H. It provides 3-D CalComp output, additional equations of state for reactor materials, and use of 2-D stresses in treatment of reactor vessels.
9. **STATUS** - Abstract first distributed December 1973.
IBM360 version submitted October 1973, sample problem executed by NESC November 1973.
10. **REFERENCES** - Y. W. Chang, J. Gvildys, and S. H. Fistedis, Two-dimensional Hydrodynamics Analysis for Primary Containment, ANL-7498, November 1969.
 REXCO-H (Release 2) Input Information Required, ANL-RAS Memorandum, October 26, 1971.
 Y. W. Chang, J. Gvildys and S. H. Fistedis, Hydrodynamic Response of Primary Reactor Containment to High-energy Excursion, Nuclear Engineering and Design, Vol. 12, pp. 344-360, 1970.
 Y. W. Chang and J. Gvildys, Dynamic Response of Reactor Containment to High-energy Excursion, Proceedings of The 1st International Conference on Structural Mechanics in Reactor Technology, Berlin, Germany, 1971.
 D. Basinger and J. Gvildys, Three Dimensional Representation of Surfaces by Computer, ANL-7633, November 1971.
 J. von Neumann and R. D. Richtmyer, A Method of the Numerical Calculation of Hydrodynamic Shocks, Journal of Applied Physics, Vol. 21, pp. 232-237, 1950.
 J. E. Ash and R. T. Julke, Comparison of a Two-dimensional Hydrodynamics Code (REXCO) to Excursion Reactor Containment, ANL-7911, January 1972.
 J. E. Ash, Y. W. Chang, and R. T. Julke, Comparison of a Two-dimensional Hydrodynamic Code (REXCO) to Excursion Experiments for Fast Reactor Containment, ANL-9711, Suppl. 1, July 1972.
11. **MACHINE REQUIREMENTS** - 700K bytes of core, two 9-track tape units, one 7-track tape unit, IBM 2280 film recorder, CalComp 780 plotter

- 12. PROGRAMMING LANGUAGE USED - FORTRAN IV**
- 13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.**
- 14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** To execute the pictorial display, the program uses the ANL Environmental Routines described in ANL-AMD Technical Memorandum No. 167, A Film-Plotting Subroutine Package (FSP) for the 2280 Film Recorder, by D. Carson, June 17, 1968, and to execute the CalComp plots, the program uses the routines described in ANL-AMD Technical Memorandum No. 130, S/360 Programming Techniques for the CalComp 780, by R. F. Krupp, January 6, 1967.
- 15. NAME AND ESTABLISHMENT OF AUTHORS -**
Y. W. Chang, J. Gvildys, and S. H. Fistedis
Reactor Analysis and Safety Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
- 16. MATERIAL AVAILABLE - Restricted Distribution**
Magnetic Tape Transmittal
Source decks (3951 cards)
Sample problem (46 cards)
Control information (JCL 57 cards)
Sample problem output (57 selected pages, 3 selected plots)
Reference report, ANL-7498, and ANL-RAS Memorandum
- 17. CATEGORY - F**
KEYWORDS - two-dimensional, containment, excursions, hydrodynamics, reactor safety, fast reactors, PLOT3D codes
- 18. SPONSOR -**

1. **NAME OR DESIGNATION OF PROGRAM** - HAFMAT
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC6600,7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - HAFMAT was developed for the calculation of the steady-state distribution of flow to all paths of any given flow system when the flow geometry and heat addition are specified for every flow path and the system boundary conditions are defined. The system is considered as a network of flow paths or pipes.
4. **METHOD OF SOLUTION** - To calculate the distribution of flow within a given system the internal flow geometry must be described and a reference pressure and enthalpy must be specified for at least one node in the network. The flow geometry is represented by a finite number of flow paths which account for all of the fluid volume. These flow paths, joined at a number of points, form a single flow network. The junctions of the networks, or nodes, do not have any capacity for heat or flow. An initial flow distribution is specified by the user or calculated by the program. For the given geometry, heat addition, and inlet enthalpy, a pressure drop is calculated for each branch or flow path. By a matrix technique, the static pressure at each node is calculated and a self-consistent new flow distribution is obtained. The program then iterates through new flow distributions, new values of enthalpy, and recalculation of pressure drops until convergence is achieved or the iteration limit is reached. The user may supply his own pressure-drop equations if the pre-programmed ones are not appropriate.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - HAFMAT has the capacity to treat networks composed of up to 90 nodes and 200 branches. Other maximum values which must not be exceeded are:
 - 20 external branches
 - 20 external nodes
 - 100 heated branches
 - 40 types of heated branchesBasic assumptions employed are that complete and instantaneous mixing of fluid occurs at all nodes and all flows which join at a node see the same static pressure at that node.
6. **TYPICAL RUNNING TIME** - The sample problem used approximately 5 seconds of CPU time.
7. **UNUSUAL FEATURES OF THE PROGRAM** - An optional special convergence technique is supplied. It should be used with caution, but it has been found useful, for example, when a few high-resistance flow paths have otherwise retarded convergence.
8. **RELATED AND AUXILIARY PROGRAMS** - FLOPSY-I, an earlier program, treated only isothermal flow problems. The original version of HAFMAT.
9. **STATUS** - Abstract first distributed March 1975.
CDC6600 version submitted October 1974, sample problem executed by NESC January 1975 on a CDC6600 and CDC7600.
10. **REFERENCES** - L. H. Wunderlich and D. R. Dolk, HAFMAT - Steady-state Flow Distribution Program, KAPL-M-7128(LXW-2), July 6, 1970.
11. **MACHINE REQUIREMENTS** - 76,000 (octal) words of core
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 3.2.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Increased flow in any branch must lead to an increased pressure drop in that branch. Otherwise, it is possible that no solution can be obtained. In preparing input decks, follow the input sheets on pages 20-22 of the reference report. The input decks which are listed in Section VI of the report were punched for a system which will accept left-justified integer input. This is not a

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standard CDC practice and will lead to input errors at many installations. Also, some variables in HAFMAT are not initialized. It is assumed that the operating system will zero the memory at load time.

16. NAME AND ESTABLISHMENT OF AUTHORS -

L. H. Wunderlich and D. R. Dolk
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301

16. MATERIAL AVAILABLE - Restricted Distribution

Magnetic Tape Transmittal
Source deck (2212 cards)
Sample problem (29 cards)
Sample problem output (17 pages)
Reference report

17. CATEGORY - H

KEYWORDS - fluid flow, steady-state conditions, heat transfer, pipes, FLOPSY-1 codes

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - KEFF, MGBS, TGAN
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - Three codes for nuclear criticality safety evaluations make up this package. The principal codes are a code for computing the buckling of fissile material moderated by water (MGBS) and a two-group diffusion theory code that uses parameters generated by the buckling code (TGAN). KEFF is an auxiliary code. KEFF computes keff from dimensions and extrapolation distances, or alternative dimensions, volumes, and masses corresponding to values of keff.
4. **METHOD OF SOLUTION** - KEFF bases its calculation on
$$keff = (1 + (m \cdot 2) \cdot bm \cdot 2) / (1 + (m \cdot 2) \cdot bg \cdot 2)$$
 where $bm \cdot 2$ and $bg \cdot 2$ are material and geometric bucklings, respectively. MGBS solves 80 equations in 12 groups and iterates to determine buckling. For heterogeneous systems MGBS performs a P3 cylinder calculation for the thermal group and makes use of the Hellstrand or Weitman resonance integral where appropriate for the resonance group. Otherwise, the system is homogenized. MGBS adjusts two-group constants to account for the different leakage expression in diffusion theory. TGAN solves two-group equations analytically by varying a dimension or the transverse buckling for criticality. TGAN permits some regions (e.g. thin and highly absorbing) to be characterized by transmission and escape probabilities.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - MGBS allows a maximum of 23 regions and 9 types of material. TGAN is limited to 6 diffusion regions and 6 transmission regions.
6. **TYPICAL RUNNING TIME** - Each program requires only a few seconds.
7. **UNUSUAL FEATURES OF THE PROGRAM** - Speed, convenience, and many correlations (in conjunction with two-group diffusion theory) with critical experiments make MGBS particularly suitable for criticality safety problems. In a criticality search TGAN recognizes terms in matrix products that are identically zero. Less care is taken with separate calculation of fluxes, which may be grossly in error. Speed, convenience, and many correlations (in conjunction with MGBS) with critical experiments make TGAN particularly suitable for criticality safety problems.
8. **RELATED AND AUXILIARY PROGRAMS** - TGAN punches keff input for dimension search for slabs, cylinders, and spheres. MGBS punches two-group cross sections for TGAN.
9. **STATUS** - Abstract first distributed October 1974. IBM360 version submitted September 1973, sample problems executed by NESC.
10. **REFERENCES** - H. K. Clark, Computer Codes for Nuclear Criticality Safety Calculations, DP-1121, November 1967.
H. K. Clark, Correlations of Computational Techniques and Experiments, DPST-71-300, March 30, 1971.
11. **MACHINE REQUIREMENTS** - 100K bytes of core are required for KEFF, 150K bytes of core for MGBS, and 135K bytes of core for TGAN.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** -
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
H. K. Clark
Savannah River Laboratory
E. I. duPont de Nemours and Company, Inc.
Aiken, South Carolina 29801

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- 16. MATERIAL AVAILABLE -** Magnetic Tape Transmittal
Source decks (KEFF 259 cards, MGBS 2545 cards, TGAN 2488 cards)
Sample problems (KEFF 2 cards, MGBS 26 cards, TGAN 102 cards)
Sample problem output (KEFF 1 page, MGBS 3 pages, TGAN 7 pages)
Reference reports, DP-1121 and DPST-71-300
- 17. CATEGORY - C**
KEYWORDS - criticality, buckling, group constants, cell calculation, one-dimensional, two-group
- 18. SPONSOR -**

1. **NAME OR DESIGNATION OF PROGRAM** - GAPCON-THERMAL2
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - GAPCON-THERMAL2 was developed as a tool for estimating fuel-cladding gap conductances and fuel stored energy. GAPCON-THERMAL2 makes nuclear fuel pin steady-state thermal performance predictions, using models which include power history, fission gas generation and release, fuel relocation and densification, and fuel cladding gap conductance. The gas release and relocation models can be used to make either best estimate or conservative predictions.
4. **METHOD OF SOLUTION** - The method consists of iterative convergence for each axial fuel mode, followed by iterative convergence on the total fuel pin internal gas inventory for each time-power step.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** -
 - (a) The first time-step must be zero time.
 - (b) The second time-step cannot be at zero power.
 - (c) The maximum number of axial nodes is 15.
 - (d) The maximum number of time-steps is 20.
6. **TYPICAL RUNNING TIME** - It takes about 1 to 3 minutes to run a typical problem, including about 20 seconds for compilation.
7. **UNUSUAL FEATURES OF THE PROGRAM** - Most models have been compared individually with experimental data; however, the code as a whole has not been adjusted to conform to any set of data.
8. **RELATED AND AUXILIARY PROGRAMS** - This program was prepared as a modification of GAPCON-THERMAL1 to reduce the uncertainties associated with the calculation of power history and burnup effects.
9. **STATUS** - Abstract first distributed March 1974.
UNIVAC1108 version of GAPCON-THERMAL1 submitted October 1973, replaced by revised Edition B, October 1975, deleted January 1976.
CDC6600 version of GAPCON-THERMAL2 submitted January 1976, sample problem executed by NESC March 1976 on a CDC6600 via remote terminal to Brookhaven National Laboratory.
10. **REFERENCES** - C. E. Beyer, C. R. Hann, D. D. Lanning, F. E. Panisko and L. J. Parchen, GAPCON-THERMAL-2: A Computer Program for Calculating the Thermal Behavior of an Oxide Fuel Rod, BNWL-1898, November 1975.
C. E. Beyer, C. R. Hann, D. D. Lanning, F. E. Panisko and L. J. Parchen, User's Guide for GAPCON-THERMAL-2: A Computer Program for Calculating the Thermal Behavior of an Oxide Fuel Rod, BNWL-1897, November 1975.
11. **MACHINE REQUIREMENTS** - About 60K words of core memory is needed for compilation and execution.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 3.4.2.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The source code consists of 20 subroutines, 6 functions, 1 COMDECK and the GAPCON main program.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
C. E. Beyer, C. R. Hann, D. D. Lanning,
F. E. Panisko, and L. J. Parchen
Pacific Northwest Laboratories
Battelle

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P. O. Box 999
Richland, Washington 99352

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (2589 cards)
Sample problem (10 cards)
Reference reports

17. CATEGORY - I

KEYWORDS - fuel rods, steady-state conditions, thermal conductivity, performance, LWR reactors, GAPCON-THERMAL1 codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ISOTAB
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360/50
3. DESCRIPTION OF PROBLEM OR FUNCTION - Given measured calorimeter measurement dates and the isotopic composition for a plutonium sample, ISOTAB computes for a sample of mixed isotopes (Pu238, Pu239, Pu240, Pu241, Pu242, and Am241) a table between two specified dates. The table contains: a) the power output (in watts), b) the specific power (in milliwatts/gram), c) the total plutonium mass (in grams), and d) the estimated error (in grams) for each date in the table. If you do not desire all the table values printed between the table start date and the table end date, a table interval greater than one day may be specified.
4. METHOD OF SOLUTION - The theory and an outline of the calculations are given in the American National Standards Institute document N15.22-1975 titled, "Calibration Techniques for the Calorimetric Assay of Plutonium-Bearing Solids Applied to Nuclear Materials Control". The program requires for input the isotopic composition and power of the sample, with corresponding uncertainties and dates. It calculates the effective chemical separation date; then the table values are calculated for any date from the chemical separation date forward.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - This program cannot be used for samples containing Pu236.
6. TYPICAL RUNNING TIME - Five to six minutes are required for a sample problem.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed May 1974.
IBM360 version submitted September 1973, replaced by revised Edition B March 1978, sample problem executed by NESC May 1978 on an IBM370/195.
10. REFERENCES - J. Lemming, C. Rudy, M. Baston and F. Conkle, ISOTAB: PLU500RQ Job Documentation, Mound Laboratory Document, November 11, 1977.
F. A. O'Hara, J. D. Nutter, W. W. Rodenburg, and M. L. Dinsmore, Calorimetry for Safeguards Purposes - Determination of Plutonium in Reactor Feed Material, MLM-1978, January 5, 1972.
11. MACHINE REQUIREMENTS - 38K core, a card reader, and a printer
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 MVT, Release 21.6.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - ISOTAB was revised to simplify the input format for users and to use the constants from ANSI Standard N15.22-1975.
15. NAME AND ESTABLISHMENT OF AUTHORS -
J. Lemming, C. Rudy, M. Baston, and F. Conkle
Mound Laboratory
Monsanto Research Corporation
P. O. Box 32
Miamisburg, Ohio 45342
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (530 cards)
Sample problem (8 cards)
Control information (JCL 27 cards)
Reference report and Document

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- 17. CATEGORY - Q**
KEYWORDS - calorimetry, fuel elements, plutonium, americium
- 18. SPONSOR -**

1. **NAME OR DESIGNATION OF PROGRAM** - GROUP2
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360,370/195, CDC6600,7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - This program calculates the symmetry properties of lattice vibrations either for atomic crystals or for external modes of molecular crystals and generates the irreducible multiplier representations (IMR's) including the effects of time reversal invariance (TRI) on the symmetry coordinates.
4. **METHOD OF SOLUTION** - The invariance of the dynamical matrix under unitary transformations by matrices in a reducible multiplier representation of the time reversal invariant point group of the wavevector leads to a formula for the symmetry-reduction of the dynamical matrix. The projection operator method is used to construct the symmetry coordinates. The projection operator is dependent on the reducible multiplier representation used and the IMR's of the group of the wavevector. These IMR's are generated in the program by the method of orbitals from the representations of cyclic subgroups of the group of the wavevector which in turn are constructed from the roots of unity. The symmetry coordinate vectors form a matrix, which transforms the symmetry-reduced dynamical matrix into block-diagonalized form.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The program is dimensioned for up to 30 degrees of freedom per unit cell. This may be 10 atoms or 5 molecular units per unit cell or some combination of atoms and molecular units. Each atom has 3 degrees of freedom, and each molecular unit has 6. By changing a dimension statement, up to 60 degrees of freedom per unit cell may be considered. Because of the use of random numbers instead of algebraic techniques, the symmetry reduction will be incomplete for crystals of the D3 or C3 point groups. This same problem sometimes occurs for other crystals with a large number of atoms per unit cell.
6. **TYPICAL RUNNING TIME** - 10 seconds are required for all wave vectors of a crystal with two atoms per unit cell.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The program requires only the three lattice vectors, the atomic positions, and the desired wave vectors as input. It determines all of the symmetry properties in one pass. It will also calculate external modes of molecular crystals. Time reversal is considered in all calculations.
8. **RELATED AND AUXILIARY PROGRAMS** - ACMI/EM/IMR was an earlier version.
9. **STATUS** - Abstract first distributed November 1974.
IBM360 version submitted October 1974, sample problem executed by NESC October 1974 on an IBM370/195.
CDC6600 version submitted October 1974, sample problem executed by NESC October 1974 on a CDC7600.
10. **REFERENCES** - T. G. Worlton and J. L. Warren, Group Theoretical Analysis of Lattice Vibrations, Computer Physics Communications, Vol. 3, pp. 88-117, 1972.
T. G. Worlton and J. L. Warren, Erratum, Ibid., Vol. 4, pp. 382-383, 1972.
T. G. Worlton, External Modes of Molecular Crystals, Ibid., Vol. 4, pp. 249-256, 1972.
T. G. Worlton, Irreducible Multiplier Representations, Ibid., Vol. 6, pp. 149-155, 1973.
J. L. Warren and T. G. Worlton, Improved Version of Group-theoretical Analysis of Lattice Dynamics, Ibid., in press (October 1974).
J. L. Warren and T. G. Worlton, Symmetry Properties of the Lattice Dynamics of Twenty-three Crystals, ANL-8053 and LA-5465-MS, December 1973.
11. **MACHINE REQUIREMENTS** - The IBM360 version requires 240K bytes to compile and 230K bytes to execute. The CDC6600 version requires 55,000 (octal) words to compile, 125,000 (octal) words to execute.

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- 12. PROGRAMMING LANGUAGE USED - FORTRAN IV**
- 13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 (IBM360) and SCOPE 3.1 (CDC6600).**
- 14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** The input deck structure is indicated on comment cards in the main program. The system library or user must supply the function `RANF(N)` which produces a uniformly-distributed sequence of real random numbers. In the IBM version, $n=-1$; in the CDC, $n=0$. In some cases, the phase angle matrix and the block-diagonalized dynamical matrix are not fixed by symmetry considerations and may differ from the sample output. Also, other vectors may have different representations, depending on the specific implementation of the ATAN function.
- 15. NAME AND ESTABLISHMENT OF AUTHORS -**

6600	John L. Warren Los Alamos Scientific Laboratory P. O. Box 1663 Los Alamos, New Mexico 87544
360	Thomas G. Worlton Solid State Science Division Argonne National Laboratory 9700 South Cass Avenue Argonne, Illinois 60439
- 16. MATERIAL AVAILABLE - Magnetic Tape Transmittal**

Source decks (360-2288 cards, 6600-2290 cards)
Sample problems (360-35 cards, 6600-35 cards)
Sample problem output (360-7 pages, 6600-7 pages)
Reference preprint: Improved Version of Group-theoretical Analysis of Lattice Dynamics
- 17. CATEGORY - Q**
KEYWORDS - solid state physics, lattice vibrations, group theory, phonons, crystals
- 18. SPONSOR -**

1. NAME OR DESIGNATION OF PROGRAM - BH99
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - BH99 is used for the statistical analysis of data based on the extreme value distribution.
4. METHOD OF SOLUTION - The distribution function $f(x) = \exp(-e^{-(x-\mu)/\beta})$, called the extreme value distribution is used to describe a population each of whose elements may be looked upon as the maximum of a set of possible values. The density function is positively skewed. μ is a location parameter, the mode, while β is a scale parameter. The estimation problem is solved using two methods. One is where maximum likelihood estimates of μ and β are computed using an iterative scheme to solve the nonlinear normal equations. The other is by a method developed by Lieblein (reference 3) using the order statistics. The results of the fit using the method of maximum likelihood are printed and, for samples of sizes n less than 36, the results using order statistics are also given. This is followed by a frequency distribution of the observations.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - When fitting the distribution using order statistics, samples of sizes up to $n=35$ may be computed.
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM - For either method used, the estimates of μ and β are printed followed by estimates of several percentiles of the distribution together with their approximate 68 percent confidence intervals.
8. RELATED AND AUXILIARY PROGRAMS - BH99 uses the Bettis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed March 1974.
CDC6600 version submitted January 1974.
10. REFERENCES - T. Shimamoto, BH99 - A Program for the Statistical Analysis of Data Based on the Extreme Value Distribution, WAPD-TM-1137, August 1973.
C. J. Pfeifer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967.
J. Lieblein, A New Method of Analyzing Extreme-Value Data, NASA Technical Note 3053, January 1954.
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
T. Shimamoto
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
Pittsburgh, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (890 cards)
Sample problem (6 cards)
Reference report, WAPD-TM-1137

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17. CATEGORY - P

KEYWORDS - statistics, maximum-likelihood fit, distribution functions, data

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GAUSS6
 2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360/75
 3. DESCRIPTION OF PROBLEM OR FUNCTION - GAUSS6 is used for the production analysis of gamma-ray spectra obtained with a Ge(Li) detector and a multichannel pulse-height analyzer system. In addition to determining gamma-ray energies and intensities, it provides isotopic identification, decay corrections and correlation of data from different peaks and different spectra to obtain isotopic decay rates.
 4. METHOD OF SOLUTION - GAUSS6 carries out the following steps -
 - (a) Sorts master nuclide library to obtain a subset including only the nuclides of interest.
 - (b) Automatically locates peaks by means of an auto-correlation routine.
 - (c) Fits each peak with a Gaussian function plus a linear function representing the spectral background. Only the three Gaussian parameters (height, width, and position) are allowed to vary. The fit extends down to 1.5 times the width of the Gaussian (FWHM). Fits that fail to converge are repeated with a fixed width.
 - (d) Determines peak width and energy calibration functions from a Th228 spectrum. These functions as well as the energy calibration from any spectrum can be transferred to subsequent spectra.
 - (e) Attempts isotopic assignments for all peaks. Decay corrections are made.
 - (f) For spectra from the same sample, edits and averages the results to obtain the isotopic decay rates.
 5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - GAUSS6 will handle any number of spectra of up to 4096 channels with up to 300 peaks and 20 energy calibration lines. The subset of the isotopic library is limited to 1000 gamma rays.
 6. TYPICAL RUNNING TIME - Typical spectra can be analyzed at a rate of about 5 per minute.
 7. UNUSUAL FEATURES OF THE PROGRAM -
 8. RELATED AND AUXILIARY PROGRAMS - The program package includes the following auxiliary programs -
 - (a) LCTAPE for putting nonlinearity correction and efficiency tables on disk.
 - (b) UPDATE for updating the master nuclide library.
 - (c) RASLIB for producing a subset of the master nuclide library (normally run as part of the analysis run).
 - (d) MERGE for combining the output tapes from several GAUSS6 analyses.
 - (e) CORLAT for carrying out the comparison and averaging of the several measurements for each sample.
 - (f) LIBRER for generating a nuclide library data set from cards.
 - (g) SECLIB for generating a secondary library subset for CORLAT.
- GAUSS6 is based on GAUSS5 (NESC Abstract 605), but is written to analyze large groups of spectra efficiently and includes calculations beyond the gamma-ray energies and intensities and can compare results from different gamma-rays and different spectra to verify nuclide assignments for individual peaks.
9. STATUS - Abstract first distributed March 1974.

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IBM360 version submitted October 1973, sample problem executed by NESC February 1974.

10. **REFERENCES** - J. E. Cline, M. H. Putnam, and R. G. Helmer, GAUSS VI, A Computer Program for the Automatic Batch Analysis of Gamma-ray Spectra from Ge(Li) Spectrometers, ANCR-1113, June 1973.
R. G. Helmer and M. H. Putnam, GAUSS V, A Computer Program for the Analysis of Gamma-ray Spectra from Ge(Li) Spectrometers, ANCR-1043, January 1972.
GAUSS6, ACC No. 622, Argonne Code Center Programming Note 74-29, March 29, 1974.
11. **MACHINE REQUIREMENTS** - GAUSS6 requires storage devices for the spectral library, nuclide library subset, and the correlation data in addition to three scratch devices and the card reader and printer. CORLAT requires storage devices for the secondary library subset and the correlation data plus four scratch devices and the card reader and printer.
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV, BAL, PL/1
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360 MVT.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The CORLAT program requires the IBM360 SORT package.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
R. G. Helmer, J. E. Cline, and M. H. Putnam
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (GAUSS6 6640 cards, RASLIB 461 cards, LCTAPE 164 cards, LIBRER 182 cards, CORLAT 1824 cards, MERGE 248 cards, UPDATE 518 cards)
Load modules (GAUSS6 149 blocks, SECLIB 59 blocks, CORLAT 96 blocks)
Object deck (MERGE 14 cards)
Sample problems (GAUSS6 2533 cards, RASLIB 5 cards, LCTAPE 59 cards, LIBRER 10 cards, MERGE 1 card)
Control information (JCL GAUSS6 28 cards, RASLIB 11 cards, LCTAPE 8 cards, LIBRER 10 cards, CORLAT 130 cards, MERGE 14 cards, UPDATE 9 cards)
Reference reports and ACC Note
17. **CATEGORY** - W
KEYWORDS - gamma spectra, Li-drifted Ge detectors, isotopes, LIBRER codes, CORLAT codes, RASLIB codes, MERGE codes, UPDATE codes, SECLIB codes, GAUSS5 codes
18. **SPONSOR** -

1. **NAME OR DESIGNATION OF PROGRAM - SETS**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** SETS is used to achieve the symbolic manipulation of set (or Boolean) equations, particularly the reduction of set equations by the application of set identities.
4. **METHOD OF SOLUTION -** The SETS program is used to read, interpret, and execute the statements of a SETS user program which is an algorithm that specifies the particular manipulations to be performed and the order in which they are to occur.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Any properly formed set equation involving the set operations of union, intersection, and complement is acceptable for processing by the SETS program. Restrictions on the size of a set equation that can be processed are not absolute but rather are related to the number of terms in the disjunctive normal form of the equation, the number of literals in the equation, etc. Nevertheless, set equations involving thousands and even hundreds of thousands of terms can be processed successfully.
6. **TYPICAL RUNNING TIME -** Running time varies with respect to the particular set equations being processed and the symbolic manipulations being performed. Although no general rule for predicting run time is known, the reduction (expansion, simplification, and factorization) of a set equation usually requires more run time than other manipulations, and this time tends to increase as the number of terms in the disjunctive normal form of the set equation increases. The sample problem requires less than 7 seconds of central processor time.
7. **UNUSUAL FEATURES OF THE PROGRAM -** The SETS program is an interpretive program used to execute the statements of a SETS user program. The SETS user program provides the user with a flexible capability for achieving the symbolic manipulation of set equations.
8. **RELATED AND AUXILIARY PROGRAMS -**
9. **STATUS -** Abstract first distributed March 1974.
CDC6600 restricted distribution version submitted October 1973, replaced by CDC6600B unrestricted version December 1974.
10. **REFERENCES -** R. B. Worrell and B. L. Hulme, Efficient Ordering of Set Expressions for Symbolic Expansion, Journal for the Association for Computing Machinery, Vol. 20, July 1973.
M. D. Oltman and R. B. Worrell, A Fault Tree Representation Designed for Computer Analysis, SC-RR-71 0615A, July 1972.
R. B. Worrell, Set Equation Transformation System (SETS), SLA-73-0028A, May 1974, and Addendum, November 1974.
R. B. Worrell, Instructions for Using the SETS Program, SLA-73-0908A, October 1974, and Errata, November 1974.
B. L. Hulme and R. B. Worrell, A Prime Implicant Algorithm with Factoring, SLA-74-0218, May 1974.
R. B. Worrell, Using the Set Equation Transformation System in Fault Tree Analysis, SAND74-0240, September 1974.
11. **MACHINE REQUIREMENTS -** CDC6600 with extended core storage (ECS)
12. **PROGRAMMING LANGUAGE USED -** FORTRAN Extended
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** SCOPE 3.3.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** A special routine with the calling sequence CALL SETEP(I), where I is an integer or an integer variable representing a logical file number, is used to enable parity checking within the SETS program for

irrecoverable parity errors. Otherwise, irrecoverable parity errors will be handled by SCOPE.

A substantial reprogramming effort would be required to convert the SETS program to a machine that is not compatible with the CDC6600 due to the extensive use of masking instructions and the packing of data within the 60-bit word structure.

15. NAME AND ESTABLISHMENT OF AUTHOR -

R. B. Worrell
Safety Assessment Technologies Division 1659
Sandia Laboratories
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Albuquerque, New Mexico 87115

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (4149 cards)
Sample problem (205 cards)
Sample problem output
Reference reports, SC-RR-71 0615A, SLA-73-0028A and Addendum, SLA-73-0908A and Errata

17. CATEGORY - P

KEYWORDS - network analysis, fault tree analysis, mathematical logic

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GRAPH
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370/195
3. DESCRIPTION OF PROBLEM OR FUNCTION - This program calculates and graphs statistical results of experimental data. It calculates the linear regression, correlation coefficients, the confidence intervals for 90-95-99 percent confidence that the next sample will be within the printed interval, the 90 percent confidence interval that 95 percent of the remaining population will be within, and the mean and standard deviation of each parameter. The program graphs these confidence intervals, the regression line and the experimental data to obtain a visual indication of correlation. Input data is printed in tabular form and all dependent data are displayed against all independent data, one parameter at a time.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - Less than 1 second is required for a typical problem.
7. UNUSUAL FEATURES OF THE PROGRAM - Routine GRAPH can be overlayed by GRAPH2 to save about 10,000 bytes.
8. RELATED AND AUXILIARY PROGRAMS - This program is the ALO-00189 program transferred from the ALO-COSMIC collection.
9. STATUS - Abstract first distributed October 1974.
IBM360 program submitted September 1974, sample problem executed by NESC on an IBM370/195.
10. REFERENCES - Herman H. Faucette and W. J. Kirk, GRAPH - Regression Confid GRAPH, Bendix Corporation Computer Program Report, April 19, 1967.
11. MACHINE REQUIREMENTS - 19,880 bytes for program
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360,370.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
D. L. Wantoch and W. J. Kirk
Kansas City Division
Bendix Corporation
P. O. Box 1159
Kansas City, Missouri 64141
16. MATERIAL AVAILABLE -
Source deck (818 cards)
Object deck (402 cards)
Sample problem (837 cards)
Sample problem output (41 pages)
Reference report
17. CATEGORY - P
KEYWORDS - statistics, correlations, computer graphics
18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - VARI-1D
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360,370/195
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - The VARI-1D code calculates estimates of changes in reactivity worths, keff, reaction rates, power fractions, prompt-neutron generation time, delayed neutron effectiveness, and flux integral ratios due to changes in nuclear data or composition by use of a variational formalism. The code is applicable to a wide range of reactor or critical experiment design problems and sensitivity studies.
4. **METHOD OF SOLUTION** - VARI-1D first calculates the diffusion theory flux and adjoint in the reference one-dimensional system using a standard power iteration algorithm with Chebyshev extrapolation. Next, the generalized functions GAMMA+ and GAMMA- are calculated using a successive approximation method with the source term appropriate to the type of estimate. These generalized functions are then used to calculate the integrals required to obtain variational and first-order perturbation theory estimates of the effect of different system alterations on the given reactivity perturbation, reaction rate ratio, etc.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Maxima of -
 - 50 spatial mesh points
 - 10 material regions
 - 15 isotopes
 - 10 fissionable isotopes
 - 27 energy groups
 - 15 downscatter groupsThe geometry is one-dimensional slab, cylinder, or sphere. The boundary conditions are $\phi = 0$ and/or $\phi' = 0$. Cross section data may be input from cards or ARC System XS.ISO file (NESC Abstract 594) or CCCO ISOTXS.
6. **TYPICAL RUNNING TIME** - The central processor time for a sample problem with one reactivity estimate and 9 system alterations is less than 30 seconds on an IBM360/195.
7. **UNUSUAL FEATURES OF THE PROGRAM** - VARI-1D allows the estimation of the effect on reactivity worth, etc., of many alterations in temperature, composition, or nuclear data to be made with a single set of flux, adjoint, and generalized functions calculated for a reference condition. Both the ARC System XS.ISO and CCCO format ISOTXS cross section files are processed.
8. **RELATED AND AUXILIARY PROGRAMS** -
9. **STATUS** - Abstract first distributed October 1974.
IBM360 version submitted February 1974, sample problem executed by NESC.
10. **REFERENCES** - W. M. Stacey, Jr. and J. P. Regis, VARI-1D: A One-dimensional Variational Sensitivity Code, Argonne Applied Physics Division Report, August 1973.
W. M. Stacey, Jr., Variational Estimates of Reactivity Worths and Reaction Rate Ratios in Critical Nuclear Reactors, Nuclear Science and Engineering, Vol. 48, p. 444, 1972.
W. M. Stacey, Jr., An Improved Reactivity Table Model for Liquid Metal Fast Breeder Reactor Dynamics, Nuclear Science and Engineering, Vol. 49, p. 213, 1972.
L. C. Just, H. Henryson, II, A. S. Kennedy, S. D. Sparck, B. J. Toppel, and P. M. Walker, The Systems Aspects and Interface Data Sets of the Argonne Reactor Computation (ARC) System, ANL-7711, April 1971.
B. M. Carmichael, D. A. Meneley, and D. Vondy, Report of the Subcommittee on Standard Interface Files, LA-5324-MS, July 1973.
11. **MACHINE REQUIREMENTS** - A typical execution requires about 450K bytes. One peripheral I/O device is required for a cross section input file.

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- 12. PROGRAMMING LANGUAGES USED** - FORTRAN IV is used except for subroutine SQUEZE which is in Assembly language.
- 13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360,370.
- 14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** -
- 15. NAME AND ESTABLISHMENT OF AUTHORS** -
Authors	W. M. Stacey, Jr. and J. P. Regis
Contact	W. M. Stacey, Jr.
Applied Physics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
- 16. MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (4688 cards)
Load modules (2314-270 blocks, 3330-270 blocks)
Sample problem (350 cards)
Sample problem output (45 selected pages)
Library (ISOTXS format 6 blocks)
Control information (JCL 49 cards)
Reference report, Applied Physics Division Report
- 17. CATEGORY** - C
KEYWORDS - reactivity, reaction kinetics, one-dimensional
- 18. SPONSOR** -

1. **NAME OR DESIGNATION OF PROGRAM** - ARC-DIF1D
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - The ARC 1D-diffusion capability provides complete one-dimensional solutions of the multigroup diffusion equations with edits and a neutron inventory on option.
4. **METHOD OF SOLUTION** - This package consists of four modules that are invoked by the path STP001. The module NUC002 solves the multigroup diffusion equations. The module NUC004 handles searches. The module NUE001 provides more detailed edits, if desired. The path invokes other modules to provide for cross section homogenization and the processing of input data.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** -
6. **TYPICAL RUNNING TIME** - The sample problem provided requires about 66 seconds on an IBM360/195.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The modular design allows the use of any or all of the modules in this package with other desired modules with data communicated via interface data sets.
8. **RELATED AND AUXILIARY PROGRAMS** - The path STP001 is invoked by executing the catalogued procedure ARCSPO01. The ARC System environment is provided by ARC-SYSTEM (NESC Abstract 522). The BCD input is processed by ARC-NU1002 (NESC Abstract 533). The cross section homogenization is provided by ARC-XSEC1 (NESC Abstract 594). Cross section data for the sample problem are provided in the NESC 594 package.
9. **STATUS** - Abstract first distributed October 1974.
IBM360 version submitted February 1974, sample problem executed by NESC.
10. **REFERENCES** - D. E. Neal, G. K. Leaf, and A. S. Kennedy, The ARC System One-dimensional Diffusion Theory Capability, DARC1D, ANL-7715, May 1971.
D. E. Neal, T. A. Daly, D. A. Schoengold, G. Jensen Main, E. A. Kovalsky, and G. K. Leaf, The ARC System One-dimensional Adjunct Calculations and Edits, ANL-7719, March 1972.
W. L. Woodruff, T. A. Daly, H. Henryson, II, P. H. Kier, J. P. Regis, C. G. Stenberg, and B. J. Toppel, The ARC System Standard Paths and Catalogued Procedures, ANL-7712, December 1971.
L. C. Just, H. Henryson, II, A. S. Kennedy, S. D. Sparck, B. J. Toppel, and P. M. Walker, The System Aspects and Interface Data Sets of the Argonne Reactor Computation (ARC) System, ANL-7711, April 1971.
Supplemental Information for ARC-DIF1D, ANL-AP Note, February 1974.
11. **MACHINE REQUIREMENTS** - 260K bytes of core and at least 2 peripheral I/O devices for scratch files in addition to files for the load module library and cross section data.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** -
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
Authors D. E. Neal, G. K. Leaf, and A. S. Kennedy
Contact B. J. Toppel
Applied Physics Division
Argonne National Laboratory

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9700 South Cass Avenue
Argonne, Illinois 60439

- 16. MATERIAL AVAILABLE - Magnetic Tape Transmittal**
Source deck (PDS DIF1D.SOURCE 1597 records)
Object module (PDS DIF1D.SEGLIB 651 records)
Load module (2314 PDS DIF1D.MODLIB 968 records)
Sample problem (162 cards)
Sample problem output (87 selected pages)
Linkage editor control statements (PDS DIF1D.OVERLAY 6 records)
Control information (JCL 54 cards)
Reference reports and Supplemental Information Note
- 17. CATEGORY - C**
KEYWORDS - multigroup, one-dimensional, diffusion equations, ARC codes
- 18. SPONSOR -**

1. NAME OR DESIGNATION OF PROGRAM - TOODY2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC3600
3. DESCRIPTION OF PROBLEM OR FUNCTION - TOODY2 is used to compute wave propagation in two dimensions in rectangular or cylindrical coordinates.
4. METHOD OF SOLUTION - TOODY2 is based on the conventional finite difference analogs to the Lagrangian equations of motion. The finite difference technique is an approximate method of solving the nonlinear partial differential equations describing two-dimensional motion. The degree of approximation depends on the mesh sizes, mesh shape, and artificial viscosity coefficients which are used. Four types of boundary conditions are considered. These are (1) a free surface, (2) a surface with an applied stress acting on it, (3) a symmetry plane, and (4) a rigid non-sliding boundary.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maximum per problem of - 19 different materials
6. TYPICAL RUNNING TIME - TOODY2 can calculate $3.3 \cdot 10^{+5}$ mesh cycles per hour.
7. UNUSUAL FEATURES OF THE PROGRAM - TOODY2 features include -
 - (1) Intermediate tape storage is used. The values of properties computed are written on these tapes after they have been computed. After the computation has proceeded and these values are again required, they are read from these tapes. This allows values to be stored outside of the computer memory when they are not being used in the calculations.
 - (2) A sliding interface option is included. This option yields a more accurate description of the problem when the motion of two adjacent meshes is very different. Further, this allows more convenient zoning when more than one material is involved. Eight sliding interfaces can be used per problem and the interface friction can be specified as zero, infinite, or finite.
8. RELATED AND AUXILIARY PROGRAMS - TOODY2 is ALO-008 transferred from the ALO-COSMIC collection. It is an improved version of TOODY.
9. STATUS - Abstract first distributed April 1974.
CDC3600 version submitted February 1974.
10. REFERENCES - L. D. Bertholf and S. E. Benzley, TOODY II, A Computer Program for Two-dimensional Wave Propagation, SC-RR-68-41, November 1968.
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - 3600 FORTRAN
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 6.2.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
L. D. Bertholf and S. E. Benzley
Sandia Laboratories
P. O. Box 5800
Albuquerque, New Mexico 87115
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (4036 cards)
Sample problem (42 cards)

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Sample problem output (14 pages)
Reference report

- 17. CATEGORY - I**
KEYWORDS - two-dimensional, wave propagation, stresses, hydrodynamics
- 18. SPONSOR -** AEC Division of Military Application

1. **NAME OR DESIGNATION OF PROGRAM** - ETOT-3
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - ETOT-3 processes basic nuclear information given in the ENDF/B format (reference 3) and produces data decks for use in generation of KATE, THERMOS, TEMPEST and LASER libraries.
4. **METHOD OF SOLUTION** - ETOT-3 performs a straight-forward group average using an input weighting function or takes point values of the microscopic data from the ENDF/B files. The Breit-Wigner single-level and multi-level formulae are available. The Reich-Moore and Adler-Adler formulae are not included.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - In addition to the restrictions on the ENDF/B data itself, ETOT-3 has the following restrictions: Maxima of -
 309 groups or points
 500 resolved resonances
 ETOT-3 will process ENDF/B-III data. A predigested file called the Universal Supergroup System (see ETOT-3 document) is also acceptable.
6. **TYPICAL RUNNING TIME** - About 5 seconds per isotope are required on the 7600 with additional time dependent on the number of resonance parameters and resonance energy regions.
7. **UNUSUAL FEATURES OF THE PROGRAM** -
8. **RELATED AND AUXILIARY PROGRAMS** - In the program, use is made of the general purpose processor and retrieval subroutines (reference 12) written at Brookhaven for handling ENDF/B data files. This program is related to ETOG-3 (NESC Abstract 538) which generates epithermal cross sections.
9. **STATUS** - Abstract first distributed May 1974.
 CDC7600 version submitted February 1974.
10. **REFERENCES** - M. Raymund, Supplement to WCAP-7363, ETOT, A FORTRAN-IV Program to Process Data from the ENDF/B File to Thermal Library Format, WCAP-7363 (ENDF-146) Supplement, November 1973.
 C. L. Beard and R. A. Dannels, ETOT, A FORTRAN-IV Program to Process Data from the ENDF/B File to Thermal Library Format, WCAP-7363 (ENDF-146), March 1971.
 M. K. Drake, Ed., Data Formats and Procedures for the ENDF Neutron Cross Section Library, BNL-50274 (ENDF-102), Vol. 1, October 1970.
 D. E. Kusner, R. A. Dannels and S. Kellman, ETOG-1, A FORTRAN-IV Program to Process Data from the ENDF/B File to the MUFT, GAM, and ANISN Formats, WCAP-3845-1 (ENDF-114), December 1969.
 M. Raymund, Supplement to WCAP-3845-1, ETOG-1, A FORTRAN-IV Program to Process Data from the ENDF/B File to the MUFT, GAM and ANISN Formats, WCAP-3845-1 Supplement, August 1973.
 C. G. Poncelet, LASER--A Depletion Program for Lattice Calculations Based on MUFT and THERMOS, WCAP-8073, April 1966.
 H. Amster and R. Suarez, The Calculation of Thermal Constants Averaged over a Wigner-Wilkins Flux Spectrum: Description of the SOFOGATE Code, WAPD-TM-39, January 1957.
 R. H. Shudde and J. Dyer, TEMPEST II, A Neutron Thermalization Code, AMTD-111, June 1962.
 H. J. Amster and J. B. Callaghan, KATE-1, A Program for Calculating Wigner-Wilkins and Maxwellian Averaged Thermal Constants on the Philco-2000, WAPD-TM-232, October 1960.
 R. H. Shudde, Preparation of Square Root of E Sigma Cross Sections for the TEMPEST Decimal Library, AMTD-115, November 1961.
 H. C. Honeck, Thermos--A Thermalization Transport Theory Code for Reactor Lattice Calculations, BNL-5826, September 1961.

O. Ozer, Ed., Description of the ENDF/B Processing Codes and Retrieval Subroutines, ENDF-110, National Neutron Cross Section Center, Brookhaven National Laboratory, Revised June 1971.

11. **MACHINE REQUIREMENTS** - Core storage required by the program, associated system library functions, and SCOPE 2.0 operating system is 50,000 locations. The program uses one scratch tape in addition to the library tape and standard input, output and punch units.
12. **PROGRAMMING LANGUAGE USED** - ANSI Standard FORTRAN (FORTRAN IV)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 2.0.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Please note that the graph option is not operational, and binary tape mode has not been tested on the CDC7600.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
C. L. Beard, R. A. Dannels, and M. Raymond
Westinghouse Electric Corporation
Nuclear Energy Systems
P. O. Box 355
Pittsburgh, Pennsylvania 15230
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (5842 cards)
Sample problem (5 cards)
CDC UPDATE source deck (5883 cards)
Reference reports, WCAP-7363 (ENDF-146) and Supplement to WCAP-7363 (ENDF-146)
17. **CATEGORY** - B
KEYWORDS - ENDF/B, cross sections, libraries, KATE codes, THERMOS codes, TEMPEST codes, LASER codes, ETOG3 codes
18. **SPONSOR** -

1. **NAME OR DESIGNATION OF PROGRAM - ORRIBLE**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360,370/195
3. **DESCRIPTION OF PROBLEM OR FUNCTION - ORRIBLE** is a group of programs used to predict flow and temperature distribution for steady single-phase flow through bundles of heated rods separated by helical wire-wrap spacers. Any combination of flow subchannels can be blocked at the inlet. Turbulent interaction, sweeping cross flow due to the wire wrap, and transverse thermal conduction are considered. The eleven ORRIBLE programs in the package are for three duct configurations of 19-rod bundles, and for 37-, 91-, and 217-rod bundles in hexagonal ducts. In three versions, periodic channel area variations due to the wire wraps moving through channels and the possibility of the rod bundle forming a helix in the duct are considered.
4. **METHOD OF SOLUTION -** An approximate relationship for pressure-diversion cross flow in terms of local axial mass velocities is used to eliminate pressure as a variable; hence the computational procedure does not require iterative techniques. Each flow channel is assumed to be divided into a fixed number of length increments, dx . If, for a given value of x , values of the channel axial mass velocity and temperature are known, the cross flows at x can be calculated and then the axial mass velocity and temperature at $x+dx$. Since the inlet conditions are specified, the conditions at each successive increment can be calculated until the outlet is reached.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** For each program, the component dimensions, flow parameters, thermal parameters, etc. may be varied within reasonable limits. A new program must be written in order to study the effect of a different duct cross-section shape or a different rod arrangement.
6. **TYPICAL RUNNING TIME -** 0.5 to 2 minutes are required.
7. **UNUSUAL FEATURES OF THE PROGRAM -** An approximate relationship for pressure-diversion cross flow in terms of local axial mass velocities is used to eliminate pressure as a variable; hence the computation does not require iterative procedures.
8. **RELATED AND AUXILIARY PROGRAMS -** COBRA3C (NESC Abstract 432)
9. **STATUS -** Abstract first distributed March 1975.
IBM360 version submitted August 1974, sample problems executed by NESC December 1974 on an IBM370/195.
10. **REFERENCES -** J. L. Wantland, ORRIBLE - A Series of Computer Programs for Flow and Temperature Distribution in LMFBR Fuel Rod Bundles of Different Sizes and Configurations, ORNL-TM-4384, March 1974.
11. **MACHINE REQUIREMENTS -** No sample problem required more than 120K bytes during execution. The three programs for 217-rod bundles required 400K bytes for compilation.
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/360,370.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -**
15. **NAME AND ESTABLISHMENT OF AUTHOR -**
J. L. Wantland
Oak Ridge National Laboratory
P. O. Box Y
Oak Ridge, Tennessee 37830
16. **MATERIAL AVAILABLE -** Magnetic Tape Transmittal
Source decks (4719 cards)

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Sample problems (181 cards)
Sample problem output (40 selected pages and 1 microfiche)
Reference report

17. **CATEGORY** - H
KEYWORDS - temperature distribution, fluid flow, flow blockage, ducts, fuel element clusters, LMFBF reactors, COBRA3C codes
18. **SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - LATIN SQ
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360/50
3. DESCRIPTION OF PROBLEM OR FUNCTION - LATIN SQ is used for the statistical analysis of data generated from an $N \times N$ Latin Square experimental design. The program output includes an analysis of variance table for testing the significance of the row, column and treatment main effects. The analysis of variance table also includes information for testing the linear and higher-order curvilinear components for each main effect. A subroutine is provided for performing Duncan's new multiple range test for making all pair-wise comparisons among the factor level mean values.
4. METHOD OF SOLUTION - LATIN SQ employs the standard method of analysis of variance in calculating the various sums of squares, degrees of freedom, and mean squares for the analysis of variance table (see reference 8). The partitioning of the main effects into linear and higher-order curvilinear components is accomplished by the use of orthogonal polynomial coefficients. The comparisons among mean values is performed by the method of David B. Duncan (see reference 2).
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The program is designed to handle Latin Squares of size 3×3 , 4×4 , ..., 10×10 . An error message will result if this restriction is violated.
6. TYPICAL RUNNING TIME - Execution of three sample Latin Square problems of size 3×3 , 4×4 , and 5×5 requires approximately 3 minutes.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed February 1975.
IBM360 version submitted January 1975, sample problem executed by NESC.
10. REFERENCES - Anthony D. Grandillo, Analysis of Variance of an $N \times N$ Latin Square, with a Subroutine for Duncan's New Multiple Range Test, Monsanto Research Corporation.
D. B. Duncan, Multiple Range and Multiple F Tests, Biometrics, Vol. 11, pp. 1-42, March 1955.
J. L. Jaech, The Latin Square, Journal of Quality Technology, Vol. 1, pp. 242-255, October 1969.
C. A. Bennett and N. L. Franklin, Statistical Analysis in Chemistry and the Chemical Industry, John Wiley and Sons, Inc., New York, N. Y., 1961.
O. L. Davis, The Design and Analysis of Industrial Experiments, Hafner Publishing Company, New York, 1956.
A. J. Duncan, Quality Control and Industrial Statistics, Richard D. Erwin, Inc., Homewood, Illinois, 1960.
C. R. Hicks, Fundamental Concepts in the Design of Experiments, Holt and Rinehart, and Winston, Inc., 1964.
N. L. Johnson and F. C. Leone, Statistics and Experimental Design in Engineering and the Physical Sciences, Vols. 1 and II, John Wiley and Sons, New York, N. Y., 1964.
H. L. Harter, Order Statistics and their Use in Testing and Estimation, Vol. 1, Aerospace Research Laboratories, U. S. Air Force, 1969.
11. MACHINE REQUIREMENTS - 25K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - DOS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

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15. NAME AND ESTABLISHMENT OF AUTHORS -

A. D. Grandillo and T. C. Bishop⁺
Mound Laboratory
Monsanto Research Corporation
Miamisburg, Ohio 45342

16. MATERIAL AVAILABLE -

Source deck (372 cards)
Object deck (171 cards)
Sample problem (62 cards)
Control information (JCL 14 cards)
Reference report, Monsanto Research Corporation document

17. CATEGORY - P

KEYWORDS - statistics, experiment planning, quality control

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - RAFFLE2/MOD2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
IBM360/75,370/195
3. DESCRIPTION OF PROBLEM OR FUNCTION - RAFFLE is a three-dimensional general-purpose Monte Carlo program for the solution of static neutron transport problems. Either fission source iteration or external source problems can be solved. Reaction rates and fluxes or cell-averaged P0 and P1 transfer matrices can be obtained for up to 100 input energy groups. Multiplication factors, lifetimes, generation times, and probable errors are also computed. Groupwise currents from any region to adjacent regions can be computed. A zone geometry option, designated "mixed" zone geometry, is included to simplify the preparation of input data for problems having an array of fuel pins. This option combines features of the rectangular, cylindrical r-z, and cylindrical r-theta-z zone geometries in a two-level zone search.
4. METHOD OF SOLUTION - A Monte Carlo method is used with options of path type, ray type, or KENO scoring techniques. Standard biasing techniques including weight, reduction, neutron splitting, and Russian roulette are available.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
100 energy groups for editing
200 surfaces
400 regions
6. TYPICAL RUNNING TIME - Running time is very problem dependent, but often 1 to 2 hours are required on an IBM360/75. The sample problem requires 1 minute.
7. UNUSUAL FEATURES OF THE PROGRAM - Features include the combined use of multigroup and pointwise cross sections, optional use of multigroup thermal cross sections, and the solution of external source problems.
8. RELATED AND AUXILIARY PROGRAMS - The INCITE program (NESC Abstract 565) can be used to prepare the multigroup thermal libraries used by RAFFLE.
9. STATUS - Abstract first distributed December 1974.
IBM360 versions of RAFFLE-ANC submitted October 1974, replaced by RAFFLE2/MOD2 edition March 1976, sample problem executed by NESC October 1976 on an IBM370/195.
10. REFERENCES - W. E. Vesely, F. J. Wheeler, and R. S. Marsden, The RAFFLE General Purpose Monte Carlo Code, ANCR-1022, April 1973.
R. S. Marsden, F. J. Wheeler, and D. E. Wessol, A Mixed Zone Geometry Option for the RAFFLE General Purpose Monte Carlo Code, ANCR-1206, February 1975.
RAFFLE2/MOD2 Notes, Aerojet Memorandum February 1976, revised by ACC December 1976.
11. MACHINE REQUIREMENTS - 570K bytes of memory
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and Assembly language
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360,370.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
W. E. Vesely*, F. J. Wheeler, R. S. Marsden, and
D. E. Wessol
Idaho National Engineering Laboratory
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401

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•Present address—U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (13,143 cards)
2314 and 3330 load modules RAFL2.LOAD (300 blocks)
Sample problem (308 cards)
Sample problem output (49 pages, 196 blocks)
Control information (JCL 71 cards)
Libraries (FAST 5900 cards, THERMAL 2913 cards)
Reference reports and Memorandum

17. CATEGORY - B

KEYWORDS - Monte Carlo method, transport theory, reactivity, neutron flux, multiplication factors, reaction kinetics, INCITE codes, RAFFLE-ANC codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - MMM3
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - MMM3 computes the eigenvalues (frequencies) and eigenvectors (normal modes) for a semi-rigid molecule, and computes the transformation matrix for expressing the Cartesian displacements of the atoms in terms of the normal coordinates. Computation of the effective atomic masses and mean-squared amplitudes of vibration for use in slow neutron scattering calculations is included as well.
4. METHOD OF SOLUTION - The procedure centers around the manipulation of matrices: 1) the force constant matrix, 2) the transformation matrix which describes changes in bond angles and distances, and 3) the new coordinate matrix. In formulating a problem for solution, the group vibration method is used, i.e. a molecule is divided into groups of atoms with each atom in one and only one group, and the motion of each atom is described as the sum of displacements within a group (intragroup motions), together with translational and rotational motions of the groups considered as rigid units (skeletal motions).
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Matrices with dimensions up to 55 x 55 are acceptable.
6. TYPICAL RUNNING TIME - 3 seconds are required to execute the sample problem.
7. UNUSUAL FEATURES OF THE PROGRAM - The group vibration approach systematizes and simplifies preparation of the input data.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed June 1974.
IBM360 version submitted April 1974, sample problem executed by NESC June 1974 on an IBM370/195.
10. REFERENCES - D. H. Speas, Matrix Routine for Calculating Normal Modes, Frequencies, and Atom Displacements in Molecules, Aerojet Nuclear Company Program Description No. P00320, August 1964.
H. L. McMurry, A Simplified Group Vibration Method for Calculating Normal Vibrations of Large Molecules, Spectrochimica Acta, Vol. 21, pp. 2091-2103, 1965.
H. L. McMurry and D. Speas, Vibrational Analysis of Propane and Its Symmetrical Deuterium Substituted Isomers, Spectrochimica Acta, Vol. 21, pp. 2105-2117, 1965.
11. MACHINE REQUIREMENTS - 300K bytes of memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - If a degeneracy exists, the eigenvalues are calculated correctly, but the eigenvectors may be wrong unless special precautions are employed in formulating the problem. The procedure to be followed in such cases is given in the program instructions.
15. NAME AND ESTABLISHMENT OF AUTHORS -
H. L. McMurry and D. H. Speas
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401
16. MATERIAL AVAILABLE -
Source deck (527 cards)
Sample problem (258 cards)

NESC ABSTRACT 632

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Sample problem output (22 pages)
Reference documents

17. **CATEGORY** - W
KEYWORDS - molecules, eigenvalues, eigenvectors, lattice vibrations, scattering
18. **SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - LOS ALAMOS SUBROUTINE LIBRARY
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - LOS ALAMOS SUBROUTINE LIBRARY is a subset of the CDC6600 subroutine library of Los Alamos Scientific Laboratory. This subset includes library categories A-W:

IDENTIFICATION		DESCRIPTION
A101A COM	UNPAK	Unpack a floating-point number
A102A COM	IUNPK	Unpack a floating-point number
A202A F4	DCABS	Absolute value of d.p. complex number
A203A COM	CABS	Magnitude of a complex number
B104A COM	ATAN	Arctangent of x or of y/x
B106A COM	SINCOS	Sine or cosine for arg. in rad. & deg.
B107A F4	TAN	Fl.-pt. tangent or cotangent routine
B108A COM	ASIN	Arcsine or arccosine
B109A COM	CSIN	Sine or cosine of a complex number
B203A COM	SINH	Hyperbolic sine & cosine
B204A COM	TANH	Hyperbolic tangent
B306A COM	EXP	Exponential function e**x
B307A COM	CLOG	Complex natural log
B310A COM	CEXP	Natural exponential of a complex number
B313A COM	DBAIEX	Eval. dx**n where dx is d.p. & n is int.
B407A COM	CUBRT	Cube root FORTRAN IV single-precision
B408A COM	SQRT	Square root
B409A COM	CSQRT	Complex square root of a complex number
C302A F4	GAMMA	Incomplete gamma function
C304A F4	ELLI	Complete & incomplete elliptic integrals
C309A F4	E1	Exponential integral E1(x)
C310A F4	ERF	Error function
C325A F4	GAM1	Gamma function
C326A F4	LNGAM	Cmplx nat. log of gamma fn. with cmplx arg
C327A F4	BASF	Bessel functions for large real arguments
C328A F4	BJYIK	Bessel fns. for real order & argument
D301A F4	TBPSDN	Truncated Buneman Poisson solver
E102A F4	SPL1D1	Spline interpolation-coefficient eval.
E103A F4	SPL1D2	Spline interpolation-function evaluation
E104A F4	SPL2D1	2-D bi-cubic spline interp.-coeff. calc.
E105A F4	SPL2D2	2-D bi-cubic spline interp.-funct. eval.
E106A F4	AKNINT	Interpolation by Aitken's repeated process
E107A F4	SPL2D3	Spline interp. fn. to be used with E105A
E203A F4	SMOOTH	Least-square spline approximation
E208A F4	PFTS	Orthogonal polynomial least squares
F115A F4	MAXV	Vector max., min., max. abs. or min. abs.
F116A F4	MAXM	Matrix max., min., max. abs., min. abs.
F119A F4	MATTRS	Matrix transpose in place
F120A F4	MATMOV	Matrix move
F121A F4	MATTRA	Matrix move & transpose
F122A F4	MATMPY	Matrix multiply routine
F123A F4	MTMPY	Matrix transpose multiply routine
F124A COM	DOTPRO	Inner product of two vectors (dot product)
F128A F4	MGS	Modified Gram-Schmidt orthogonalization
F132A F4	MATINV	Matrix inverse
F133A COM	VECSUM	Vector addition
F134A F4	ECMATPY	ECS matrix multiply
F135A F4	ECMTRPY	ECS matrix transpose multiply
F136A F4	COTPRO	Inner product of two complex vectors
F137A F4	CATINV	Complex matrix inversion
F139A COM	ADDVEC	Vector addition
F222A F4	SMEVAL	Eigenvalue routine--real symmetric matrix
F223A F4	SMHTR	Tridiagonalize real symmetric matrix

F224A F4	SMEVEV	Eigenval/eigenvec rout. for real sym. mtrx
F225A F4	PRODHH	Cpute transform to tridiag. a symm. matrix
F226A F4	HMEVAL	Eigenvalue routine--cmplx Hermitian mtrx
F227A F4	HMHHTR	Tridiagonalize complex Hermitian matrix
F228A F4	HMEVEV	Eigenval/eigenvec rout. for Hermitian mtrx
F229A F4	PROHHH	Cpute transform to tridiag. Hermitian mtrx
F230A F4	BISECT	Cpute subset of eigenvals of tridiag. mtrx
F404A F4	LSS	Linear system solver
F405A F4	GLSS	Generat linear system solver
F409A F4	MATFAC	Lin. syst. solver & mtrx factorization(LU)
F410A F4	LSSIT	Iterative solution of linear systems
F411A F4	BANMAT	Band mtrx factorization & lin. syst solver
F413A COM	ABTDSS	Symm. constant tridiag. linear syst solver
F414A F4	SPERLSS	Symmetric periodic linear system solver
F415A F4	ECSGLSS	ECS general linear system solver
F416A F4	CATFAC	Complex linear system solver
F417A F4	CLSIT	Soln of cmplx lin. syst by iterative rfnmt
F418A COM	FACTTD	LU decomp. of diag. dom. tridiag. matrix
F419A COM	SOLTDM	Solve diag. dominant tridiag. linear syst.
G601A F4	SPCTRL	Spectral analysis of time series
G602A F4	ACFCN	Autocovariance/autocorrelation function
G603A F4	WINDOW	Lag-window generator
G604A F4	PWRSPCT	Power spectrum computation
I401A F4	LOAD	Load FORTRAN IV format free input
J506A COM	ADV	Advance film
J510A F4	ASCL	Automatic graph scaling
J516A COM	PLT	Plot a point
J517A COM	DRV	Draw vector
J518A COM	GXA	Generate x or y axis
J520A COM	TSP	Type specific point
J521A COM	TCP	Type current point
J522A COM	TSPV	Type specified point vertically
J523A COM	FRAME	Draw frame
J524A COM	STB	Store word in buffer
J526A F4	CONVRT	Convert to 4020 coordinate
J527A F4	TCR	Test coordinate for range
J528A COM	DGA	Define graph area
J529A F4	DLNLN	Draw linear-linear grid
J530A F4	DLNLG	Draw combination of linear & log grids
J533A F4	SLLIN	Scale left side linearly
J535A F4	SBLIN	Scale top or bottom of graph linearly
J540A F4	SBLOG	Scale a boundary of graph logarithmically
J541A F4	PLOT	Plot n points
J542A COM	WLCH	Write large characters horizont. or vert.
J562A F4	PLOJB	Standardized plot on film
J565A COM	BS4020	Double buffer film output
J567A F4	DLCH	Draw large characters
J569A F4	COLOR	Color
J592A F4,COM	PICTURE	Pict-perspec plots, hidn lines out, color
K203A COM	ECR	ECR reads one word from ECS
K204A COM	ECW	ECW writes one word to ECS
M101A F4	SORT1	Extended sort routine
M117A F4	SORT2	Two level extended sort routine
M118A F4	SEARCH	Rapid search of a floating-point table
M119A F4,COM	ESEARCH	Binary search through ECS
M401A COM	SHIFT	Shift word w/o zero end a,ound or sign ext
M403A COM	PUTFTCH	Puts & fetches characters
N103A F4	LABRT	Los Alamos aborter & message printer
Q408A COM	RWPRU	Read/write binary PRU (physical record)
Q409A F4	ECSBUFO	Data transfer ECS to file & file to ECS
W113A COM	OPEN	Open & close files

5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -**
6. **TYPICAL RUNNING TIME -**
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -** This package includes revisions and later versions of routines included in the ALO-COSMIC collection.
9. **STATUS -** Abstract first distributed May 1974.
CDC6600 version submitted August 1973, replaced by Edition B March 1975, replaced by Edition C May 1976.
10. **REFERENCES -** Los Alamos Scientific Laboratory Programmer's Information Manual, Guide to the Program Library and Abstracts, LA-5525-M, Volume 2, with revisions through April 1976.
LASL 6600 Subroutine Library Descriptions, ACC 633, May 1974.
LASL 6600 Subroutine Library Descriptions, ACC 633.6600B Revisions, March 1975.
LASL 6600 Subroutine Library Descriptions, ACC 633.6600C Revisions, May 1976.
11. **MACHINE REQUIREMENTS -**
12. **PROGRAMMING LANGUAGES USED -** FORTRAN IV and COMPASS each indicated by F4 and COM in the identification given in item 3 above.
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** NOS 1.1.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** Routine M401A is currently being revised. It is not included in this package but will be available at a later date.
15. **NAME AND ESTABLISHMENT OF AUTHOR -**
Contact Ray Davenport
'C' Division
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87545
16. **MATERIAL AVAILABLE -** Magnetic Tape Transmittal
Source decks (10,140 cards)
LASL 6600 Subroutine Library Descriptions, May 1974, with Revisions March 1975 and May 1976
17. **CATEGORY - P**
KEYWORDS - elementary functions, special functions, polynomials, interpolation, matrices, computer graphics, data processing, utility routines, eigenvalues, eigenvectors
18. **SPONSOR -**

1. **NAME OR DESIGNATION OF PROGRAM** - REBUS2
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - Using one or more specified external fuel supplies to load the reactor and a fixed fuel management scheme, REBUS2 computes the equilibrium (i.e. infinite-time) operating conditions of a fast reactor. Optionally, reprocessing plants may be included in the specification of the external fuel cycle and discharged fuel may be recycled back into the reactor. The code will optimize, at user option -
 - (a) the burn cycle time in order to achieve a specified discharge fuel burnup,
 - (b) the fresh fuel enrichment in order to achieve a specified effective reproduction constant at a specified time during the burn cycle, and
 - (c) the poison control to achieve a specified value of keff. Non-equilibrium problems consisting of an explicit sequence of burn/shutdown/refuel cycles may also be handled although fuel recycle is not allowed.
4. **METHOD OF SOLUTION** - The total burn cycle time is broken into one or more subintervals. An explicit burnup is performed in each region of the reactor over each of these subintervals using the average reaction rates over the subinterval. These average reaction rates are based on fluxes obtained from an explicit, two-dimensional, diffusion theory neutronics solution computed at both the beginning and end of the subinterval. The isotopes to be considered in the burnup equations, as well as their transmutation reactions, are specified by the user.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Fuel recycle is not allowed for non-equilibrium problems. Only two-dimensional problems are handled.
6. **TYPICAL RUNNING TIME** - Three to 30 minutes are required on the IBM 370/195 depending on the size of the problem.
7. **UNUSUAL FEATURES OF THE PROGRAM** - REBUS2 will handle both equilibrium and non-equilibrium problems using a number of core geometries including hexagonal mesh. The program has an automatic restart capability.
8. **RELATED AND AUXILIARY PROGRAMS** - This is a stand-alone version of the ARC System (reference 7) fuel cycle analysis code REBUS2. It utilizes the ARC System's two-dimensional, diffusion theory capability (reference 6), an improved version of the cross section homogenization code NUC001 (reference 8), the neutronic input processor NUI002 (reference 9), and the hexagonal mesh input processor NUI004.
9. **STATUS** - Abstract first distributed December 1974.
IBM360 version submitted April 1974, revised November 1974, replaced by Edition B April 1976, modified August 1976, sample problem executed by NESC July 1976 on an IBM370/195.
10. **REFERENCES** - A. P. Olson, A User's Manual for the Reactor Burnup System, REBUS-2, ANL Report, March 1974.
R. P. Hosteny, An IBM 360/370 Stand-alone Version of REBUS-2: A Supplement to the REBUS-2 User's Manual, 1976.
R. P. Hosteny, Description of Cross Section Libraries Used by REBUS2, ANL-Applied Physics Note, January 6, 1975.
#634.360 REBUS2 List of Subroutines and Overlay Structure, September 1976.
J. Hoover, G. K. Leaf, D. A. Meneley, and P. M. Walker, The Fuel Cycle Analysis System, REBUS, Nuclear Science and Engineering, Vol. 45, pp. 52-65, 1971.
T. A. Daly, G. K. Leaf, and A. S. Kennedy, The ARC System Two-dimensional Theory Capability, DARC2D, ANL-7716, May 1972.
L. C. Just, H. Hanryson, II, A. S. Kennedy, S. D. Sparck, B. J. Toppel, and P. M. Walker, The System Aspects and Interface Data Sets of the Argonne Reactor Computation (ARC) System, ANL-7711, April 1971.

E. A. Kovalsky, J. Zapatka, H. Henryson, II, J. Hoover, and P. M. Walker, The ARC System Cross-section Homogenization and Modification Capabilities, ANL-7714, June 1971.
E. A. Kovalsky and D. E. Neal, The ARC System Neutronics Input Processor, ANL-7713, January 1971.

11. **MACHINE REQUIREMENTS** - At least 400K storage is required (580K for the sample problem).
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV (99.9%)
Assembly language (0.1%)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360,370.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Creation of a load module requires a total of approximately 8.4 million bytes of direct-access storage.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
Contacts R. P. Hosteny and B. J. Toppel
Applied Physics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
For 360 users:
Source deck (3330 PDS REBSRC 5466 blocks)
Object module (3330 PDS REBOBJ 3870 blocks)
Load module (3330 PDS REBMOD 1892 blocks)
Sample problem (634 cards)
Sample problem output (157 pages)
Control information (JCL 152 cards)
Libraries (XSISO1 1 block*, XSISO2 1 block)
Reference report, ANL report, and Supplement
Reference reports ANL-7711, ANL-7713, ANL-7714, and ANL-7716 are available as microfiche copies upon request
For non-360 users:
Source deck (53,204 cards)
Control information (152 overlay cards)
Sample problem (634 cards)
Sample problem output (157 pages)
Reference reports as for 360 users plus Applied Physics Note and List of Subroutines and Overlay Structure
• 6447 bytes
17. **CATEGORY** - D
KEYWORDS - two-dimensional, breeding, criticality, depletion, LMFBR reactors, fuel cycle
18. **SPONSOR** -

1. **NAME OR DESIGNATION OF PROGRAM** - SLACMON, SLACMON/370
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - SLACMON and SLACMON/370 operating as systems' tasks or jobs under OS/VS2, are designed to monitor hardware and software performance over a given period of time. Input specified in the parameter field on the execute card coupled with the corresponding operand in the operator's start command allows selected functions to be performed. Five data sets optionally provide names of queues, I/O devices, or modules that the programs monitor. Output consists of a number of reports followed by a summary page; certain summary data may appear on the console device. The output is most useful for identifying bottlenecks and interactions, tuning a system for peak performance and for indicating desirable hardware and software reconfiguration.
4. **METHOD OF SOLUTION** - Monitoring is performed by counting various events (SVC calls, I/O interrupts) and by sampling others (the changing of control blocks). Because as the number of samples increases the sampling results become more accurate, use of this sampling technique makes it possible to obtain a significant amount of performance data with very little additional systems overhead.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Meaningful reports are prepared for the disks, drums, tapes, printers, and readers. Average SEEK/RPS and data transfer times, not calculated in SLACMON, are available with SLACMON/370 for the 3330 and 2305 RPS devices. SLACMON/370 can report cylinder usage also.
6. **TYPICAL RUNNING TIME** - The monitors may be run for a given amount of time or indefinitely until stopped.
7. **UNUSUAL FEATURES OF THE PROGRAM** -
8. **RELATED AND AUXILIARY PROGRAMS** - SLACMON is Version 2.2 and SLACMON/370 Version 4.0 of the earlier SLACMON Version 1.2, also known as SUPERMON.
9. **STATUS** - Abstract first distributed January 1975.
IBM360 SLACMON 2.2 MVT version submitted November 1974.
IBM370 SLACMON/370 Version 4.0 submitted July 1975.
10. **REFERENCES** - T. Butler, SLACMON/370 (SLACMON Version 4.0), SLAC VS Software Monitor, Stanford Center for Information Processing Publication, March 1, 1975.
G. T. Scharf, SLACMON Version 2.2, SLAC MVT Software Monitor, Stanford Center for Information Processing Publication, September 1, 1973.
11. **MACHINE REQUIREMENTS** -
12. **PROGRAMMING LANGUAGE USED** - Assembly language
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360 MVT or MFT (SLACMON), OS/370 VS2 Release 1.6 (SLACMON/370).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - SLACMON consists of three separate modules whose structure and functions are often highly-dependent upon various services provided by the OS supervisor. Multitasking is used to obtain wait time and to perform the sampling technique.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
V. Androsciani, R. A. Cook,
R. Lonergan, and T. J. Butler.
Stanford Center for Information Processing
Stanford Linear Accelerator Center
Stanford University
P. O. Box 4349

Stanford, California 94305

• Contact

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (380-6677 cards, 370 PDS SLACMON.SOURCE 571 records)

Object module (370 PDS SLACMON.OBJECT 44 records)

Load module (370 PDS SLACMON.LOAD 31 records)

Control information (380 JCL-336 cards, 370 PDS SLACMON.JOBS 14 records, PDS
SLACMON.PARMS 9 records)

Reference report appropriate to the version

17. CATEGORY - P

KEYWORDS - performance testing, sampling, configuration, computers, monitoring, SUPERMON
codes

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM -** 6KILER
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360,370/195.
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** 6KILER was developed for predictive and post-test analyses of core heat transfer during a loss-of-coolant accident for a General Electric BWR/6 type nuclear reactor plant.
4. **METHOD OF SOLUTION -** A pseudo-two-dimensional model in which radiation and conduction in the axial direction are assumed to be negligible is used. The model treats interchange of thermal radiation among surfaces using the network method of Sparrow and Cess. Heat conduction in the fuel rods is computed by numerical integration of the one-dimensional Fourier heat conduction equation assuming the temperature is independent of axial and angular position and the heat generation in the heated regions is independent of position and temperature. Time-dependent decay heat sources are calculated by linear interpolation from a table of values. The zirconium-steam reaction rate follows the parabolic rate law. Convection heat transfer coefficients are supplied by the user.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** The program applies only to the geometry and materials of the General Electric BWR/6 reactor core.
6. **TYPICAL RUNNING TIME -** 2 minutes are required to compile the program and execute the sample problem on an IBM370/195.
7. **UNUSUAL FEATURES OF THE PROGRAM -** This program is specialized to the analysis of heat transfer in the General Electric BWR/6 type plant. However, it is composed of modular subroutines, each with a distinct function, such as computing radiant heat transfer. Such subroutines may be adaptable for use in solving a wider range of problems. 6KILER maintains the same one-dimensional heat conduction solution technique for the fuel pins and utilizes the same techniques as the MOXY code. However, 6KILER generates its own viewfactor matrix internal to the code based on an 8 x 8 array of fuel rods, modifies the radiation heat transfer matrix each time an emissivity change occurs on fuel rods, water rod, or canister, and considers rod number 37, which is designated the "water rod", to be a passive element.
8. **RELATED AND AUXILIARY PROGRAMS -** MOXY/MOD1 is a predecessor of 6KILER.
9. **STATUS -** Abstract first distributed June 1974.
IBM360 version submitted April 1974, sample problem executed by NESC June 1974 on an IBM370/195.
10. **REFERENCES -** R. W. Griebbe, K. D. Richert, M. E. Radd, and C. M. Moser, 6KILER, Ver 001, A Digital Computer Code for BWR/6 Core Heat Transfer Analysis, EI 74-5, February 1974.
6KILER Organization of the Code and Code Input, EI Memorandum, April 1974.
11. **MACHINE REQUIREMENTS -** 210K bytes required to execute the program
12. **PROGRAMMING LANGUAGES USED -** FORTRAN IV (95%) and BAL (5%)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/360.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -**
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
R. W. Griebbe, K. D. Richert, M. E. Radd,
and C. M. Moser
Energy Incorporated
P. O. Box 736
Idaho Falls, Idaho 84401

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- 16. MATERIAL AVAILABLE -** Magnetic Tape Transmittal
Source deck (1287 cards)
Sample problem (52 cards)
Control information (JCL 81 cards)
Sample problem output (49 selected pages)
Reference report and Memorandum

- 17. CATEGORY - H**

KEYWORDS - heat transfer, BWR/6 reactors, fuel elements, zircaloy, LOCA, MOXY/MOD1 codes

- 18. SPONSOR -**

1. NAME OR DESIGNATION OF PROGRAM - GAMTAB
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - This package contains a two-part catalog of gamma rays emitted by nuclides in radioactive decay and a list of corresponding references. The first part lists the gamma rays in order of ascending energy. This listing consists of gamma-ray energy and uncertainty, abundance, half-life, production mode, and the energies of two of the more abundant associated gamma rays. The second part of the catalog lists up to 50 of the more abundant gamma rays for each nuclide. The listing for each nuclide includes half-life, production mode, possible genetic relationships, and references. This listing is followed by the energy, uncertainty in energy, and abundance of each gamma ray. References available through May 1973 corresponding to the reference keys listed for each nuclide in part 2 are listed as the third file.
4. METHOD OF SOLUTION - The gamma ray data is arranged in increasing energy in part 1 and in ascending mass number of the nuclide in part 2.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed June 1974.
IBM360 version submitted May 1974, corrected to version B January 1975.
10. REFERENCES - W. W. Bowman and K. W. MacMurdo, Radioactive Decay Gammas Ordered by Energy and Nuclide, Atomic Data and Nuclear Data Tables, Vol. 13, No. 2-3, February 1974.
W. W. Bowman and K. W. MacMurdo, Radioactive-Decay Gammas, Savannah River Laboratory Memorandum, May 1974.
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED -
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
W. W. Bowman and K. W. MacMurdo
Savannah River Laboratory
E. I. duPont de Nemours and Company, Inc.
Aiken, South Carolina 29801
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal.
Energy data (file 1 19,416 cards)
Nuclide data (file 2 6905 cards)
References (file 3 550 cards)
Reference memorandum
• 2 tapes if card image records, 1 tape blocked
17. CATEGORY - Z
KEYWORDS - gamma radiation, radioactivity, isotopes
18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - RIGEL4/CHECK4/SUMUP4/LISTF4
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - These programs are updated versions of ENDF/B checking, retrieval, and display codes capable of processing the Version-IV data files.
RIGEL4 retrieves ENDF/B data and changes mode (BCD-BIN) or arrangement. Updated version processes decay data (mf=1, mt=457) and error files.
CHECK4 checks the structure, consistency, and formats of ENDF data files. Updated version recognizes newly defined mt and mf numbers, checks mt=457 and the formats of the error files, contains RSIC photon file changes.
SUMUP4 checks whether partial cross sections add up to the total. Updated version flags grid points present in the partial cross section, absent in the total.
LISTF4 produces interpreted listings of ENDF/B data. Updated version lists mt=457, skips over error files, contains minor corrections.
PLOT4 produces plots of ENDF/B data. Updated version plots mt=457, skips over error files, contains minor corrections.
RESEND processes ENDF materials with resonance parameters into a pointwise form. Capability of processing Adler-Adler parameters added.
CRECT corrects ENDF/B data files.
DICT4 generates a section table of contents (dictionary) for ENDF/B materials.
CAREN4 tests for discontinuities across the limits of resonance ranges of an ENDF/B material. Updated version contains minor corrections.
4. **METHOD OF SOLUTION** -
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** -
6. **TYPICAL RUNNING TIME** -
7. **UNUSUAL FEATURES OF THE PROGRAM** -
8. **RELATED AND AUXILIARY PROGRAMS** -
9. **STATUS** - Abstract first distributed October 1974.
CDC6600 version submitted May 1974, replaced by revised edition October 1974.
10. **REFERENCES** - National Neutron Cross Section Center, Description of the ENDF/B Processing Codes and Retrieval Subroutines, BNL-50300 (ENDF-110), September 1967, Revised April 1969, Revised April 1970, Revised June 1971.
H. C. Honeck, Specifications for an Evaluated Nuclear Data File for Reactor Applications, BNL-50066, May 1966, Revised July 1967.
M. K. Drake, Data Format and Procedures for the ENDF Neutron Cross Section Library, BNL-50274, October 1970.
O. Ozer and B. Sapienza, Distribution of ENDF/B Checking, Retrieval and Display Codes, BNL Memorandum, April 8, 1974.
11. **MACHINE REQUIREMENTS** -
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** -
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
National Nuclear Data Center
Brookhaven National Laboratory
Upton, Long Island, New York 11973

- 16. MATERIAL AVAILABLE - Magnetic Tape Transmittal**
Source decks (RIGEL4 2174 cards, CHECK4 3707 cards, SUMUP4 575 cards, LISTF4 3413 cards, PLOT4 4802 cards, RESEND 2504 cards, CRECT 259 cards, DICT4 203 cards, GAREN4 1529 cards)
Reference report, BNL-50300, and Memorandum
- 17. CATEGORY - M**
KEYWORDS - data processing, cross sections, computer graphics, libraries, maintenance, information retrieval
- 18. SPONSOR -**

1. NAME OR DESIGNATION OF PROGRAM - POLLA
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370/195
3. DESCRIPTION OF PROBLEM OR FUNCTION - The program transforms a set of *r*-matrix nuclear resonance parameters into a set of equivalent *s*-matrix (or Kapur-Peierls) resonance parameters.
4. METHOD OF SOLUTION - The program utilizes the multilevel formalism of Reich and Moore and avoids diagonalization of the level matrix. The parameters are obtained by a direct partial fraction expansion of the Reich-Moore expression of the collision matrix. This approach appears simpler and faster when the number of fission channels is known and small. The method is particularly useful when a large number of levels must be considered because it does not require diagonalization of a large level matrix.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - By DIMENSION statements, the program is limited to maxima of 100 levels and 5 channels.
6. TYPICAL RUNNING TIME - The sample problem requires less than one minute on the IBM360/91.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed November 1974.
IBM360 version submitted August 1974, sample problem executed by NESC October 1974 on an IBM370/195.
10. REFERENCES - G. de Saussure and R. B. Perez, POLLA, A FORTRAN Program to Convert R-Matrix-Type Multilevel Resonance Parameters for Fissile Nuclei into Equivalent Kapur-Peierls-Type Parameters, ORNL-TM-2599, June 1969.
11. MACHINE REQUIREMENTS - The program requires 240K bytes to compile, 62K bytes to execute.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The running time increases as the ratio of average width to spacing increases.
15. NAME AND ESTABLISHMENT OF AUTHORS -
G. de Saussure and R. B. Perez
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE -
Source deck (232 cards)
Sample problem (107 cards)
Sample problem output (4 pages)
Reference report
17. CATEGORY -- A
KEYWORDS - *r* matrix, *s* matrix, multilevel analysis, Reich-Moore formula, resonance
18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - DE/STEP,INTRP; DEROOT/STEP,INTRP
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360, CDC6000-7000 (see item 14)
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - DE/STEP,INTRP performs the solution of an initial-value problem for a system of first-order ordinary differential equations to a fixed endpoint. With the companion program, DEROOT/STEP,INTRP, the endpoint may be specified implicitly as the root of a nonlinear function of the independent variable, the solution, and its first derivative. Each of these programs is supplied in both a basic and in a more versatile extended version.
4. **METHOD OF SOLUTION** - The numerical algorithm is a variable-order, variable-step Adams method which uses a modified divided difference representation of the PECE formulas and local extrapolation. (PECE stands for predict-evaluate-correct-evaluate.) Four codes are provided: the core integrator step which advances the numerical solution of an equation one step, an interpolation routine INTRP to interpolate the solution and its derivative at output points, a driver DE or DEROOT which simplifies using the other codes for routine problems, and a root-finding subroutine.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The basic versions are limited to the integration of a maximum of 20 equations, but the limit can be changed easily. The extended versions use variable dimensioning and have no fixed limits.
6. **TYPICAL RUNNING TIME** - Less than 1 minute is required to compile and execute the sample problem.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The codes emphasize efficiency in terms of function evaluations, flexibility in the integration, and ease of use. They detect and deal with discontinuities and moderate stiffness, warn the user of severe stiffness, detect requests for too much accuracy and are essentially independent of the number and placement of output points. The codes are written in single-precision; instructions for converting them to double-precision are included in the reference reports.
8. **RELATED AND AUXILIARY PROGRAMS** - Subroutine MACHIN, used to determine the machine-dependent roundoff error, is included.
9. **STATUS** - Abstract first distributed August 1974.
 Author's version submitted May 1974, replaced by revised Edition B September 1975, revised Edition C February 1976, revised Edition D March 1976, sample problem executed by NESC February 1976 on an IBM370/195 and on a CDC7600.
10. **REFERENCES** - L. F. Shampine and M. K. Gordon, Using DE/STEP,INTRP to Solve Ordinary Differential Equations, SLA Memorandum, July 1974.
 M. K. Gordon, Using DEROOT/STEP,INTRP to Solve Ordinary Differential Equations, SAND-75-0211, April 1975.
 L. F. Shampine and M. K. Gordon, Computer Solution of Ordinary Differential Equations: The Initial Value Problem, W. H. Freeman and Company, San Francisco, 1975.
 DE/STEP,INTRP, ACC No. 640.6600D, ACC Programming Note 75-8, November 19, 1974, Revised February 26, 1976.
 DE/STEP,INTRP, ACC No. 640.360D, ACC Programming 75-9, November 19, 1974, Revised February 26, 1976.
 G. D. Byrne, ACC Programming Note 76-3, August 21, 1975.
 DE/STEP,INTRP, ACC No. 640.360D, 640.6600D, ACC Author Note 76-23, February 26, 1976.
11. **MACHINE REQUIREMENTS** - For execution of the basic version: 44K bytes (IBM360), 12000 (octal) words (CDC6600).
12. **PROGRAMMING LANGUAGE USED** - ANSI STANDARD FORTRAN

- 13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360 (IBM360), SCOPE 3.3 (CDC6600), SCOPE 2.1.3 (CDC7600).
- 14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The programs are expected to be machine-independent. However, subroutines DE, DEROOT, and STEP store several variables internally between calls; this ability is not guaranteed in Standard FORTRAN. The extended versions do not assume internal storage, but are unacceptable to the WATFIV compiler (and possibly to others).
- 15. NAME AND ESTABLISHMENT OF AUTHORS** -
L. F. Shampine and M. K. Gordon
Sandia Laboratories
P. O. Box 5800
Albuquerque, New Mexico 87115
- 16. MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (DE/STEP,INTRP: basic, 360-760 cards, 6600-761 cards, extended, 360-819 cards, 6600-820 cards; DEROOT/STEP,INTRP: basic, 360-1035 cards, 6600-1036 cards, extended, 360-1091 cards, 6600-1092 cards)
Sample problems (DE/STEP,INTRP: basic, 360-28 cards, 6600-30 cards, extended, 360-30 cards, 6600-32 cards; DEROOT/STEP,INTRP: basic, 360-32 cards, 6600-34 cards, extended, 360-33 cards, 6600-35 cards)
Auxiliary programs (360-24 cards, 6600-26 cards)
Sample problem output (2 pages)
Reference reports and ACC Notes
- 17. CATEGORY** - P
KEYWORDS - ordinary differential equations, numerical solution, Adams method, initial-value problems
- 18. SPONSOR** -

1. **NAME OR DESIGNATION OF PROGRAM** - SAP4
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360,370/195
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - SAP4 is a structural analysis program for determining the static and dynamic response of linear systems. The structural systems to be analyzed may be composed of combinations of a number of different structural elements. Presently, the program contains the following element types -
 - (a) three-dimensional truss element,
 - (b) three-dimensional beam element,
 - (c) plane stress and plane strain element,
 - (d) two-dimensional axisymmetric solid,
 - (e) three-dimensional solid,
 - (f) variable-number nodes thick shell and three-dimensional element,
 - (g) thin-plate or thin-shell element,
 - (h) boundary element, and
 - (i) pipe element (tangent and bend).
4. **METHOD OF SOLUTION** - The formation of the structure matrices is carried out in the same way in a static or dynamic analysis. The static analysis is continued by solving the equations of equilibrium followed by the computation of element stresses. In a dynamic analysis the choice is between frequency calculations only, frequency calculations followed by response history analysis, frequency calculations followed by response spectrum analysis, or response history analysis by direct integration. To obtain the frequencies and vibration mode shapes, solution routines are used which calculate the required eigenvalues and eigenvectors directly without a transformation of the structure stiffness matrix and mass matrix to a reduced form. In the direct integration an unconditionally stable integration scheme is used, which also operates on the original structure stiffness matrix and mass matrix. In this manner the program operation and necessary input data for a dynamic analysis is a simple addition to what is needed for a static analysis.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The capacity of the program depends mainly on the total number of nodal points in the system, the number of eigenvalues needed in the dynamic analysis, and the computer used. There is practically no restriction on the number of elements used, the number of load cases or the order and bandwidth of the stiffness matrix. Each nodal point in the system can have from zero to six displacement degrees of freedom. The element stiffness and mass matrices are assembled in condensed form. Therefore, the program is equally efficient in the analysis of one-, two- or three-dimensional systems.
6. **TYPICAL RUNNING TIME** - Execution times vary with the problem being solved and the computer resources requested. Typical problems may require 5 to 10 minutes.
7. **UNUSUAL FEATURES OF THE PROGRAM** -
8. **RELATED AND AUXILIARY PROGRAMS** - SAP4 is one edition of the SAP series of programs. Earlier editions were designated SAP2 or SOLIDSAP and SAP3. This edition includes a new variable-number nodes thick shell and three-dimensional element and permits out-of-core direct integration for time-history analysis. The original SAP4 program, a CDC version, was obtained from the Earthquake Engineering Research Center, University of California at Berkeley.
9. **STATUS** - Abstract first distributed December 1974.
IBM360 version submitted October 1974, replaced by revised Edition B March 1975,
replaced by revised Edition C November 1977, replaced by revised Edition D
April 1979, sample problem executed by NESC March 1979 on an IBM3033.
10. **REFERENCES** - Klaus-Jurgen Bathe, Edward L. Wilson, and Fred E. Peterson, SAP IV, A Structural Analysis Program for Static and Dynamic Response of Linear Systems, EERC 73-11, June 1973, Revised April 1974.

S. Zawadzki, Notes on Argonne's version of the structural analysis program - SAP4, ANL-AMD Memorandum, February 9, 1978.

National Energy Software Center Note 79-34, SAP4, NESC No. 641.370D, Contents of Transmittal Tape, May 22, 1979.

Argonne Code Center Note 78-22, SAP4, ACC No. 641.360C, May 10, 1978.

11. **MACHINE REQUIREMENTS** - The computer resources required depend on the type of problem and trade-offs are selectable to an extent. Storage needs may vary from 250K to 2000K bytes. Peripheral device usage has been optimized for static analysis and step-by-step integration.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360,370.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Three local Argonne routines are called by SAP4. NOFLOW suppresses underflow messages; it may be replaced by a call to ERRSET. TLEFT is called with one dummy argument which returns to the calling program the difference, in hundredths of a second, between the user's time estimate for the job and the elapsed time, i.e. the time left. DCUBRT computes the double precision cube root of a normalized, double-precision, floating-point argument.
SAP4 should be compiled by the FORTRAN H, not the FORTRAN H Extended, compiler because of a diagnostic produced in subroutine ELGSOL when using the Extended compiler. For more information, see ACC Note 78-22 (reference 4).
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
S. Zawadzki
Applied Mathematics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (15,544 cards)
Sample problem (74 cards)
Control information (JCL 255 cards)
Sample problem output (15 pages, 660 133-character records)
Reference report, Memorandum, and Notes
17. **CATEGORY** - I
KEYWORDS - three-dimensional, beams, shells, mechanical structures, mechanical vibrations, pipes, matrices
18. **SPONSOR** - Argonne National Laboratory

1. NAME OR DESIGNATION OF PROGRAM - PROGLOOK
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - PROGLOOK makes it possible to monitor the execution of virtually any OS/MVT or OS/VS2 Release 1.6 load module. The main reason for using PROGLOOK is to find out which portions of a code use most of the CPU time so that those parts of the program can be rewritten to reduce CPU time. For large production programs, users have typically found it possible to reduce CPU time by 10 to 30 percent without changing the program's function.
4. METHOD OF SOLUTION - PROGLOOK determines how much of the total CPU time for a run is used by each portion of the load module by attaching the load module as a subtask. The status of this subtask (the user's load module) is sampled regularly, and a record of it is written on an intermediate file. After the run is completed, a postprocessor is invoked which summarizes and plots the data collected.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The measured task cannot attach more than 254 subtasks. If the data produced by PROGTIME exceeds 127 distinct entities or 2500 histogram cells PROGLOOK terminates, producing no histograms.
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM - PROGLOOK can be used to monitor something as simple as a FORTRAN main program or as complex as the PL/I compiler or HASP.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed March 1975.
IBM360 version submitted November 1974, replaced by revised Edition B July 1976.
10. REFERENCES - R. Johnson and T. Johnston, PROGLOOK User's Guide, User Note 33, Revision 5, May 15, 1976.
PROGLOOK Version 6 Notes, July 1976.
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and Assembly language
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - PROGLOOK monitoring overhead is on the order of 6 percent. PROGLOOK consists of two programs PROGTIME and PROGLOOK. PROGTIME is an Assembly language program which uses the interval timer to catch a picture of any program running under it and records this information in a data set, PROGLOOK is a FORTRAN program which uses the data set produced by PROGTIME to create the summary reports and plots.
15. NAME AND ESTABLISHMENT OF AUTHORS -
R. H. Johnson* and T. Johnston
Stanford Center for Information Processing
Stanford Linear Accelerator Center
Stanford University
P. O. Box 4349
Stanford, California 94305

* Contact
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (PROGLOOK 1049 cards, PROGTIME 1421 cards)
2314 load module (129 blocks)

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Control information (JCL 38 cards)
Reference report and Notes

17. **CATEGORY - P**
KEYWORDS - data processing, performance, operating systems, programming
18. **SPONSOR -**

1. NAME OR DESIGNATION OF PROGRAM - NUBOW
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370/195
3. DESCRIPTION OF PROBLEM OR FUNCTION - NUBOW performs a two-dimensional elastic analysis of reactor core systems subjected to thermal and/or mechanical bowing. Reactor assemblies are considered to be elastic beam members which may have variable geometry. Equilibrium forces and positions are calculated along with the shapes of individual rows. Clearance and local flexibility are allowed at all contacts.
4. METHOD OF SOLUTION - A relaxation procedure is used to find equilibrium positions of contacting nodes. Reactor ducts are modeled as elastic beams with local flexibility treated by linear springs. Contact forces are set to zero for non-interacting nodes. The relaxation procedure adjusts the positions of nodes, both individually and in blocks, until mechanical equilibrium is achieved to within a specified error on forces.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - An axisymmetric model is assumed. Friction forces are not included. Possible contact is allowed only at specified axial locations on the assemblies. The program currently is dimensioned for maxima of 16 rows of beams and 25 nodes per beam.
6. TYPICAL RUNNING TIME - The sample problem, consisting of two complete runs of similar systems, was compiled and executed on the IBM370/195 as a 1-minute job.
7. UNUSUAL FEATURES OF THE PROGRAM - A built-in procedure for establishing relaxation blocks uses a random number process to avoid relaxation difficulties encountered as contact gaps open and close.
8. RELATED AND AUXILIARY PROGRAMS - BOW-V treats similar systems, but with less generality. PARABOW extends NUBOW to allow arbitrarily multi-linear stiffness parameters for semi-empirical modeling of three-dimensional effects such as mis-alignment, circumferential bow, and friction.
9. STATUS - Abstract first distributed December 1974.
IBM360 version submitted September 1974, revised Edition B submitted January 1975, sample problem executed by NESC January 1975 on an IBM370/195.
10. REFERENCES - G. A. McLennan, NUBOW: A FORTRAN IV Program for the Static Elastic Analysis of Bowed Reactor Cores, ANL-8068, April 1974.
11. MACHINE REQUIREMENTS - 240K words of memory are required to compile, 130K to execute.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360,370.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
G. A. McLennan
Components Technology Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. MATERIAL AVAILABLE -
Source deck (727 cards)
Sample problem (28 cards)
Reference report with Errata

17. CATEGORY - I

KEYWORDS - two-dimensional, reactor cores, elasticity, beams, mechanical structures, BOW-V codes, PARABOW codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GETCOR/FRECOR
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370/195
3. DESCRIPTION OF PROBLEM OR FUNCTION - GETCOR and FRECOR are assembly language subroutines which may be called from FORTRAN subroutines during execution to allocate and release core storage. Those variables for which core storage is to be allocated must be passed as arguments of the FORTRAN subroutines. These programs allow variable dimensioning in subroutines without a previous specification of the maximum allowable dimensions.
4. METHOD OF SOLUTION - GETCOR checks to determine if the dynamic allocation request is reasonable, writes any warning or error messages, and calls subroutine ERROR if the request cannot be honored. Otherwise, it provides the requested space through the GETMAIN macro, alters the tables of the calling program as necessary, and returns control to the calling program. FRECOR releases space in the same general manner by use of the FREEMAIN macro.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Before the FORTRAN subroutine can return to its caller it must release all core storage allocated to any of its arguments.
6. TYPICAL RUNNING TIME - Less than one millisecond is required to allocate or release storage for one array.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1974.
IBM360 version submitted September 1974, sample problem executed by NESC November 1974 on an IBM 370/195.
10. REFERENCES - R. C. Durfee, FORTRAN Dynamic Storage Allocation, ORNL-TM-3892, July 17, 1972.
11. MACHINE REQUIREMENTS - GETCOR occupies 1440 (decimal) bytes of storage and FRECOR, 1328 bytes.
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and Assembly language
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360,370.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The test program as coded occupies a 240K region.
15. NAME AND ESTABLISHMENT OF AUTHOR -
R. C. Durfee
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE -
Source decks (896 cards)
Sample problem (98 cards)
Control information (JCL 86 cards)
Sample problem output (6 selected pages)
Reference report
17. CATEGORY - P
KEYWORDS - FORTRAN, utility routines, storage
18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM - DYNAMIC ANALYSIS OF GASES**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** The program processes mass spectral data to determine the rate at which gases evolve from a solid sample and the total quantity of gas evolved. Calibration data and mass-peak measurements are described as input data. Gas flow rate and gas quantity are described as output data. It is used for the dynamic analysis of gases by fast scanning mass spectrometry. Although written for data obtained from a Bendix model 12-107 time-of-flight (TOF) mass spectrometer, it may be applied to any type of mass spectrometer. The Bendix mass spectrometer is used to continually monitor gases evolved during vacuum bakeout of solid samples. The technique is used to determine surface contaminants, adsorbed and trapped gases and other volatile outgas products.
4. **METHOD OF SOLUTION -** The rate at which a gas evolves from a solid sample is determined from a peak-height measurement and a flow rate factor. The arithmetic expression for gas flow rate will contain as many cracking pattern coefficients as needed to correct the parent peak-height measurement of the sample gas analyzed. The quantity of gas analyzed in millimoles and molecules is determined by integrating the gas flow rate over the elapsed time of analysis.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** A total of 12 gases are used in the present study.
6. **TYPICAL RUNNING TIME -** The sample problem executes in a few minutes.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -** The program was originally written for use with the General Electric Mark 1 time sharing service. This version is a modification of ALO-00229 transferred from the ALO-COSMIC collection.
9. **STATUS -** Abstract first distributed October 1974.
GE400 modified version submitted May 1970, revised to run on an IBM360 August 1974, sample problem executed by NESC.
10. **REFERENCES -** Robert W. Loser, Carey A. Chambers, Evain D. Ruby, A Time-Sharing FORTRAN Program for the Dynamic Analysis of Gases by Time-of-Flight Mass Spectrometry, RFP-1400, November 7, 1969.
11. **MACHINE REQUIREMENTS -**
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV(G)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** IBM360 TSO.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -**
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
R. W. Loser, C. A. Chambers, and E. D. Ruby
Rocky Flats Division
Dow Chemical Company
P. O. Box 888
Golden, Colorado 80401
16. **MATERIAL AVAILABLE -**
Source deck (179 cards)
Sample problem (18 cards)
Reference report

NESC ABSTRACT 645

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- 17. CATEGORY - U**
KEYWORDS - gases, mass spectrometers, flow rate
- 18. SPONSOR -**

645.2

1. NAME OR DESIGNATION OF PROGRAM - COPYCAT
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - COPYCAT is an OS utility program designed to produce an efficient system-wide catalog which may reside on many volumes. Substantial improvement in performance may also be obtained on a system with only a single catalog. First, catalog entries from many different catalogs may be redistributed to equalize the load on each catalog. Second, each individual catalog is restructured in a way designed to minimize the I/O time required for searching and updating. Redistribution and restructuring parameters are under user control. Model DSCB's for generation data groups and alias entries are also processed. Catalogs on all direct access devices, including data cells, are supported. Backup copies may also be made.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maximum of -
32 catalogs defined as input
COPYCAT has been designed for a catalog system where a high-level index name, other than a CVOL pointer, may only appear in one catalog. When a conflict is found, the entry from the first defined input catalog is used. When more than one output catalog is produced, one is defined as the master catalog and the others as secondary catalogs. COPYCAT must be run once to produce the master catalog in master mode, and if there are secondary catalogs, once in secondary mode.
6. TYPICAL RUNNING TIME - Revision D is about 20 times faster than the previous revision because reading and writing is done by track rather than by block using EXCP.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed October 1974.
IBM360 version submitted August 1974, replaced by revised Edition B December 1974,
replaced by revised Edition C October 1975, replaced by revised Edition D
January 1976.
10. REFERENCES - Douglas E. Engert, COPYCAT - OS Catalog Utility Program, ANL-8103, May 1974.
11. MACHINE REQUIREMENTS - A large region size is recommended since COPYCAT will use all of the core available to it for buffers.
12. PROGRAMMING LANGUAGE USED - Assembly language
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/MVT, OS/MFT, OS/VS1 and OS/VS2 Release 1.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The minimum number of buffers equals the number of input catalogs plus 1. Each buffer is the size of a track.
15. NAME AND ESTABLISHMENT OF AUTHOR -
D. E. Engert
Applied Mathematics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (2619 cards)

NESC ABSTRACT 646

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Documentation (tape description file 1 26 cards, report text file 3 for TN chain and file 4 for PN chain 112 records)
Reference report, ANL-8103

- 17. CATEGORY - P**
KEYWORDS - operating systems, data processing, utility routines
- 19. SPONSOR -**

1. **NAME OR DESIGNATION OF PROGRAM - SLOP/CROSS**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370**
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** The package contains two PL/I codes, SLOP (Structural Layout Of Programs) and CROSS, designed to check IBM FORTRAN H source programs. SLOP examines the SYSPRINT file produced by a FORTRAN H compilation for local errors and sends its observations to CROSS which detects potential global errors. SLOP summarizes variables, labels, common blocks, and other items in a subroutine, showing which symbols are being improperly used. Optionally, the SLOP program can list the output from the original FORTRAN subroutine compilation, can list and/or save a 'corrected' and resequenced FORTRAN file, and save and/or list the information intended for the CROSS routine.
 For each subroutine CROSS tabulates:
 the subroutine name and size,
 entry points,
 listed but unused symbols,
 uninitialized variables,
 unreferenced statement numbers,
 internal statement numbers of input-output statements,
 symbols which appear in input-output statements,
 called subroutines, and
 the active variables in common and/or equivalence blocks,
 together with block names and addresses.
 CROSS lists common and/or equivalenced variables in alphabetic order with addresses and corresponding block names, along with the names of routines in which these variables are actively used. Any suspicious-looking or inconsistent items are flagged. The same information will also be sequenced and listed according to block names and addresses within each block. CROSS also produces a table designed to show instantly which routines need attention because SLOP found errors in them, which are missing or defined more than once, and which routine is calling (and how many times it is being called by) another. Finally, if any cycles of subroutine calls are detected, then a second table indicating these recursive calls will be produced.
 The test case supplied with this package is designed to be self-explanatory, removing the need for reference documents.
4. **METHOD OF SOLUTION -** The SLOP code processes the results of the IBM FORTRAN H compilation using the XREF option. This compilation produces records of varying length, allowing SLOP to isolate useful information without examining these records directly. Compilation results normally contain FORTRAN source code if the record length is 105, the 'SYMBOL INTERNAL STATEMENT NUMBERS' data if the record length is 133, the 'NAME TAG TYPE ADD.' information if the record length is 128, the 'LABEL DEFINED REFERENCES' information if the record length is 133, and the error messages if the record length is 155. The final record for each subroutine block is indicated by a record length of 100. If an input FORTRAN line is not a comment or continuation line, then the first few non-blank characters after column 6 are examined and used to set a one-character classification tag: A(dimension), C(common), D(data), E(equivalence), G(integer), H(logical), I(if), L(loop), N(entry), R(read), S(store), V(real), W(write or punch or print), X(subroutine or function call), or Z(namelist).
 If a READ, WRITE, PUNCH, or PRINT occurs in an IF statement, the tag 'I' is replaced by a corresponding 'W' or 'R'. When the 'NAME TAG TYPE ADD.' information is encountered, the corresponding data are placed into another type of internal tag. These internal tags and the one-character classification tags are used for each tabulated symbol to identify entries, errors, etc. Errors in the FORTRAN code are corrected whenever possible.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** A program containing up to 300 routines can be processed.
6. **TYPICAL RUNNING TIME -** This varies according to size and complexity of the tested FORTRAN program and the options which are exercised. The sample test case took 19 seconds of CPU time on Argonne's Model 195 to execute the three-step procedure, including compilations of the FORTRAN data and the SLOP and CROSS source.

7. UNUSUAL FEATURES OF THE PROGRAM - Both PL/I and FORTRAN are used.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed November 1975.
IBM360 version submitted October 1975, replaced by Edition B May 1977, sample problem executed by NESC May 1977 on an IBM370/195.
10. REFERENCES -
11. MACHINE REQUIREMENTS - 600K of core storage is required.
12. PROGRAMMING LANGUAGE USED - PL/I
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 with IBM FORTRAN H and PL/I compilers.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - SLOP was designed to examine only output produced from the IBM FORTRAN H compiler using the XREF option.
15. NAME AND ESTABLISHMENT OF AUTHOR -
A. J. Strecok
National Energy Software Center
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (SLOP 806 cards, CROSS 352 cards)
Sample problems (SLOP FORTRAN test deck 292 cards, option control input 1 card)
Control information (JCL 42 cards)
Sample problem output (SLOP 69 cards, 34 pages)
17. CATEGORY - P
KEYWORDS - FORTRAN, errors, testing, programming
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - LUGS
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - LUGS calculates stresses, stress indices, and flexibility factors for a rectangular attachment on a cylindrical shell.
4. METHOD OF SOLUTION - The program implements Bijlaard's series solution to the thin-shell equations.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Caution is recommended in using the code for attachments on very thin shells that have large circumferential dimension and small longitudinal dimension (GAMMA.GE.80, BETA2.LE.0.05, and BETA1.GE.0.3) as series convergence and/or numeric problems seem to exist.
6. TYPICAL RUNNING TIME - Approximately 30 seconds are required to execute the sample problems.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed March 1976.
IBM360 version submitted May 1975, sample problem executed by NESC March 1976 on an IBM370/195.
10. REFERENCES - W. G. Dodge, Secondary Stress Indices for Integral Structural Attachments to Straight Pipe, ORNL-TM-3476 (June 1973); Welding Research Council Bulletin 198, September 1974.
E. C. Rodabaugh, W. G. Dodge, and S. E. Moore, Stress Indices at Lug Supports on Piping Systems, ORNL-TM-4211 (May 1974); Welding Research Council Bulletin 198, September 1974.
11. MACHINE REQUIREMENTS - 468K bytes of core storage are used.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
W. G. Dodge
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE -
Source deck (509 cards)
Sample problems (5 cards)
Sample problem output (28 pages)
Reference bulletin
17. CATEGORY - I
KEYWORDS - stresses, pipes, power plants, shells
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - COMQC
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - COMQC is a quality control data analysis statistical program that calculates mean, standard deviation, range, skewness and kurtosis. Tolerance limits, confidence limits on the percent defective, and a one-way analysis of variance are also provided.
4. METHOD OF SOLUTION - The program consists of four subroutines which produce the following: histograms, control charts, group comparisons, and process capability study. Standard statistical methods and techniques are employed.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - Less than 20 seconds is required to execute the sample problem. Typically execution is less than one minute, although running time is dependent upon the size of the data set.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed February 1976.
IBM360 version submitted August 1975, sample problem executed by NESC January 1976 on an IBM370/195.
10. REFERENCES - COMQC-Histogram, Control Chart, Groups Comparison, and Capability Study Program, Program Description and Input Required, The Bendix Corporation Kansas City Division, August 21, 1975.
11. MACHINE REQUIREMENTS - 300K bytes of core storage
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
Author W. Rutherford

Contact G. M. Grogger
Kansas City Division
Bendix Corporation
P. O. Box 1159
Kansas City, Missouri 64141
16. MATERIAL AVAILABLE -
Source deck (871 cards)
Sample problem (26 cards)
Sample problem output (7 pages)
Reference program description
17. CATEGORY - P
KEYWORDS - statistics, quality control, computer graphics
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ELBOW-ORNL
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - ELBOW-ORNL calculates the stresses, stress indices, and flexibility factors for in-plane and out-of-plane bending of elbows and curved pipe subjected to internal pressure. Comparison with experiments indicates that the results accurately represent the maximum stresses which occur at the center of the bend.
4. METHOD OF SOLUTION - Results are obtained using a trigonometric series solution, which is a modified version of the method of Rodabaugh and George to include a correction for transverse compression recommended by Gross.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The program does not account for the effects of end restraint or out-of-roundness. Since end-effects are not included, the calculated stresses and flexibility of the elbow may be larger than the actual values.
6. TYPICAL RUNNING TIME - Approximately 15 seconds are required to execute the sample problem.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed February 1976.
IBM360 version submitted May 1975, sample problem executed by NESC January 1976 on an IBM370/195.
10. REFERENCES - W. G. Dodge and S. E. Moore, ELBOW: A FORTRAN Program for the Calculation of Stresses, Stress Indices, and Flexibility Factors for Elbows and Curved Pipe, ORNL-TM-4098, April 1973.
W. G. Dodge and S. E. Moore, Stress Indices and Flexibility Factors for Moment Loadings on Elbows and Curved Pipe, ORNL-TM-3658, March 1972.
11. MACHINE REQUIREMENTS - 80K bytes of core storage
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and Assembly language
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
W. G. Dodge
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE -
Source decks (707 cards)
Sample problem (3 cards)
Reference report, ORNL-TM-4098
17. CATEGORY - I
KEYWORDS - flexibility, bending, pipes, stresses
18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - SOLA/SOLA-SURF
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - SOLA and SOLA-SURF are numerical solution algorithms for transient fluid flows. SOLA is for incompressible fluid flows without free surfaces. SOLA-SURF, an extension of the SOLA code, permits a free surface or curved rigid boundary (free-slip) to be located across the top or bottom of the fluid region.
4. **METHOD OF SOLUTION** - SOLA uses a finite difference technique, based on the marker-and-cell (MAC) method, to solve the Navier-Stokes equations for an incompressible fluid in two-dimensional plane or axisymmetric coordinates. Boundaries of the rectangular computing region can be chosen as (1) rigid walls with free-slip or no-slip tangential velocities, (2) specified inflow or outflow boundaries, (3) continuative outflow boundaries, or (4) periodic boundaries. Internal walls and obstacles or sources and sinks can be added by inserting additional boundary conditions in a special section of the code reserved for this purpose.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The surfaces used in SOLA-SURF must be definable by single-valued functions, for example, $y=h(x,t)$ for the top surface and $y=hb(x,t)$ for the bottom surface. Also, the slope of the surface must not exceed the cell aspect ratio, deltay/deltax .
6. **TYPICAL RUNNING TIME** - The SOLA-SURF test problem required 15 seconds of CP time on the CDC7600 to run to a problem time of 10 (50 cycles).
7. **UNUSUAL FEATURES OF THE PROGRAM** - The basic solution algorithm contained in the SOLA code can serve as a foundation for developing other codes. For example, a scalar transport equation for density (or temperature) can be added to investigate buoyancy-driven flows and flows of stratified fluids.
8. **RELATED AND AUXILIARY PROGRAMS** -
9. **STATUS** - Abstract first distributed January 1976.
CDC7600 version submitted April 1975, replaced by revised Edition B March 1977, sample problems executed by NESC March 1977 on a CDC7600 via remote terminal to Brookhaven National Laboratory.
10. **REFERENCES** - C. W. Hirt, B. D. Nichols, and N. C. Romero, SOLA - A Numerical Solution Algorithm for Transient Fluid Flows, LA-5852, April 1975, and Addendum, December 1975, Revised March 1977.
11. **MACHINE REQUIREMENTS** -
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - SOLA and SOLA-SURF call a number of LASL subroutines - DATE1, CLOCK1, and several film output routines. These will have to be replaced by the user for his environment.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
C. W. Hirt, B. D. Nichols, and N. C. Romero
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87544
16. **MATERIAL AVAILABLE** -
Source decks (SOLA 303 cards, SOLA-SURF 550 cards)

Sample problems (SOLA 8 cards, SOLA-SURF 9 cards)
Reference report and Addendum

- 17. **CATEGORY** - H
KEYWORDS - fluid flow, transients, finite difference method, Navier-Stokes equation
- 18. **SPONSOR** - ERDA Division of Military Application

1. **NAME OR DESIGNATION OF PROGRAM** - STFODE/COLODE
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC6600, IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - COLODE is a subroutine intended primarily for solving first-order systems of stiff differential equations by collocation methods. STFODE is a driver routine written to simplify the use of COLODE.
4. **METHOD OF SOLUTION** - The principal subroutine COLODE uses one-step collocation to integrate over a given interval, taking two equal steps at a time. The collocation method, chosen either by COLODE or by the user, is fixed during the integration, but the size of each pair of steps is automatically varied. At each step a vector of continuous nth degree piecewise polynomials is made to satisfy the o.d.e. at n Gauss-Legendre or Radau (right-end) points, where $1 \leq n \leq 12$. The Gauss-Legendre methods are a-stable and of order $2n$, while the Radau methods are strongly a-stable and of order $2n-1$.
STFODE, the driver for COLODE, is intended for users who never want to supply a Jacobian subroutine or select the method.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Storage requirements limit the number of equations to about 100 for the CDC6600 version.
6. **TYPICAL RUNNING TIME** - Running time varies widely with the number and type of equations and the magnitude and type of error tolerance requested.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The user has two options which are uncommon to o.d.e. solvers. First, the user may indicate that the Jacobian of the derivative vector is constant, allowing COLODE to economize on Jacobian evaluations. Second, the user may choose to obtain results only at the end of the integration interval or to have intermediate returns after each pair of steps yielding the results from both steps.
COLODE is particularly effective on stiff problems with (a) extremely rapidly decaying solution components, (b) all nonreal eigenvalues of the Jacobian, (c) periodic transients, or (d) any stiff problem with very small error tolerances.
8. **RELATED AND AUXILIARY PROGRAMS** - COLODE actually uses a third subroutine, TWOSTP, to advance the solution two steps.
9. **STATUS** - Abstract first distributed April 1975.
CDC6600 version submitted February 1975, sample problems executed by NESC March 1975 on a CDC6600.
IBM360 version submitted March 1975, sample problems executed by NESC March 1975 on an IBM370/195.
10. **REFERENCES** - B. L. Hulme, Discrete Galerkin and Related One-step Methods for Ordinary Differential Equations, Mathematics of Computation, Vol. 26, pp. 881-891, 1972.
B. L. Hulme and S. L. Daniel, COLODE: A Collocation Subroutine for Ordinary Differential Equations, SAND74-0380, December 1974.
B. L. Hulme and S. L. Daniel, Using STFODE/COLODE to Solve Stiff Ordinary Differential Equations, SAND74-0381, December 1974.
11. **MACHINE REQUIREMENTS** - CDC6600 version load used 24,500 (octal) words, sample problem execution 15,000 (octal) words. IBM360/370 version sample problem execution used 140K bytes.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 3.3 (CDC6600), OS/360 (IBM360).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Besides the Gauss-Legendre and Radau abscissas in DATA statements of TWOSTP, there are machine constants for the roundoff level, twice the roundoff level, the underflow level, and 10^{+4} times the underflow level

in DATA statements of COLODE and TWOSTP. In the original CDC6600 version, STFODE has one call, COLODE has three calls, and TWOSTP has one call of ERRCHK, a system subroutine which processes error messages. These five calls of ERRCHK must be changed to conform with local installation practices. In the IBM360 version, these were changed to PRINT statements.

15. NAME AND ESTABLISHMENT OF AUTHORS -

6500

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Albuquerque, New Mexico 87115

360

A. J. Strecok
National Energy Software Center
Argonne National Laboratory
9700 South Cass Avenue
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16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (6600-1154 cards, 360-1161 cards)
Object deck (360-314 cards)
Sample problems (SAMPL 51 cards, EXCOL 58 cards)
Sample problem output (360 file 5)
Reference reports, SAND74-0380 and SAND74-0381

17. CATEGORY - P

KEYWORDS - ordinary differential equations, nonlinear problems, numerical solution, collocation method, polynomials, TWOSTP codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - MOCUS
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - From a description of the Boolean failure logic of a system, called a fault tree, and control parameters specifying the minimal cut set length to be obtained MOCUS determines the system failure modes, or minimal cut sets, and the system success modes, or minimal path sets.
4. METHOD OF SOLUTION - MOCUS uses direct resolution of the fault tree into the cut and path sets. The algorithm used starts with the main failure of interest, the top event, and proceeds to basic independent component failures, called primary events, to resolve the fault tree to obtain the minimal sets. A key point of the algorithm is that an and gate alone always increases the number of path sets; an or gate alone always increases the number of cut sets and increases the size of path sets. Other types of logic gates must be described in terms of and and or logic gates.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Output from MOCUS can include minimal cut and path sets for up to 20 gates.
6. TYPICAL RUNNING TIME - Running time is problem dependent. The sample test case requires 2 seconds on the Model 195.
7. UNUSUAL FEATURES OF THE PROGRAM - MOCUS guarantees that all the minimal sets requested have been found.
8. RELATED AND AUXILIARY PROGRAMS - PREP/KITT (NESC Abstract 528). The fault tree description input to MOCUS is identical to the fault tree description input to TREBIL in the PREP package. The output from MOCUS is compatible with KITT input requirements for quantitative reliability evaluation.
9. STATUS - Abstract first distributed March 1975.
IBM360 version submitted February 1975, sample problem executed by NESC March 1975.
10. REFERENCES - J. B. Fussell, E. B. Henry, and N. H. Marshall, Minimal Sets from Fault Tree, ANCR-1156, August 1974.
W. E. Vesely and R. E. Narum, PREP and KITT: Computer Codes for the Automatic Evaluation of a Fault Tree, IN-1349, August 1970.
J. B. Fussell, Synthetic Tree Model--A Formal Methodology for Fault Tree Construction, ANCR-1098, March 1973.
11. MACHINE REQUIREMENTS - 222K bytes for execution and 7 I/O units
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The sample problem uses more storage than that given in the reference report, ANCR-1156. Sample problem execution at Argonne used 222K bytes.
15. NAME AND ESTABLISHMENT OF AUTHORS -
J. B. Fussell, E. B. Henry, and N. H. Marshall
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (1739 cards)
Object deck (928 cards)

Sample problem (20 cards)
Control information (JCL 29 cards)
Sample problem output (19 cards, 15 pages)
Reference report, ANCR-1156

17. CATEGORY - G

KEYWORDS - reliability, fault tree analysis, system failure analysis, PREP/KITT codes

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM - MATHLIB**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC6600,7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** MATHLIB contains routines for linear algebraic equations, eigenvalues and eigenvectors, numerical quadrature, ordinary differential equations, data fitting, Fourier transforms, zeros and optimization of functions, zeros of polynomials, special functions, and numerical sorting.
4. **METHOD OF SOLUTION -** The mathematical method or numerical algorithm is stated briefly in the instructions for each subroutine in the reference report SAND75-0545.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** The restrictions (e.g. maximum number of equations, maximum degree of polynomial, range of argument) vary from subroutine to subroutine and are included in SAND75-0545.
6. **TYPICAL RUNNING TIME -** Timing varies from problem to problem.
7. **UNUSUAL FEATURES OF THE PROGRAM -** During the years that MATHLIB has been in use at Sandia, many new routines have been added, many old routines have been purged, and many existing routines have been refined - some more than once. At Sandia, the library is actively supported by a library development and maintenance project, consultants to help users of the library, and a committee that guides the continued active development of the library. Error diagnostics are processed uniformly by a central library routine under the control of the user. Usage of the routines is closely monitored at Sandia.
8. **RELATED AND AUXILIARY PROGRAMS -** Early versions of a few MATHLIB routines (AVINT, BES, ERF, ERFC, RUNKUT, and SEVER), included in the ALO-COSMIC collection were described in USAEC computer program summaries, ANL-8040, April 1973. MATHLIB is updated periodically. MATHLIB uses some of the EISPACK routines (NESC Abstract 534).
9. **STATUS -** Abstract first distributed August 1975.
CDC6600 version submitted August 1974, replaced by revised Edition B February 1976, sample problem executed by NESC July 1975 on the Berkeley CDC7600, replaced by revised Edition C May 1976, sample problems executed by NESC June 1976 via remote terminal to Brookhaven National Laboratory.
10. **REFERENCES -** Rondall E. Jones and Carl B. Bailey, Brief Instructions for Using MATHLIB (Version 6.0), SAND75-0545, February 1976.
Rondall E. Jones, ACC Programming Note 76-45, May 16, 1976, Revised June 30, 1976.
11. **MACHINE REQUIREMENTS -** There are no special hardware requirements for the FORTRAN routines. For certain routines the stated restriction on the size of the problem (e.g. order of a matrix) is based on a machine having 400,000 (octal) words of storage. Two of the fast Fourier transform routines are usable only on a CDC6600 or 7600.
12. **PROGRAMMING LANGUAGES USED -** About 96 percent of the library is written in CDC6600/7600 FORTRAN Extended. Most of the FORTRAN routines conform for the most part to Standard ANSI FORTRAN 1966. COMPASS is used only for the two alternate fast Fourier transform routines and an auxiliary utility routine used to count the number of arguments in a call.
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** MATHLIB operates under SCOPE 3.3 and the FTN compiler. By changing only three lines in ABTERM, the package may be compiled by FUN or RUN.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** Minimal effort is required for implementation in a CDC6600 or 7600 environment. The COMPASS routines are not transferable to other computers and some of the special functions may require considerable effort. Care should be exercised in converting the automatic quadrature and ODE codes to shorter word-

length computers. NBITS in QNC3, QNC7, and GAUS8, must be decreased and error tolerances in the ODE codes adjusted. MATHLIB makes use of some of the EISPACK routines not transmitted with the package; these may be requested separately as NESC No. 534.

- 15. NAME AND ESTABLISHMENT OF AUTHORS** - The list of authors changes as subroutines are added or replaced.

Contact: Rondall E. Jones
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Albuquerque, New Mexico 87115

- 16. MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (MATHLIB 18,981 cards, UNBLK 21 cards)
Validation problems (3915 cards)
Quick-check validation problem output (1 microfiche)
Reference report and Note

- 17. CATEGORY** - P
KEYWORDS - quadratures, special functions, differential equations, matrices, optimization, eigenvalues, eigenvectors, sorting

- 18. SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - XDTRAP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - XDTRAP calculates gas diffusion with trapping. The effect of trapping on hydrogen permeation and evolution was explored for a range of parameter values from computer-generated tables of concentrations of diffusing and trapped hydrogen.
4. METHOD OF SOLUTION - The nonlinear partial differential equations derived by A. McNabb and P. K. Foster for a general model of diffusion-plus-trapping for a plane are replaced by finite difference equations which are solved by a special adaptation of the Gauss elimination procedure.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maximum of -
2000 mesh points along one space variable
6. TYPICAL RUNNING TIME - 5 seconds are required for 2000 time increments and 100 mesh points. The sample problem takes 3 seconds of CPU time on an IBM370/195.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed April 1975.
IBM360 version submitted March 1975, sample problem executed by NESC April 1975 on an IBM370/195.
10. REFERENCES - George R. Caskey, Jr. and William L. Pillinger, Effect of Trapping on Hydrogen Permeation, DP-MS-73-80, September 1973. Published in Metallurgical Transaction A, Vol. 6A, pp. 467-476, 1975.
11. MACHINE REQUIREMENTS - 126K for the execution step with program size = 98,364 bytes
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHDRS -
W. L. Pillinger and G. R. Caskey
Savannah River Laboratory
E. I. duPont de Nemours and Company, Inc.
Aiken, South Carolina 29801
16. MATERIAL AVAILABLE -
Source deck (97 cards)
Object deck (53 cards)
Sample problem (5 cards)
Sample problem output (20 pages)
Reference report
17. CATEGORY - Q
KEYWORDS - gases, diffusion, trapping, hydrogen
18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM - BESSEL FUNCTION PACKAGE**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION - Subroutines for evaluating**
 Bessel functions:
 $J_0(x)$, $J_1(x)$, $I_0(x)$, $I_1(x)$ for x between $+$ and $-$ infinity;
 $Y_0(x)$, $Y_1(x)$, $K_0(x)$, $K_1(x)$ for x greater than zero;
 $J_{nu}(x)$, $I_{nu}(x)$ for x greater than or equal to 0 and nu greater than or equal to 0;
 $Y_n(x)$, $K_n(x)$ for x greater than 0 and $n=0,1,2,\dots$;
 Airy functions:
 $Ai(x)$, $Ai'(x)$, $Bi(x)$, $Bi'(x)$ for x between $+$ and $-$ infinity;
 and the log gamma function:
 $-LNGAMMA(x)$ for x greater than 0.
4. **METHOD OF SOLUTION -** The zero and one functions are evaluated by Chebyshev expansions or rational Chebyshev expansions with appropriate asymptotic scaling. The $Y_n(x)$ and $K_n(x)$ functions for x greater than 0 and $n=0,1,2,\dots$ are computed by forward recursion starting with Y_0 , Y_1 , or K_0 , K_1 for low orders. For higher orders the uniform asymptotic expansions are used. For $J_{nu}(x)$ and $I_{nu}(x)$, x greater than or equal to 0 and nu greater than or equal to 0, the principal expansions are the power series, the asymptotic series for x approaching infinity, and the uniform asymptotic series for nu approaching infinity. Backward recursion gets sequences $J(nu+k)$ of x and $I(nu+k)$ of x for $k=0,1,\dots,n$. The Airy functions are computed by asymptotically scaled Chebyshev expansions. $LNGAMMA(x)$ for x greater than 0 is computed by a rational Chebyshev expansion, the asymptotic expansion and backward recursion.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -**
6. **TYPICAL RUNNING TIME -** 0.1 millisecond for zero and one functions and 1 millisecond for others.
7. **UNUSUAL FEATURES OF THE PROGRAM -** The user can select the normal evaluation or scaled values:
 $EXP(-ABS(x))I_0(x)$, $EXP(-ABS(x))I_1(x)$, $EXP(-x)I_{nu}(x)$ for nu greater than or equal to 0 and x greater than or equal to 0;
 $EXP(x)K_0(x)$, $EXP(x)K_1(x)$, $EXP(x)K_n(x)$ for x greater than 0 and $n=0,1,2,\dots$;
 $EXP((2/3)*x^{3/2})Ai(x)$ and $EXP((2/3)*x^{3/2})Ai'(x)$ for x greater than 0;
 $EXP(-(2/3)*x^{3/2})Bi(x)$ and $EXP(-(2/3)*x^{3/2})Bi'(x)$ for x greater than 0 to extend the argument ranges.
8. **RELATED AND AUXILIARY PROGRAMS -** JAIRY and YBAIRY evaluate the Airy functions Ai , Ai' , Bi , Bi' for BESJ and BESYN. ERRCHK is an error print utility.
9. **STATUS -** Abstract first distributed January 1976.
 CDC6600 version submitted October 1975, drivers executed January 1976 on a CDC6600 and CDC7600 via remote terminal to Brookhaven National Laboratory.
10. **REFERENCES -** Donald E. Amos, Sharon L. Daniel, and M. Katherine Weston, CDC 6600 Subroutines for Bessel Functions $J_{nu}(x)$, X Greater than or Equal to 0, Nu Greater than or Equal to 0 and Airy Functions $Ai(x)$, $Ai'(x)$ for X between $+$ and $-$ Infinity, SAND75-0147, September 1975.
 Donald E. Amos and Sharon L. Daniel, CDC 6600 Subroutines for Bessel Functions $J_{nu}(x)$, $Nu=0,1$, X Between $+$ and $-$ Infinity and $Y_{nu}(x)$, $Nu=0,1$, X Greater than 0, SAND75-0148, September 1975.

Donald E. Amos and Sharon L. Daniel, CDC 6600 Subroutines for Bessel Functions $I_{\nu}(x)$, $\nu=0,1$, x between $+$ and $-$ Infinity and $K_{\nu}(x)$, $\nu=0,1$, and x Greater than 0, SAND75-0149, September 1975.

Donald E. Amos and Sharon Daniel, CDC 6600 Subroutines for Bessel Functions $Y_n(x)$, x Greater than 0, $n=0,1,\dots$ and Airy Functions $Bi(x)$, $Bi'(x)$, x between $+$ and $-$ Infinity, SAND75-0150, September 1975.

Donald E. Amos and Sharon L. Daniel, A CDC 6600 Subroutine for Bessel Functions $K_n(x)$, x Greater than 0, $n=0,1,\dots$, SAND75-0151, September 1975.

Donald E. Amos and Sharon L. Daniel, A CDC 6600 Subroutine for Bessel Functions $I_{\nu}(x)$, ν Greater than or Equal to 0, x Greater than or Equal to 0, SAND75-0152, September 1975.

11. MACHINE REQUIREMENTS -

12. PROGRAMMING LANGUAGE USED - FORTRAN IV

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.3.

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Diagnostic prints are handled from ERRCHK. For $J_{\nu}(x)$, $I_{\nu}(x)$, $K_0(x)$, $K_1(x)$, and $K_n(x)$, a non-zero parameter NZ is returned for underflow with a zero value assigned the function.

15. NAME AND ESTABLISHMENT OF AUTHORS -

D. E. Amos and S. L. Daniel
Numerical Mathematics Division
Sandia Laboratories
P. O. Box 5800
Albuquerque, New Mexico 87115

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (4361 cards)
Test driver (616 cards)
Test driver output (5 pages)
Reference reports

17. CATEGORY - P

KEYWORDS - special functions, Bessel functions, Airy functions, log gamma function

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - LINDA
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - LINDA implements a diagnostic procedure which depends upon the hypothesis that strain measurements obtained from a linear elastic structural test should be proportional to the applied loads. Nonlinearities in the data from such a test are expected to arise from errors in measuring or recording either the strains or the loads. The diagnostic procedure provides a means to identify and distinguish between the two types of errors.
4. METHOD OF SOLUTION - The algorithm for evaluating strain-gage data obtained from linear elastic tests is based upon the use of a series of least-square fits. Data are subjected to three distinct tests: the linearity test, the variability test, and a load-adjustment test.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The code is currently dimensioned to handle data from 400 strain rosettes and 9 load steps.
6. TYPICAL RUNNING TIME - Approximately 30 seconds of CPU time are required to run the sample problem.
7. UNUSUAL FEATURES OF THE PROGRAM - The program makes some use of object-time formatting.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed February 1976.
IBM360 version submitted May 1975, sample problem executed by NESC January 1976 on an IBM370/195.
10. REFERENCES - W. G. Dodge and J. E. Smith, A Diagnostic Procedure for the Evaluation of Strain Data from a Linear Elastic Test, ORNL-TM-3415, November 1972.
11. MACHINE REQUIREMENTS - 180K bytes of core storage are required for execution.
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and Assembly language
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The two Assembly language routines included in the package are the ORNL environment routines IDAY, a date procedure, and ICOMPARE, a routine to compare n-characters of two character strings.
15. NAME AND ESTABLISHMENT OF AUTHOR -
W. G. Dodge
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (FORTRAN 880 cards, BAL 103 cards)
Sample problem (407 cards)
Sample problem output (25 pages)
Reference report
17. CATEGORY - I
KEYWORDS - pipes, stress analysis, strains, materials testing, errors, elasticity, resolution
18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - FRAP-T/FRAP-T3
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360,370, CDC7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - FRAP-T and FRAP-T3 predict the thermal, mechanical and internal gas pressure response of a water-cooled, zircaloy-clad, oxide fuel rod during a loss-of-coolant accident (LOCA), power-coolant mismatch (PCM), or flow blockage accident. They consider the coupled effects of these response parameters by iterating to convergence at each time-step in a transient. Transient heat conduction is analyzed.
4. **METHOD OF SOLUTION** - The fuel rod to be analyzed is divided into axial and radial nodes. A one-dimensional, transient, radial or a two-dimensional in radial and azimuthal coordinates (FRAP-T3) heat conduction solution is used to determine the time-dependent radial temperature distribution at each axial node. Fuel and clad temperatures are used in conjunction with internal and external pressure forces to calculate mechanical deformation. Mechanical deformation effects on fuel clad gap and internal volume are fed back to the conduction solution and the internal pressure calculation. An iterative solution considering all the coupled effects is carried out for each time-step during the accident.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Maxima of -
 20 axial nodes
 20 radial nodes
 single-rod analysis
 thermal reactor fuel rods, zircaloy-clad with water coolant
6. **TYPICAL RUNNING TIME** - Running time varies with time-step selected and number of nodes. For a loss-of-coolant accident, FRAP-T running time is approximately 1 minute IBM360/75 CPU per second of real-time blowdown. The FRAP-T sample problem was executed by NESC in less than 5 minutes. FRAP-T3 running time is approximately 6 seconds CDC7600 CPU per second of real time for a loss-of-coolant accident. NESC executed the FRAP-T3 sample problem in less than 3 minutes.
7. **UNUSUAL FEATURES OF THE PROGRAM** - FRAP-T and FRAP-T3 are modular codes with all major computational routines as subcodes and subroutines to a main program.
8. **RELATED AND AUXILIARY PROGRAMS** - FRAP-T and FRAP-T3 use the NRTS Environmental Subroutines (NESC Abstract 613). FRAP-S is the steady-state fuel rod analysis code which is designed to supply realistic initial conditions to FRAP-T and FRAP-T3.
9. **STATUS** - Abstract first distributed October 1975.
 IBM360 version of FRAP-T submitted April 1975, sample problem executed by NESC October 1975 on an IBM370/195.
 CDC7600 version of FRAP-T3 submitted June 1977, sample problem executed by NESC September 1978 on a CDC7600.
10. **REFERENCES** - J. A. Dearien, L. J. Siefken, FRAP-T - A Computer Code for the Transient Analysis of Oxide Fuel Rods - Volume 1 - FRAP-T Analytical Models and Input Manual, Aerojet Nuclear Company Interim Report I-243-3-51.1, July 1974.
 R. L. Miller, et al., FRAP-T - A Computer Code for the Transient Analysis of Oxide Fuel Rods - Volume 2 - MATPRO: FRAP-T Material Properties Subcode, Aerojet Nuclear Company Interim Report I-243-3-51.2, July 1974.
 D. R. Coleman, FRAP-T: A Computer Code for the Transient Analysis of Oxide Fuel Rods - Volume 3 - FRAP-T Model Verification Report, Aerojet Nuclear Company Interim Report I-243-6-27, July 1974.
 NRTS Environmental Subroutine Manual, Aerojet Nuclear Company, December 1972.
 ANC CalComp Plotting Package, excerpt from ACSAP Manual, pp. 54-69.
 FRAP-T Overlay Structure, ACC Note, October 11, 1975.
 J. A. Dearien, L. J. Siefkin, and M. P. Bohn, FRAP-T3 - A Computer Code for the Transient Analysis of Oxide Fuel Rods, Report I - FRAP-T3 Analytical Models and Input Manual, TFBP-TR-194, August 1977.

D. R. Coleman and E. T. Laats, FRAP-T3 - A Computer Code for the Transient Analysis of Oxide Fuel Rods, Report II - FRAP-T3 Model Verification Report, TFBP-TR-194, August 1977.

P. E. MacDonald and L. B. Thompson, MATPRO - Version 09 - A Handbook of Materials Properties for Use in the Analysis of Light Water Reactor Fuel Rod Behavior, TREE-NUREG-1005, December 1976.

R. J. Wagner, STH20, A Subroutine Package to Compute the Thermodynamic Properties of Water, ANC Note, 1975.

FRAP-T3, NESC No. 658.7600, Tape Contents Description, NESC Note 79-1, October 2, 1978.

11. **MACHINE REQUIREMENTS** - 450K bytes for compilation, 350K bytes for execution of FRAP-T; 154,000 (octal) words for FRAP-T3.
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV except for a number of NRTS Environmental Routines written in Assembly language (FRAP-T), FORTRAN IV (FRAP-T3)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360 MVT (IBM360), SCOPE 2.1 (CDC7600).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Since, in general, plot routines are dependent upon the local environment and system conventions, the FRAP-T user is expected to have constructed the plot load module (FRAPLOT.LOAD) prior to execution of the sample problem. Changes required for execution at Argonne are noted as comments in the ANC plot routines. Each implementor will have to make the necessary modifications for his system.
FRAP-T3 was submitted in display code format suitable for use on the CDC7600 only. Translated files have been prepared by NESC for the FRAP-T3 package except for the NRTS Environmental and Thermodynamic Properties of Water Routines (NESC Abstract 613). The non-CDC FRAP-T3 user will have to provide these for his environment.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
J. A. Dearien, L. J. Siefken, and M. P. Bohn
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401
• FRAP-T3 contact
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (FRAP-T 360-7660 cards, MATPRO 360-763 cards, NRTS FORTRAN routines 360-1241 cards, NRTS Assembly routines 360-6202 cards, plot routines 360-172 cards, FRAP-T3 7600-18,340 cards, STRIP4 7600-515 cards, FRPLT 7600-231 cards)
Sample problems (FRAP-T 360-135 cards, FRAP-T3 7600-85 cards)
Load module (3330 PDS FRAPT.LOAD 293 blocks)
Load module library (3330 PDS FRAPLIB.LOAD 364 blocks)
Control information (FRAP-T JCL and linkage editor control 360-46 cards, FRAP-T3 7600-89 cards)
Sample problems output (FRAP-T 360-30 selected pages, FRAP-T3 7600-48 selected pages)
Reference reports, Manuals, and Notes appropriate to version
17. **CATEGORY** - G
KEYWORDS - accidents, heat transfer, pressure, fuel rods, flow blockage, failures, fuel-cladding interaction, transients, LOCA, power-cooling-mismatch accidents, thermal reactors, FRAP-S codes
18. **SPONSOR** - NRC Division of Reactor Safety Research

1. **NAME OR DESIGNATION OF PROGRAM** - COBRA3M
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - COBRA3M calculates the steady state and transient flow, coolant temperature and pressure drop in the subchannels of nuclear fuel pin bundles. In addition, it calculates temperatures of fuel, cladding, and duct wall.
4. **METHOD OF SOLUTION** - A lumped-parameter approach is taken for the fuel, cladding, and duct wall. The mathematical models of the flow are the same as those used in COBRA3C.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Array dimensions limit the program to handle maxima of -
 - 30 axial increments
 - 7 pins
 - 24 subchannels
 - 30 gaps
 - 6 segments for each pin
 - 10 radial nodes in each segment
 - 18 duct wall sections
 - 10 radial nodes in each duct wall section
 These can be changed by the user.
6. **TYPICAL RUNNING TIME** - Compilation time is 13 seconds, while execution of the sample problem requires 10 seconds per time-step.
7. **UNUSUAL FEATURES OF THE PROGRAM** - In addition to the features of the COBRA code, COBRA3M can handle nonuniform power generation in each fuel pin (axially, circumferentially, and radially). It also takes into consideration the temperature dependency of material property and fuel-cladding gap conductance. The effect of bypass flow outside the duct wall is also included. CalComp plotting of steady-state axial and/or radial coolant temperature profiles with experimental data is also available. COBRA3M is most suitable for analyzing small pin bundles used in experiments.
8. **RELATED AND AUXILIARY PROGRAMS** - COBRA3M is a variation of the COBRA program (NESC Abstract 432).
9. **STATUS** - Abstract first distributed November 1974.
 IBM360,370 version submitted October 1974, replaced by revised Edition B March 1976, sample problem executed by NESC March 1976 on an IBM370/195.
10. **REFERENCES** - D. S. Rowe, COBRA-III, A Digital Computer Program for Steady-state and Transient Thermal-hydraulic Subchannel Analysis of Rod Bundle Nuclear Fuel Elements, BNWL-B-82, July 1971.
 W. W. Marr, COBRA3M, A Digital Computer Code for Analyzing Thermal-hydraulic Behavior in Pin Bundles, ANL-8131, March 1975.
11. **MACHINE REQUIREMENTS** - 500K bytes of core
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360,370.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** -
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
 W. W. Marr
 Reactor Analysis and Safety Division
 Argonne National Laboratory
 9700 South Cass Avenue
 Argonne, Illinois 60439

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (3089 cards)

Load modules (3330 183 blocks, 2314 207 blocks)

Sample problem (149 cards)

Control information (JCL 39 cards)

Reference report, ANL-8131

17. CATEGORY - H

KEYWORDS - thermodynamics, fluid flow, fuel elements, ducts, liquids, vapors, enthalpy, pressure, COBRA codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - JOURNAL CONTROL SYSTEM
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
IBM360/75,91
3. DESCRIPTION OF PROBLEM OR FUNCTION - The JOURNAL CONTROL SYSTEM is a series of programs designed to handle all journal ordering for the three Union Carbide installations in Oak Ridge - ORNL, Y-12, and ORG-DP. This series of programs provides:
 - (1) management information in the form of cost, subscriber, and title statistics,
 - (2) seven-copy purchase requisitions, and
 - (3) claim letters to vendors relating to missing issues.In addition, computer check-in, notification of binding, and recording of journal arrival is supplied for the ORNL library operation.
4. METHOD OF SOLUTION - Information is recorded and included on master tape files in the three divisions which reflect the system's purpose. The order master is used for the periodical ordering. Journals are checked in and binding information supplied using the status master. The union master contains all the periodical information for the Knoxville - Oak Ridge area. Two backup tapes are used with the various programs: the title tape which is an abbreviation of the union master, and the vendor tape.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1975.
IBM360 version submitted February 1974, sample problems executed by NESC October 1975 on an IBM370/195.
10. REFERENCES - Ann S. Klein and Margaret Passiakos, Journal Control System by Batch Processing at Oak Ridge National Laboratory, ORNL-4837, January 1973.
JOURNAL CONTROL SYSTEM, ACC No. 660.360, Tape Contents Description, ACC Programming Note 76-12, November 19, 1975.
Norma A. Buhl and Myra S. Feldman, Computer Programs for Ordering, Listing, and Circulating Library Books, DP-1113, September 1967.
11. MACHINE REQUIREMENTS - A decimal feature machine with 200K memory
12. PROGRAMMING LANGUAGES USED - COBOL and Assembly language
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
A. S. Klein and M. Passiakos
Central Research Library
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (11,788 cards)
Sample problems (89 cards)
Libraries (4 files containing 21 variable-sized blocks*)
Control information (JCL 235 cards)

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Reference report, ORNL-4837, and ACC Note
• 320-byte maximum length

17. CATEGORY - M

KEYWORDS - libraries, maintenance, information systems

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GEARB
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370/195, CDC6600,7600 (see item 14)
3. DESCRIPTION OF PROBLEM OR FUNCTION - GEARB is a package of seven subroutines for the numerical solution of the initial-value problem for systems of first-order ordinary differential equations for which the Jacobian matrix is banded. The package is suitable for either stiff or non-stiff systems. It can also be used if the Jacobian matrix can be approximated by a banded matrix.
4. METHOD OF SOLUTION - GEARB contains two variable-order integration methods, which change step-size by interpolation. The two methods are an implicit Adams (non-stiff) method of orders one through twelve, and an implicit backward differentiation (Gear or stiff) method of orders one through five.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The Jacobian matrix is assumed to be banded. Current dimensioning allows for 100 simultaneous equations. Systems involving intermittent high-speed transients can lead to numerical instability or high overhead.
6. TYPICAL RUNNING TIME - Less than 1 minute is needed to compile and execute the sample problem.
7. UNUSUAL FEATURES OF THE PROGRAM - The user may select from two basic integration methods (stiff and non-stiff) and from four nonlinear system solvers. A flexible driver (subroutine DRIVEB) returns output data at a previously-specified point by interpolation, provides output data by hitting the prescribed output point without interpolation, or returns data after each step. DRIVEB controls the integration process and prints any error messages.
8. RELATED AND AUXILIARY PROGRAMS - GEAR (NESC Abstract 592) and EPISODE (NESC Abstract 675) for systems with a full Jacobian; EPISODEB (NESC Abstract 705) for systems with a banded Jacobian. EPISODE and EPISODEB are especially suited for systems with intermittent high-speed transients.
9. STATUS - Abstract first distributed August 1975.
IBM360 version submitted May 1975, replaced by revised Edition B February 1976, replaced by revised Edition C January 1977, sample problem executed by NESC December 1976 on an IBM370/195.
CDC6600 version submitted May 1975, replaced by revised Edition B February 1976, replaced by revised Edition C January 1977, sample problem executed by NESC December 1976 on a CDC7600 at Brookhaven National Laboratory.
10. REFERENCES - A. C. Hindmarsh, GEARB: Solution of Ordinary Differential Equations having Banded Jacobian, UCID-30059 Rev. 1, March 1975, with corrections January 1976 and July 1976.
A. C. Hindmarsh, Banded Linear Systems with Pivoting, UCID-30060, Rev. 1, May 1976.
A. C. Hindmarsh, GEAR: Ordinary Differential Equation System Solver, UCID-30001, Rev. 3, December 1974.
A. C. Hindmarsh and G. D. Byrne, EPISODE: An Experimental Package for the Integration of Systems of Ordinary Differential Equations, UCID-30112, May 1975.
G. D. Byrne, ACC Programming Note 76-3, Revised January 5, 1977.
11. MACHINE REQUIREMENTS - 98K bytes (IBM370/195), 22,100 (octal) words (CDC6600,7600).
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360,370 (IBM360,370), ORDER, CHAT, SCOPE 3.4.3 (CDC6600), ORDER, CHAT, SCOPE 2.1.2 (CDC7600).

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The code is heavily commented. It is intended to be readily portable. If GEARB is to be used on other systems, UROUND (the machine unit roundoff) may need to be evaluated and set in subroutine DRIVEB. The package contains an auxiliary subroutine, MACHIN, and its driver (supplied to NESC by L. F. Shampine and M. K. Gordon of SLA) which may be adapted to verify or calculate UROUND. During integration, diagnostic and warning messages may be written on logical unit LOUT, where LOUT currently is set to 3 in a DATA statement, both in subroutine DRIVEB and in the main program of the test deck. Suitable disposition of TAPE3 output should be specified.
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
A. C. Hindmarsh
Numerical Mathematics Group, L-310
Lawrence Livermore Laboratory
P. O. Box 808
Livermore, California 94550
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (360-1251 cards, 6600-1208 cards)
Sample problems (360-133 cards, 6600-126 cards)
Auxiliary programs (360-28 cards, 6600-26 cards)
Sample problem output (360-7 pages, 6600-4 pages)
Reference report, UCID-30059 Rev. 1 with corrections, and ACC Note 76-3
17. **CATEGORY** - P
KEYWORDS - ordinary differential equations, initial-value problems, Adams method, banded matrix, numerical solution, GEAR codes, EPISODE codes, EPISODEB codes
18. **SPONSOR** - ERDA Division of Military Application

1. **NAME OR DESIGNATION OF PROGRAM** - SOLVEX
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - SOLVEX simulates the dynamic and steady-state behavior of solvent extraction banks composed of either mixer-settlers or centrifugal contactors. Two options permit terminating dynamic phases by time or by achieving steady-state, and a third option permits artificial rapid close to steady-state. Distribution data may be expressed in the form of tables or cubic polynomial equations.
4. **METHOD OF SOLUTION** - SOLVEX uses a finite-difference solution of the differential equations describing the material balance. For both dynamic and steady-state options the calculation proceeds from stage 1 through the last stage specified by the user for successive time intervals, beginning at time zero with pure water and pure solvent in the bank. In the steady-state case time merely corresponds to number of iterations. The rate of change in the inventory of a given component in either the mixer or a settler zone is proportional to the flow of that component in less the component flow out. Input concentrations to the stage are taken as the output concentrations from adjacent stages during the previous time interval and the equations are solved for the aqueous and organic exit concentrations during the current time interval. Concentrations from the mixer and each settler zone are calculated before proceeding to the next stage.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Maxima of -
 - 24 stages for the bank
 - 5 chemical components
 - 5 tables and 5 equations of distribution data
 - 2 methods of expressing distribution of each component
6. **TYPICAL RUNNING TIME** - Three seconds per steady-state problem is typical. One second of computer time simulates approximately eight minutes of the solvent extraction process. The sample problem took about six minutes of CPU time to compile and execute on Argonne's IBM370/195.
7. **UNUSUAL FEATURES OF THE PROGRAM** - SOLVEX allows multiple problem input, as many as 50 lumped parameter zones in each settler, and flexible distribution data input.
8. **RELATED AND AUXILIARY PROGRAMS** -
9. **STATUS** - Abstract first distributed April 1976.
IBM360 version submitted March 1976, sample problem executed by NESC April 1976 on an IBM370/195.
10. **REFERENCES** - W. C. Scotten, SOLVEX - A Computer Program for Simulation of Solvent Extraction Processes, DP-1391, September 1975.
11. **MACHINE REQUIREMENTS** - Less than 125K bytes are required for the load module.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** -
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
 - W. C. Scotten
 - Savannah River Laboratory
 - E. I. duPont de Nemours and Company, Inc.
 - Aiken, South Carolina 29801
16. **MATERIAL AVAILABLE** -
 - Source deck (765 cards)

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Sample problem (31 cards)
Reference report

17. **CATEGORY - U**
KEYWORDS - solvent extraction, mixer-settlers, centrifugal contactors, counter current
18. **SPONSOR -**

1. **NAME OR DESIGNATION OF PROGRAM - COMRADEX4**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** COMRADEX4 was developed to evaluate potential radiological doses in the near (<10⁴ meters) environment of radioactive releases, especially postulated accident releases. Consequence-mitigating natural phenomena and engineered safety features, such as aerosol deposition inside and outside containment, meteorological dispersion, multiple containments, filtration, and shielding, may be calculated. Potential doses to body organs may be calculated from sources retained in containment, distributed in the atmosphere, and inhaled.
4. **METHOD OF SOLUTION -** The code must be supplied with an initial radioisotope inventory, leakage and cleanup rates for each level of containment, and dose rate factors for each isotope and organ. The containment inventory model contains up to four shells with leakage, aerosol cleanup, and filtration factors, as well as radioactive decay. Inventory equations both inside and outside containment are solved using a numerical method for quasi-linear equations. The meteorological dispersion is calculated from an anisotropic Gaussian cloud using Briggs' values for dispersion coefficients. Gravitational settling and dry deposition may be included for each of three isotope classes. A virtual point source release is employed. The gravitation model applies settling to both actual and image sources. Dry deposition is accounted for by uniform source depletion. Alternately, meteorological dispersion may be calculated from input attenuation factors. In both approaches, the weather conditions may be changed three times. Doses from retained sources are calculated from uniform spherical volume sources using input removal coefficient, buildup factor, and shielding factor at a single energy. The standard breathing rates for inhalation doses are built-in. The external beta and gamma cloud doses are calculated from analytical formulas for semi-infinite clouds. For modelled meteorology, the external gamma cloud dose may be calculated from the anisotropic Gaussian cloud. A numerical integration is used. Doses may be calculated separately for two groups of isotopes, such as fuel and fission products. Dose sources may be saved on auxiliary storage and used for subsequent dose-only calculations.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Maxima of -
 - 150 entries per class in leakage and fallout rate tables
 - 5 release times
 - 20 detector locations
 - 3 isotope classes
 - 4 containment levels
 - 500 isotopes
 - 12 organ dose rate factors per isotope
6. **TYPICAL RUNNING TIME -** Thirty seconds plus 2 seconds per anisotropic Gaussian cloud gamma dose calculation per detector location per release time are required.
7. **UNUSUAL FEATURES OF THE PROGRAM -** COMRADEX4 handles four containment levels; time-, chamber-, and isotopic class-dependent cleanup rates; chamber- and isotopic class-dependent leakage filter efficiencies and startup times; three changes of the meteorological model; and isotopic class-dependent gravitational settling and dry deposition.
8. **RELATED AND AUXILIARY PROGRAMS -** The initial inventory of radioactive isotopes may be obtained from RIBD2 (reference HEDL-TME-75-26). An input table of time versus leakage and fallout rates may be obtained from the HAA3B program (NESC Abstract 443).
9. **STATUS -** Abstract first distributed December 1975.
IBM370 version of COMRADEX2 submitted March 1975, replaced by COMRADEX3 February 1976, replaced by COMRADEX4 November 1977 with modifications June 1978 and October 1978, sample problem executed by NESC October 1978 on an IBM370/165.

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10. **REFERENCES** - J. M. Otter and D. K. Chung, Description of the COMRADEX-IV Code, N707T1130047, September 28, 1977.
11. **MACHINE REQUIREMENTS** - 300K bytes of memory are required. Two logical units are used as input and output (units 5 and 6), and two additional units may be needed. Use of several other units is optional.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV (H extended)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/370 VS2 Release 1.7.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** -
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
J. Otter
Atomics International Division
Rockwell International
8900 DeSoto Avenue
Canoga Park, California 91305
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (1662 cards)
Sample problem (75 cards)
Sample problem output (72 pages)
Reference report
17. **CATEGORY** - G
KEYWORDS - containment, meteorology, radioactivity, doses, LMFBR reactors, accidents, RIBD2 codes, HAA3B codes
18. **SPONSOR** - DOE Division of Reactor Research and Technology

1. **NAME OR DESIGNATION OF PROGRAM** - FLOW3
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC7600,6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - FLOW3 was developed for the steady-state thermal and hydraulic analysis of two-phase flow in three-dimensional geometries. The program was developed with particular application to the analysis of flow on the primary and secondary sides of a steam generator and may be applied to a variety of fluid flow problems of a general nature. The program employs a network representation of the flow field and predicts local fluid conditions based on a boundary value solution method. The FLOW3 program user specifies a flow region of interest as a network of nodes with interconnecting links. Flow may enter or leave the network at designated boundary nodes (where the pressure is fixed) or at designated source nodes (where the flow is fixed). The conservation equations for mass, energy, and momentum are solved for the steady-state enthalpy and pressure at each node and the flow in each link. Heat may be added to any links, and two-phase flow is allowed.
4. **METHOD OF SOLUTION** - The network conservation equations are nonlinear, and a nested inner-outer iterative method is employed. In the inner iterations the equations are solved with fixed fluid property values. A block, successive overrelaxation method is employed. In the outer iterations, the fluid properties are updated and the inner iterations repeated. A pseudo, time-dependent term is added to the momentum equation to force the outer iterations to creep slowly to the steady-state solution, thereby avoiding convergence difficulties.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Maxima of -
350 nodes
700 links
6. **TYPICAL RUNNING TIME** - The sample problem requires about 25 seconds on a CDC7600.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The program has a special capability to analyze flow conditions in the secondary loop of steam generators. The network representation is used to model the tube bundle region. Special correlations are provided for vapor fraction and pressure drop across tube banks. Separate calculations are performed for the riser, separator, and downcomer, and the program adjusts the recirculation flow rate iteratively so that the conservation equations are satisfied throughout the loop. Heat transfer calculations are used to iteratively determine the heat flux distribution and system pressure concurrently with the recirculation rate.
8. **RELATED AND AUXILIARY PROGRAMS** - FLOW3 uses the Bettis Environmental Routines (NESC Abstract 478) and the Bettis Environmental Library (NESC Abstract 665). Fluid properties are obtained through the use of subroutine HOH (NESC Abstract 294).
9. **STATUS** - Abstract first distributed October 1975.
CDC6600 version submitted November 1974, replaced by CDC7600 revised Edition B June 1976.
10. **REFERENCES** - S. G. Beus and J. H. Anderson, FLOW3 - A Computer Program for Network Analysis of Two Phase Flow in Three Dimensions, WAPD-TM-1177(L), October 1974, with Appendix A replacement, April 1975, and Addendum 1, May 1976.
W. R. Cadwell (Ed.), Reference Manual - Bettis Programming Environment, WAPD-TM-1181, September 1974.
11. **MACHINE REQUIREMENTS** - Large core memory (CDC7600) or extended core storage (CDC6600)
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV and COMPASS
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 1.1 (CDC7600) and SCOPE 3.3 (CDC6600).

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - FLOW3 is written completely in FORTRAN, however, some of the environmental library routines used by FLOW3 are in Assembly language.
The (4.0) overlay is used to read and write restart files for long running jobs. The Bettis file management routines, which are called by this overlay and are part of the Bettis Environmental Routines, are highly installation-dependent and will probably have to be rewritten by the user. FMEROR, which is called by RSFM and is not part of the Bettis Environmental Routines, provides error messages.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
S. G. Baus and J. H. Anderson
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
16. **MATERIAL AVAILABLE** - Restricted Distribution
Magnetic Tape Transmittal
Source deck (20,997 cards)
Sample problem (78 cards)
Reference report and Addendum
17. **CATEGORY** - H
KEYWORDS - three-dimensional, steady-state conditions, fluid flow, steam generators, network analysis, HOH codes, BETTIS ENVIRONMENTAL ROUTINES codes, BETTIS ENVIRONMENTAL LIBRARY codes
18. **SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - BETTIS ENVIRONMENTAL LIBRARY
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600, 7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - The BETTIS ENVIRONMENTAL LIBRARY consists of a large number of subroutines and functions which are available for use in application programs. These routines effectively extend the FORTRAN language in such areas as system communication, decimal input, file management, scratch I/O, storage allocation, and plotting.
4. METHOD OF SOLUTION - The intent is to maintain all system-dependent routines in a well-documented central library to minimize system conversion problems. Routines included are:
CARDS and INPF systems - for conversion and processing of free-field decimal input.
FTB-4 system - for very high, disk-streaming rates with storage management and allocation capabilities.
FMG routine - to interface the file management system and the using program.
RANDIO routines - for reading and writing indexed files which can be moved between the 6600 and 7600 computers.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The BETTIS ENVIRONMENTAL LIBRARY is used by the newer Bettis programs; an earlier edition of the Bettis Environmental Routines appeared as NESC Abstract 478.
9. STATUS - Abstract first distributed April 1975.
CDC6600 (RUN compiler) version submitted November 1974.
CDC6600 (FTN compiler) version submitted January 1975.
CDC7600 (RUN compiler) version submitted November 1974.
CDC7600 (FTN compiler) version submitted January 1975.
10. REFERENCES - W. R. Cadwell, (Ed.), Reference Manual - Bettis Programming Environment, WAPD-TM-1181, September 1974.
C. J. Pfeifer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967.
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGES USED - Almost all of the environmental routines are written in FORTRAN IV, the remainder in COMPASS.
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.1 and 3.2 (CDC6600), SCOPE 1.1 (CDC7600).
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - There are two versions of the BETTIS ENVIRONMENTAL LIBRARY available for each machine. The first is for use with the standard RUN compiler. The second consists of a portion of the library (chapters C-F of reference 1) which has been converted for use with the FORTRAN Extended (FTN) compiler. In the conversion all COMPASS routines were modified to conform to the FTN calling sequence conventions. The remainder of the library (chapters G-M) has not been converted but contains so few COMPASS routines that it can be converted easily by a potential user.
15. NAME AND ESTABLISHMENT OF AUTHOR -
W. R. Cadwell
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation

NESC ABSTRACT 665

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Box 79
Pittsburgh, Pennsylvania 15122

- 16. MATERIAL AVAILABLE - Restricted Distribution**
Magnetic Tape Transmittal
Source decks (RUN 6600-18,266 cards, 7600-18,778 cards, FTN 6600-7488 cards, 7600-7398 cards)
Reference report, WAPD-TM-1181
- 17. CATEGORY - P**
KEYWORDS - data processing, operation, libraries, maintenance
- 18. SPONSOR -**

1. **NAME OR DESIGNATION OF PROGRAM - FTA**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** The FTA (Fault Tree Analysis) system was designed to predict probabilities of the modes of failure for complex systems and to graphically present the structure of systems. There are three programs in the system. Program ALLCUTS performs the calculations. Program KILMER constructs a CalComp plot file of the system fault tree. Program BRANCH builds a cross-reference list of the system fault tree.
4. **METHOD OF SOLUTION -** ALLCUTS employs a top-down set expansion algorithm to find fault tree cutsets and then optionally calculates their probability using a currently accepted cutset quantification method. The methodology is adapted from that in WASH-1400 (draft), August 1974.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Maxima of -
175 basic events
425 rate events
ALLCUTS may be expanded to solve larger problems depending on available core memory.
6. **TYPICAL RUNNING TIME -** ALLCUTS requires 8 seconds for the sample problem. KILMER 2 to 15 seconds depending on the number of plots generated, and BRANCH 4 seconds.
7. **UNUSUAL FEATURES OF THE PROGRAM -** ALLCUTS uses a top-down set expansion technique to reduce a fault tree to its cutsets. KILMER is an interactive program which builds a plot file according to user-given instructions.
8. **RELATED AND AUXILIARY PROGRAMS -**
9. **STATUS -** Abstract first distributed May 1976.
CDC6600 version submitted July 1975, ALLCUTS modified September 1975, sample problem executed by NESC February and March 1976 on a CDC6600 via remote terminal to Brookhaven National Laboratory.
10. **REFERENCES -** J. Diven, D. Griffing, A. Thorpe, and W. Van Slyke, Fault Tree Analysis System User's Guide, CSC-RL-SCI-122, June 26, 1975.
W. J. Van Slyke and D. Griffing, ALLCUTS, A Fast, Comprehensive Fault Tree Analysis Code, ARH-ST-112, July 1975.
11. **MACHINE REQUIREMENTS -** 110K (octal) words for ALLCUTS, 65K (octal) words for KILMER, and 50K (octal) words for BRANCH
12. **PROGRAMMING LANGUAGES USED -** FORTRAN IV (95%) and COMPASS (5%)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** SCOPE 3.4.2.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -**
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
W. J. Van Slyke and D. E. Griffing
Atlantic Richfield Hanford Company
P. O. Box 250
Richland, Washington 99352
J. Diven
Computer Sciences Corporation
825 Jadwin Avenue
Richland, Washington 99352
16. **MATERIAL AVAILABLE -** Magnetic Tape Transmittal
Source decks (ALLCUTS 1312 cards, KILMER 2169 cards, BRANCH 222 cards)
Sample problem (59 cards)

Control information (52 cards)
Reference reports

17. CATEGORY - G

KEYWORDS - statistics, numerical solution, fault tree analysis, computer graphics

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - BUCKLE

2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600

3. DESCRIPTION OF PROBLEM OR FUNCTION - BUCKLE is a one-dimensional computer code compiled to calculate the change in ovality, of an initially oval, closed-end finite length tube, as a function of time, temperature, neutron flux and uniform external pressure. The basic concept employed in BUCKLE is that a tube, which is slightly out-of-round, tends to become more out-of-round with time when subjected to net uniform external pressure. The timewise change in ovality occurs as a consequence of creep deformations arising from tangential compressive and tangential bending stresses produced by uniform external pressures acting on an initially oval tube.

4. METHOD OF SOLUTION - BUCKLE employs two mathematical models with an incremental approach to calculate the change in ovality of an initially oval tube, as a function of time. One mathematical model describes the interrelationships between membrane and bending stresses, strain, and ovality of a symmetrical cross section of a hollow cylinder. The second mathematical model describes the interrelationships between stress and strain rate as a function of temperature, neutron flux and time. Although the analytical mechanics model is one-dimensional, stress biaxiality and material anisotropy effects are indirectly included through the selection of the stress coefficient in the creep equation model.

The computational procedure is based on the assumption that for a sufficiently small interval of time, the strain-producing stresses are essentially constant throughout the time interval. At the end of each time interval, the incremental creep strain that occurred during the time interval is used to calculate an incremental change in the ovality of the tube. This increment of ovality is added to the tube ovality existing at the beginning of the time interval. This new value of ovality is then used to recalculate the shell membrane and bending stresses which are used to calculate a new increment of creep strain in the subsequent time interval. If the time intervals are sufficiently small, the solution obtained is approximate and will tend to converge to the real solution. The repetitive calculations are terminated by a specified time limit or when the ovality and/or combined stresses equal specified values.

An option was added with Edition B to employ either a strain hardening or time hardening rule in the creep calculations.

Factors considered in the calculation include: tube dimensions, temperature-dependent material properties, external pressure, and the time-variable internal pressure, temperature and neutron flux.

5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The assumptions used in formulating the analytical mechanics model necessarily place certain restrictions on the code's applicability to problems of buckling instability. These limitations are as follows:

- (a) BUCKLE does not provide the capability to calculate creep-buckling for a perfectly round tube. The analysis for such a case typically uses the reduced modulus method wherein the modulus is determined from isochronous creep curves.
- (b) The time increment used in BUCKLE must be small enough so that approximate convergence to a real solution is obtained. The convergence is generally adequate when the time increment is less than 2% of the collapse time. For short collapse times, a time interval of less than 1% should be used.
- (c) The stress-deflection equations used in BUCKLE are based on linear elastic theory. For engineering purposes, the creep-collapse time will be given with sufficient accuracy by this simplified theory which neglects plasticity. Creep-buckling analyses, however, should not be attempted when the stresses exceed the yield strength of the tubing.
- (d) BUCKLE does not provide the capability to calculate creep-buckling for a tube which is subjected to an eccentric axial load in addition to a uniform pressure load.

Other methods must be used for the analysis in such cases.

6. **TYPICAL RUNNING TIME** - Running time is somewhat dependent upon the input options and to a lesser extent upon the complexity of the problem. A typical case with time-variable internal pressure, temperature, and neutron flux may require about 20 seconds.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The form of the analytical creep model used in BUCKLE is one of the standard forms generally used to describe creep behavior. Other analytical creep models may be equally suitable for calculating creep strains. The user may choose to specify, via input data cards, other creep equations or select coefficients so as to obtain the best fit to data applicable to his material.
8. **RELATED AND AUXILIARY PROGRAMS** -
9. **STATUS** - Abstract first distributed December 1975.
CDC6600 version submitted December 1974, replaced by revised Edition B February 1976, replaced by revised Edition C March 1976, sample problem executed by NESC March 1976 on a CDC6600 via remote terminal to Brookhaven National Laboratory.
10. **REFERENCES** - P. J. Pankaskie, BUCKLE: An Analytical Computer Code for Calculating Creep Buckling of an Initially Oval Tube, BNWL-1784, May 1974.
11. **MACHINE REQUIREMENTS** - 54K words addressable core storage are required.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 4.2.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Problem input data are specified in FORTRAN IV NAMELIST format.
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
P. J. Pankaskie
Pacific Northwest Laboratories
Battelle
P. O. Box 999
Richland, Washington 99352
16. **MATERIAL AVAILABLE** -
Source deck (558 cards)
Sample problems (25 cards)
Sample problems output (39 pages)
Reference report, BNWL-1784
17. **CATEGORY** - I
KEYWORDS - buckling, creep, neutron flux, temperature, tubes, deformation, pressure
18. **SPONSOR** -

1. **NAME OR DESIGNATION OF PROGRAM - METRICATION**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** METRICATION deals with the U.S. customary units of measure and the International System of Units (SI). The program provides for: (1) a means of converting units of one system of measurement to another, (2) standard methods of converting and rounding values, (3) standard output formats for converted and rounded values, (4) conversion of any units provided the conversion can be expressed linearly or as a table of function values, and (5) as much flexibility for the user as possible consistent with simplicity of use.
4. **METHOD OF SOLUTION -** The method employed by the program for converting from one system to another is based upon a table look-up. Given a value (V) to be converted, a "from" symbol and a "to" symbol, the computer program scans an internal table of symbols (CCT) for a matching pair of symbols. The match can occur in one of two ways. The given "from" and "to" symbols can match the "from" and "to" entries in the table directly, or they can match in reverse order. That is, the given "from" symbol matches the "to" entry, and the given "to" symbol matches the "from" entry.
Once a match is found, the appropriate conversion factor (C1) and constant (C2) are extracted from the CCT and used to convert the given value. If the match is direct, the given value (V) is converted using the formula $R=C1 \cdot V + C2$ where "R" is the converted value. If the match is in the reverse order, the given value (V) is converted using the formula $R=(V-C2)/C1$ where again, "R" is the converted value.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Maxima of -
200 data entries per data case
50 different conversion formulae per data case
6. **TYPICAL RUNNING TIME -** Less than 4 seconds is required to execute the sample problems.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -**
9. **STATUS -** Abstract first distributed December 1975.
IBM370 version submitted July 1975, replaced by revised Edition B July 1976, sample problems executed by NESC April 1976 on an IBM370/195.
10. **REFERENCES -** Gordon F. Abbey and John R. Whitney, METRICATION Planning Manual, R-9410A, November 5, 1974.
11. **MACHINE REQUIREMENTS -** The minimum batch region is 92K, a slightly larger region is required for TSO operation.
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/370.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -**
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
John R. Whitney
Rocketdyne Division
Rockwell International
6633 Canoga Avenue
Canoga Park, California 91304
16. **MATERIAL AVAILABLE -** Restricted to Use on Government Contracts
Magnetic Tape Transmittal
Source deck (2442 cards)

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Sample problems (62 cards)
Reference report

- 17. CATEGORY - P**
KEYWORDS - SI units, metric system, standardization
- 18. SPONSOR -**

1. **NAME OR DESIGNATION OF PROGRAM** - TPT01
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC7600,6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - TPT01 solves the few-group neutron transport equation with P1 scattering in two dimensions using the discrete ordinate method. The geometries available are rectangular and cylindrical. The problem allows arbitrary up- and down-scattering between groups. Explicit solutions are available for both fixed-source and eigenvalue problems. The program performs gross block depletion for all isotopes in all depletable regions and also performs fine block depletion for any subset of the isotopes in selected regions.
4. **METHOD OF SOLUTION** - Difference equations are obtained at each point by discretizing the transport equation and then integrating the differential equations over an appropriate mesh element. The final difference equations are determined through the use of the weighted diamond approximation. The group equations are solved by using a block Gauss-Seidel iteration method with cyclic Chebyshev acceleration. The eigenvalue problem is solved by the well-known power iteration method with Chebyshev acceleration.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Maxima of -
99 groups
250 discrete ordinates per quadrant
There are very few fixed constraints on spatial problem sizes. The program has successfully run 40,000 point problems with 30 discrete ordinates per quadrant per group for an 11 energy group model.
6. **TYPICAL RUNNING TIME** - Since TPT01 can be used for both large shielding design problems as well as for the depletion of small fuel cells, the running time varies appropriately. For shielding problems with 40,000 points, 8 groups, 30 discrete ordinates per quadrant per group, and r-z geometry, 5 hours are required. For a one time-step depletion calculation of a small fuel cell with 10,000 points, 10 groups, and 6 discrete ordinates in x-y geometry, the program runs approximately 25 minutes. It is important to note that problems in x-y geometry run a factor of 2 faster than problems in r-z geometry. The actual running time may differ widely from these examples due either to special convergence difficulties or to the complexity of the depletion formulation. When using a CDC6600, running time increases by a factor of between 4 and 5.
7. **UNUSUAL FEATURES OF THE PROGRAM** -
8. **RELATED AND AUXILIARY PROGRAMS** - Cross section data may be input on cards or may be obtained from a file generated by a cross section program. On request, TPT01 will prepare output files containing scalar flux, concentration, power, integral, and geometry data, and these files may be further processed in auxiliary programs. TPT01 uses the Bettis Environmental Routines (NESC Abstract 478) and the Bettis Programming Environment Library (NESC Abstract 665).
9. **STATUS** - Abstract first distributed July 1975.
CDC7600 version submitted November 1974.
10. **REFERENCES** - R. J. Selva, TPT01 Reference Manual, WAPD-TM-1120(L), April 1974.
C. J. Pfeifer, CDC6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967.
W. R. Cadwell, (Ed.), Reference Manual - Bettis Programming Environment, WAPD-TM-1181, September 1974.
11. **MACHINE REQUIREMENTS** - 64K small core memory, up to 500,000 words of large core memory (if available), and 4 non-system disks
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV and COMPASS

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13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 2.0.

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHOR -

R. J. Seiva
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122

16. MATERIAL AVAILABLE - Restricted Distribution

Magnetic Tape Transmittal
Source deck (39,686 cards)
Sample problem (68 cards)
Reference report, WAPD-TM-1120(L)

17. CATEGORY - D

KEYWORDS - two-dimensional, few-group, transport theory, depletion, x-y, r-z, discrete ordinate method, HARMONY codes

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - RECAP-12
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - RECAP-12 is a Monte Carlo program which estimates neutron capture rates over the energy range important to the fission process, i.e. 10 MeV to 0 eV. The geometry is a three-dimensional general geometry. General geometry is available through the use of a 'doubly repetitive subcell' concept with elliptical surfaces. There is an eigenvalue capability as well as the usual fixed source capability. Smooth and resonance absorption edits are performed in each composition by nuclide, by energy group. The probable errors on each quantity edited are also computed.
4. **METHOD OF SOLUTION** - All neutron histories are processed group by group until the particle is absorbed, escapes, or its energy falls below some specified cut-point. All events are determined through the use of pseudo random sequences. Estimators include the binomial, the nonterminating $(\sigma_a)/(\sigma_t)$, and the terminating $(\sigma_a)/(\sigma_t)$.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Maxima of -
 - 50 compositions
 - 15 nuclides per composition
 - 10 resonance-type nuclides
 - 5 non-resonance nuclides
 - 50 groups
 - 1000 energy points per group for cross section detail
 - 25 different subcells specified for general geometry
6. **TYPICAL RUNNING TIME** - Running time varies widely depending upon the complexity of the problem.
7. **UNUSUAL FEATURES OF THE PROGRAM** - Features include -
 - (a) inclusion of hydrogen binding effects in the low epithermal energy range through an effective source temperature.
 - (b) availability of an exact perturbation capability for one composition in addition to the usual correlated sampling techniques.
 - (c) optional region edits available through the use of a collision file.
8. **RELATED AND AUXILIARY PROGRAMS** - The detailed cross sections required for the neutron collision process are provided by RECAP-0 (NESC Abstract 671). RECAP-12 is the fourth program in the reported RECAP series and contains the complete capabilities of all previous editions. It uses the Bettis Environmental Routines (NESC Abstract 478) and a number of routines from the Bettis Environmental Library (NESC Abstract 665).
9. **STATUS** - Abstract first distributed May 1975.
CDC7600 version submitted December 1974, sample problem added June 1975.
10. **REFERENCES** - N. R. Candelore and R. C. Gast, Monte Carlo Techniques and Input Description for the CDC-7600 Program, RECAP-12, WAPD-TM-1139(L), October 1974.
R. C. Gast and N. R. Candelore, The RECAP-12 Monte Carlo Eigenfunction Strategy and Uncertainties, WAPD-TM-1127(L), October 1974.
N. R. Candelore and R. C. Gast, RECAP-1: A Monte Carlo Program for Estimating Epithermal Capture Rates in Slabs, WAPD-TM-407, October 1963.
N. R. Candelore and R. C. Gast, RECAP-2: A Monte Carlo Program for Estimating Epithermal Capture Rates in Rod Arrays, WAPD-TM-427, April 1964.
N. R. Candelore and R. C. Gast, RECAP-3: A Monte Carlo Program for Estimating Epithermal Capture Rates in Rectangular or 60 Degree Parallelogram Geometry, WAPD-TM-437, March 1960.
N. R. Candelore and R. C. Gast, RECAP-0: A CDC 6600 Program which Prepares a RECAP-12 Cross Section Library, WAPD-TM-1096(L), October 1974.

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C. J. Pfeifer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967.

W. R. Cadwell, (Ed.), Reference Manual - Bettis Programming Environment, WAPD-TM-1181, September 1974.

11. **MACHINE REQUIREMENTS** - 140,000 (octal) words of central memory
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV and COMPASS
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** -
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
N. R. Candelore and R. C. Gast
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
16. **MATERIAL AVAILABLE** - Restricted Distribution
Magnetic Tape Transmittal
Source decks (FORTRAN 13,853 cards, COMPASS 940 cards)
Sample problem (37 cards)
Sample problem output (49 pages)
Reference reports, WAPD-TM-1127(L) and WAPD-TM-1139(L)
17. **CATEGORY** - C
KEYWORDS - Monte Carlo method, three-dimensional, reaction kinetics, criticality, RECAP-0 codes
18. **SPONSOR** -

1. **NAME OR DESIGNATION OF PROGRAM** - RECAP-0(M0481)
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - RECAP-0 calculates detailed Doppler-broadened neutron resonance cross sections from unresolved and either single level or multilevel resolved resonance parameters, for up to 10 nuclides, within an arbitrary energy structure consisting of up to 49 epithermal groups and 1 thermal group. The highest energy groups are divided into as many as 500 energy intervals for resonance cross section detail. These groups also allow inelastic scattering, expressed through groupwise transfer matrices, for the resonance nuclides and for as many as 5 additional nuclides without detailed resonance descriptions. Subsequent epithermal groups may be subdivided into 1000 intervals, and the thermal group may contain 299 intervals. Elastic scattering for each nuclide is described by the first four components of the differential scattering cross sections in the CM system, and the thermal group will treat two P3 thermal kernels through 25 x 25 transfer matrices. All data used for construction of neutron job libraries are taken from a master neutron cross section library.
4. **METHOD OF SOLUTION** - Point-wise unresolved neutron cross sections are tabulated by RECAP-0 using an approximate sampling scheme, and resonance parameters which obey the Porter-Thomas chi-squared distribution functions. Single level resolved resonance calculations are based on the Breit-Wigner representation, with Doppler broadening using the psi and chi functions evaluated in accordance with the method outlined by Amster. Both the Reich-Moore and Adler-Adler formulations are available in RECAP-0 for treatment of multilevel resonance nuclides. Doppler broadening is performed using the exact kernel treatment described by Solbrig.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Neutron job libraries are limited to 15 nuclides of which 10 are permitted to have detailed resonance cross sections. One set of unresolved parameters is allowed, with up to 100 single level resonances permitted. Multilevel resonance parameters are grouped into spin states. A spin state may contain up to 8 resonances and only the resonances assigned to a given state are allowed to interfere with each other. Forty spin states, or a total of 320 resonances are permitted.
6. **TYPICAL RUNNING TIME** - A typical 30-group library consisting of 10 resonance nuclides, together with 5 non-resonance nuclides, runs approximately 45 minutes on the CDC6600.
7. **UNUSUAL FEATURES OF THE PROGRAM** - RECAP-0 presents its cross section library output both in file manager and FORTRAN binary formats. The file manager file is read directly by RECAP-12 while the binary file may be selectively manipulated by the user before subsequent conversion to file manager format. A merge feature in RECAP-0 permits the user to modify or replace data in an existing library.
8. **RELATED AND AUXILIARY PROGRAMS** - RECAP-0 prepares the cross section libraries for the Monte Carlo neutron transport program RECAP-12 (NESC Abstract 670). RECAP-0 uses the Bettis Environmental Routines (NESC Abstract 478).
9. **STATUS** - Abstract first distributed May 1975.
CDC6600 version submitted December 1974, sample problem added June 1975.
10. **REFERENCES** - N. R. Candelore and R. C. Gast, RECAP-0: A CDC-6600 Program which Prepares a RECAP-12 Cross Section Library, WAPD-TM-1098(L), October 1974.
N. R. Candelore and R. C. Gast, Monte Carlo Techniques and Input Description for the CDC-7600 Program, RECAP-12, WAPD-TM-1139(L), October 1974.
C. J. Pfifer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967.
W. R. Cadwell, (Ed.), Reference Manual - Bettis Programming Environment, WAPD-TM-1181, September 1974.
11. **MACHINE REQUIREMENTS** - 140,000 (octal) words of central memory

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- 12. PROGRAMMING LANGUAGES USED - FORTRAN IV and COMPASS**
- 13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE.**
- 14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** Subroutine NEXT from the Bettis Environmental Library (NESC Abstract 665) has been included as part of the RECAP-0 package.
- 15. NAME AND ESTABLISHMENT OF AUTHORS -**
N. R. Candelore and R. C. Gast
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
- 16. MATERIAL AVAILABLE - Restricted Distribution**
Magnetic Tape Transmittal
Source decks (FORTRAN 4209 cards, COMPASS 940 cards)
Sample problem (90 cards)
Sample problem output (48 selected pages)
Reference report, WAPD-TM-1096(L)
- 17. CATEGORY - B**
KEYWORDS - Doppler broadening, resonance, cross sections, libraries, Breit-Wigner formula, Porter-Thomas distribution, inelastic scattering, MUFT codes, MAGMA codes, RECAP-12 codes
- 18. SPONSOR -**

1. **NAME OR DESIGNATION OF PROGRAM - HONDO**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600**
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** HONDO is used to compute the time-dependent displacements, velocities, accelerations, and stresses within elastic or inelastic, two-dimensional or axisymmetric bodies of arbitrary shapes and materials.
4. **METHOD OF SOLUTION -** HONDO is a finite-element method program. To accommodate a variety of applications, the user has a choice between either finite strain calculations or infinitesimal strain calculations. Spatially, the program employs a four-node isoparametric quadrilateral element. In time, the program performs the integration using a central-difference method time integrator. Since the time integration scheme is only conditionally stable with respect to step-size, the program continuously monitors the step-size and adjusts it to keep the calculation stable. The program contains eight material subroutines covering elastic, viscoelastic, elastic-plastic, crushable foam, and soil behavior. Initial conditions on velocity but not displacement are allowed. Pressure loadings are allowed. Thermal loads are not implemented.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** HONDO is called by a main program, SIZE (6 cards), whose sole function is to declare tapes and define the dimension of COMMON array A so that the amount of storage is greater than or equal to that needed for the solution. Large problems are easily accommodated and are limited only by the core storage available.
6. **TYPICAL RUNNING TIME -** The running time is entirely dependent upon the maximum time requested. The sample problem, which is comprised of 142 nodes, 70 elements, and 236 time-steps, runs in 29 seconds.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -**
9. **STATUS -** Abstract first distributed December 1975.
CDC6600 version submitted September 1975, replaced by revised Edition B June 1976, sample problem executed by NESC August 1976 on a CDC7600 via remote terminal to Brookhaven National Laboratory.
10. **REFERENCES -** S. W. Key, HONDO - A Finite Element Computer Program for the Large Deformation Dynamic Response of Axisymmetric Solids, SLA-74-0039, April 1974.
S. W. Key, A Finite Element Procedure for the Large Deformation Dynamic Response of Axisymmetric Solids, Computer Methods in Applied Mechanics and Engineering, Vol. 4, pp. 195-218, 1974.
Installation Dependent Features of HONDO, SLA Note, October 1975.
11. **MACHINE REQUIREMENTS -** 3 tapes besides the standard input/output units are required.
12. **PROGRAMMING LANGUAGE USED - FORTRAN IV**
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.3.**
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** The function SECOND (T) and subroutine FTNBIN (1,0,IDUM) are machine-dependent routines but are standard on the CDC6600 SCOPE library. The argument, T, for SECOND is the CP time in seconds from dead start. The subroutine FTNBIN controls the blocking of tape 7 and tape 10 in HONDO for compatibility with local Sandia mesh-generators and plot codes.
The subroutine HOROLOG (IDUM,IDUM,IDATE) is a local Sandia routine. The first two parameters are not used in HONDO. The third parameter IDATE is the current date returned in Hollerith as month, day, and year in the format mm/dd/yy.

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15. NAME AND ESTABLISHMENT OF AUTHOR -

S. W. Key
Division 1281
Sandia Laboratories
P. O. Box 5800
Albuquerque, New Mexico 87115

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (2154 cards)
Sample problem (26 cards)
Reference report, SLA-74-0039, and SLA Note

17. CATEGORY - I

KEYWORDS - two-dimensional, deformation, finite element method, numerical solution, solids, mechanical structures, accidents, stresses, nonlinear problems, strains

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SIEX
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600, CYBER74
3. DESCRIPTION OF PROBLEM OR FUNCTION - SIEX is a steady-state heat transfer code for the calculation of mixed-oxide fuel pin thermal performance and dimension change (swelling and thermal expansion) in a fast neutron environment. Fuel restructuring, fuel and cladding displacements due to swelling and thermal expansion, fuel-to-cladding gap heat transfer, and fission gas release are included to provide an assessment of fuel, cladding, and coolant temperatures.
4. METHOD OF SOLUTION - The fuel pin is assumed to be axisymmetric, with the fuel region divided axially into segments of equal height. Material temperatures are computed using common one-dimensional solutions to the heat transfer equations. Certain physical phenomena such as fuel-to-cladding gap closure, fuel-to-cladding heat transfer, fuel restructuring, and fission gas release are modeled using physically based models correlated to data from a test program studying the performance of fast reactor fuels.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
21 axial segments
10 radial nodes in the fuel
10 time-step per printout intervals
6. TYPICAL RUNNING TIME - Approximately 0.5 second per case (21 nodes, 10 print intervals) is required on the CDC CYBER74.
7. UNUSUAL FEATURES OF THE PROGRAM - Models correlated to thermal performance data from EBR-II irradiation tests are used to replace complicated mathematical models which would result in significantly larger computer storage and longer computational time. The result is a fast running code which may be used to predict thermal performance for fast reactor fuels with fabrication parameters and operating conditions similar to the fuel pins included in the data set.
8. RELATED AND AUXILIARY PROGRAMS - MELT III-A, the neutronics, thermal-hydraulic program for fast reactor safety described in HEDL-TME 74-47.
9. STATUS - Abstract first distributed December 1975.
CDC CYBER74 version submitted September 1975, sample problem executed by NESC December 1975 on a CDC7600 via remote terminal to Brookhaven National Laboratory.
10. REFERENCES - D. S. Dutt and R. B. Baker, SIEX: A Correlated Code for the Prediction of Liquid Metal Fast Breeder Reactor (LMFBR) Fuel Thermal Performance, HEDL-TME-74-55, June 1975.
11. MACHINE REQUIREMENTS - The amount of core storage required is 50K (octal) of 60-bit words. No auxiliary storage is needed and the input/output devices are selected by the user.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.4.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
D. S. Dutt
Hanford Engineering Development Laboratory
Westinghouse Hanford Company
P. O. Box 1970
Richland, Washington 99352

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (1809 cards)

Sample problem (27 cards)

Sample problem output (42 pages)

Reference report, HEDL-TME-74-55

17. CATEGORY - H

KEYWORDS - one-dimensional, heat transfer, correlations, fuels, fission products, LMFBR reactors, MELT III-A codes

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM - SAFTAC**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
UNIVAC1108, IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** SAFTAC is a Monte Carlo fault tree simulation program that provides a systematic approach for analyzing system design, performing trade-off studies, and optimizing system changes or additions.
4. **METHOD OF SOLUTION -** SAFTAC assumes an exponential failure distribution for basic input events and a choice of either Gaussian distributed or constant repair times. The program views the system represented by the fault tree as a statistical assembly of independent basic input events, each characterized by an exponential failure distribution and, if used, a constant or normal repair distribution.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** The program is dimensioned to handle 1100 basic input events and 1100 logical gates. It can be redimensioned to handle up to 2000 basic input events and 2000 logical gates within the existing core memory.
6. **TYPICAL RUNNING TIME -** Running time is dependent upon the fault tree size and structure and the degree of resolution in the quantitative evaluation desired.
7. **UNUSUAL FEATURES OF THE PROGRAM -** The fault tree technique provides analysis flexibility which ranges from equipment analysis to over-all plant analyses incorporating all the influencing elements on a total-system basis. The deductive approach used in this technique is useful for evaluating design consistency and reliability, for judging alternatives, for determining acceptability of trade-offs, and for analyzing multiple failure combinations and common mode failures in complex systems. The fault tree method allows analyses to consider the rate at which failures or events are detected after they occur (detection time) and the rates at which they are restored to normal (repair time). The fault tree method is concerned with assuring that all critical activities are identified and eliminated or controlled. A system, when defined in terms of the all encompassing analysis capability of fault tree analysis, is a composite of operational and support equipment, personnel, facilities and software which are used together as an entity and are capable of performing and/or supporting an operational role.
8. **RELATED AND AUXILIARY PROGRAMS -** SAFTAC is an improved version of an earlier program. See reference 5.
9. **STATUS -** Abstract first distributed August 1975.
UNIVAC1108 version submitted December 1974.
IBM360,370 version submitted May 1977, sample problem executed by NESC June 1978 on an IBM370/195.
10. **REFERENCES -** Paul A. Crosetti, Fault Tree Simulation Computer Program, DUN-7697, June 1971.
P. A. Crosetti and R. A. Bruce, Commercial Application of Fault Tree Analysis, Ninth Reliability and Maintainability Conference, Annals of Reliability and Maintainability, Vol. 9, p. 230, 1970.
P. A. Crosetti, Fault Tree Analysis with Probability Evaluation, DUN-SA-157, November 3, 1970.
P. A. Crosetti, Fault Tree Analysis for Reactor Systems, DUN-SA-165, February 25, 1971.
P. A. Crosetti, Computer Program for Fault Tree Analysis, DUN-5508, April 1969.
Excerpt from CSCX RJE/CRJE Reference, Vol. 2: Library Elements, E00003-02-00, April 1971.
NOTES ON THE IBM VERSION OF SAFTAC, NEA-CPL Note, November 22, 1976.
11. **MACHINE REQUIREMENTS -** 300K bytes for compilation, 140K bytes for running the sample problem on an IBM370.

12. **PROGRAMMING LANGUAGES USED** - FORTRAN V and SLEUTH (UNIVAC1108), FORTRAN IV (IBM360)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - CSCX or EXEC2 (UNIVAC1108), OS/360,370 (IBM360,370).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The CALL OVERFL(K000FX) statement on UNIVAC1108 execution causes the overflow condition to be set for K000FX=1; for K000FX=2 the condition is not set.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
1108 P. A. Grosetti
United Nuclear Industries, Inc.
P. O. Box 490
Richland, Washington 99352

360 L. Garcia de Viedma
NEA Data Bank
B. P. 9
Batiment 45
91190 Gif-sur-Yvette, France
16. **MATERIAL AVAILABLE** -
Source decks (1108-665 cards, 360-769 cards)
Sample problems (1108-11 cards, 360-11 cards)
Reference report, DUN-7697, Excerpt, and NEA-CPL Note appropriate to machine version
17. **CATEGORY** - G
KEYWORDS - fault tree analysis, reliability, probability, system failure analysis, Monte Carlo method
18. **SPONSOR** - ERDA Richland Operations Office

1. **NAME OR DESIGNATION OF PROGRAM - EPISODE**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360,370 (see item 14)
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** EPISODE is a package of eight subroutines for the numerical solution of the initial-value problem for systems of first-order ordinary differential equations. The package can be used for either stiff or non-stiff systems. It is especially suited to problems with intermittent high-speed transients.
4. **METHOD OF SOLUTION -** EPISODE contains both a variable-step, variable-order backward differentiation method of orders one through five and a variable-step, variable-order implicit Adams method of orders one through twelve. The user may select either method to solve a stiff or a non-stiff system. He may also select from four nonlinear system solvers.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Because the stepsize is truly variable, EPISODE is best suited to problems with intermittent high-speed transients. Smooth problems can lead to high overhead costs. Current dimensioning allows for 20 simultaneous equations. The documentation and comments in DRIVE show how to alter this limit.
6. **TYPICAL RUNNING TIME -** Less than 1 minute is required to compile and execute the sample problem.
7. **UNUSUAL FEATURES OF THE PROGRAM -** The user may select from two integration methods (for stiff and non-stiff problems), and from four nonlinear system solvers. A flexible driver (subroutine DRIVE) returns output data at a previously-specified point by interpolation, provides output data by hitting the prescribed output point without interpolation, or returns data after each step. Absolute error, true relative error, or a quasi-relative error may be controlled. DRIVE controls the integration process and prints any error messages.
8. **RELATED AND AUXILIARY PROGRAMS -** GEAR (NESC Abstract 592) for systems with a full Jacobian, and GEARB (NESC Abstract 661) for systems with a banded Jacobian matrix.
9. **STATUS -** Abstract first distributed August 1975.
IBM360 version submitted May 1975, sample problem executed by NESC July 1975 on an IBM370/195.
10. **REFERENCES -** A. C. Hindmarsh and G. D. Byrne, EPISODE: An Experimental Package for the Integration of Systems of Ordinary Differential Equations, UCID-30112, May 1975.
A. C. Hindmarsh and G. D. Byrne, Applications of EPISODE: An Experimental Package for the Integration of Systems of Ordinary Differential Equations, UCRL-75868, June 1975.
G. D. Byrne and A. C. Hindmarsh, A Polyalgorithm for the Numerical Solution of Ordinary Differential Equations, ACM Transactions on Mathematical Software, Vol. 1, pp. 71-96, March 1975. (Also in UCRL-75652, April 1974.)
A. C. Hindmarsh, GEARB: Solution of Ordinary Differential Equations having Banded Jacobian, UCID-30059, Rev. 1, March 1975.
G. D. Byrne, A. C. Hindmarsh, K. R. Jackson, and H. G. Brown, Comparative Test Results for Two ODE Solvers—EPISODE and GEAR, ANL-77-19, March 1977.
G. D. Byrne, ACC Programming Note 76-3, August 21, 1975.
11. **MACHINE REQUIREMENTS -** 62K bytes are used to execute the double-precision version of the sample problem.
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/360,370 (IBM360,370).

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The code is heavily commented. An auxiliary routine, CONVRT, and its driver are provided to change precision from double to single. The user then need only change UROUND in subroutine DRIVE as indicated in the code. A CDC6000-7000 version can be prepared from the IBM version with only minor changes. If EPISODE is to be used on other systems, UROUND (the machine unit roundoff) may need to be evaluated and set in subroutine DRIVE. The package contains an auxiliary subroutine, MACHIN, and its driver (supplied to NESC by L. F. Shampine and M. K. Gordon of SLA) which may be adapted to verify or calculate UROUND. Error messages and the printed output of the sample problem are on logical unit 3.
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
G. D. Byrne
Department of Mathematics
University of Pittsburgh
Pittsburgh, Pennsylvania 15260
A. C. Hindmarsh
Numerical Mathematics Group, L-310
Lawrence Livermore Laboratory
P. O. Box 808
Livermore, California 94550
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (1664 cards)
Sample problem (137 cards)
Auxiliary programs (153 cards)
Sample problem output (9 pages)
Reference reports, UCID-30112 and UCRL-75868, and ACC Programming Note 76-3
17. **CATEGORY** - P
KEYWORDS - ordinary differential equations, numerical solution, initial-value problems, Adams method, GEAR codes, GEARB codes
18. **SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - DEMO4

2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC7600

3. DESCRIPTION OF PROBLEM OR FUNCTION - DEMO4 is a simulation model used to generate thermal-hydraulic transients for the Clinch River LMFBR demonstration plant. The three heat transport loops of the plant are simulated by a two-loop model. One loop, the L-loop, represents two of the actual plant loops, and the second loop, the S-loop, represents a single plant loop.

Thermal power is generated by point neutron kinetics and decay heat tables. The vessel internals are represented by a lower plenum, lower axial blanket, active core, upper axial blanket, radial blanket, bypass channel and an upper plenum with a variable sodium level and a cover gas. Plenum stratification on reduced flow can be modelled. The heated sodium leaves the vessel upper plenum to the primary heat transport system and returns to the vessel lower plenum. The overflow nozzle of the sodium purification system effects the vessel upper plenum level, as well as a user-input return flow from this system.

Each primary heat transport system is represented by piping, valves, the primary pump tank with a free surface and cover gas, and the shell side of the IHX. Each intermediate heat transport system is represented by piping, the tube side of the IHX, the shell side of the superheater and evaporator, and the intermediate pump.

Each water-steam system is represented by piping, recirculation pumps, the tube side of the superheater and evaporator, and a steam drum. The steam leaving all superheaters enters a common steam header, flows through piping to the turbine throttle valve and a steam dump valve. Limited modelling is provided for the feedwater system.

4. METHOD OF SOLUTION - The DEMO code contains sufficient detail in both model and time resolution to handle CRBR plant operational transients and failure events. The reactor model provides both average and hot channel calculations in core in sufficient detail to accommodate most sub-prompt critical excursions. DEMO also provides two optional special-case calculations - the primary sodium pipe rupture (RUPTURE) and the steam break and blowdown (SUSOD). DEMO uses two integration methods. The SUSOD model, a specialized steam generator program for blowdown and steam/feed pipe break analyses, runs semi-independently on its own variable time-steps, which are set by an internal time-step criterion. These time-steps are typically much shorter than the time-steps of the main program. The simplified steam generator model, STGEN, will call SUSOD at each time-step, and subsequently SUSOD will run using its own time-steps until it reaches the time of the next STGEN step, at which time it will return to the calling program. This cycle will be repeated at each time-step.

The remaining program uses Euler integration. Under normal transient conditions the reactor and protection system integrate on a 0.01 second time-step (H fast) and the remainder of the program integrates on a 0.05 second time-step (H). However, to accommodate slow thermal-hydraulic transients, there is a time-step control to allow for large time-steps (H=0.1 second).

5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The reactor core model in DEMO provides only for single-phase liquid sodium flow. The steam generator model represents the mixing zone as if it is a small mixed volume at the drum bottom. The remainder of the drum is assumed homogeneous.

6. TYPICAL RUNNING TIME - The sample problem requires about 15 minutes.

7. UNUSUAL FEATURES OF THE PROGRAM -

8. RELATED AND AUXILIARY PROGRAMS - DEMO4 is revision 4 of the DEMO program.

9. STATUS - Abstract first distributed October 1975.

CDC7600 version of DEMO submitted May 1975, revised July 1975, replaced by DEMO4 February 1976, sample problem executed by NESC August 1976 on a CDC7600 via remote terminal to Brookhaven National Laboratory.

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10. **REFERENCES** - Clinch River Breeder Reactor Plant Nuclear Island, LMFBR Demonstration Plant Simulation Model (DEMO), WARD-C-0005, Revision 0, November 15, 1973, Revision 1, February 5, 1974, Revision 2, July 30, 1974, Revision 3, February 15, 1975, and April 15, 1975, Revision 4, January 23, 1976.
11. **MACHINE REQUIREMENTS** - 1 user-defined tape or disk is required for optional plotting in addition to the standard input/output devices.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 2.0.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - In routine USERMAN the user sets up a time limit, CPTLIM, which is later compared to the elapsed time to determine when the problem should be terminated.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
Performance Analysis Group
CRBRP Plant Engineering
Advanced Reactors Division
Westinghouse Electric Corporation
Box 158
Madison, Pennsylvania 15663

Contact W. H. Alliston
16. **MATERIAL AVAILABLE** - Restricted Distribution
Magnetic Tape Transmittal
Source deck (8866 cards)
Sample problem (640 cards)
Reference report and Revisions
17. **CATEGORY** - K
KEYWORDS - simulation, nuclear power plants, transients, pipes, blowdown, steam generators, LMFBR reactors, DEMO codes
18. **SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - MARGE/SLUMP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - The MARGE/SLUMP code performs a series of one-dimensional (radial) calculations at fixed intervals along the axial length of a LMFBR fuel element to determine sodium temperature, clad temperature, fuel temperature, central void diameter, and amount of fuel addition or removal necessary to maintain the inner surface of the central void at the melting temperature of mixed oxide fuel.
4. METHOD OF SOLUTION - Calculation of coolant temperature, initial temperature differentials across the fuel element clad and the gas bond region, and the temperature field within the fuel, are based on a chopped cosine power distribution. Volumetric heat generation rate is assumed to be proportional to the local fuel density. Geometry of the initial density, equiaxed and columnar grain growth regions are determined by integration of the mixed-oxide thermal conductivity correlation between the temperature bounds for the model being used. Fuel slumping after melting is determined from calculations involving the decrease of fuel in the upper portion of the fuel column until the central void inner-surface temperature equals the fuel melting temperature and the corresponding increase in amount of fuel in the lower portion until the central void inner-surface temperature equals the melting temperature or the void is completely filled.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - In the present version, fuel relocation results must be processed manually.
6. TYPICAL RUNNING TIME - Compilation time is 6 seconds, and execution of the sample problem takes 1 second.
7. UNUSUAL FEATURES OF THE PROGRAM - MARGE/SLUMP takes into consideration the temperature dependence of clad thermal conductivity, and a variable fuel-clad gap conductance that is specified for each axial level. Five mixed-oxide fuel models describing fuel thermal conductivity and restructuring parameters (GE, AI, Karlsruhe, W, and FFTF) are options within the code. Two options exist to describe the downward slumping of molten fuel:
 - (a) the central void fills completely in the lower portion of the fuel pin, or
 - (b) a fuel bridge forms at the location where the molten fuel can solidify to the center.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed July 1975.
IBM360 version submitted April 1975, sample problem executed by NESC July 1975 on an IBM370/195.
10. REFERENCES - D. H. Thompson and W. W. Marr, Prediction of Maximum Temperature or Melting Fraction in a LMFBR Fuel Element, Nuclear Engineering and Design, Vol. 17, pp. 361-370, 1971.
W. W. Marr, MARGE/SLUMP, A Computer Code for Predicting Maximum Temperature or Melting Fraction with Fuel Relocation in a LMFBR Fuel Element, ANL Note, March 28, 1975.
11. MACHINE REQUIREMENTS - 240K bytes of core
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360,370.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
D. H. Thompson
Reactor Analysis and Safety Division

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9700 South Cass Avenue
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A. Padilla, Jr.
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Westinghouse Hanford Company
P.O. Box 1970
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16. MATERIAL AVAILABLE -

Source deck (1386 cards)
Sample problem (12 cards)
Sample problem output (5 pages)
Reference reprint and ANL Note

17. CATEGORY - H

KEYWORDS - fuel elements, heat transfer, melting, temperature, thermal conductivity, LMFBR reactors

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM -** MORTRAN2
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** MORTRAN2 is a FORTRAN language extension that permits a relatively easy transition from FORTRAN to a more convenient and structured language. Its features include free-field format; alphanumeric statement labels; flexible comment convention; nested block structure; for-by-to, do, while, until, loop, if-then-elseif-else, exit, and next statements; multiple assignment statements; conditional compilation; and automatic listing indentation. The language is implemented by a macro-based pre-processor and is further extensible by user-defined macros.
4. **METHOD OF SOLUTION -** The MORTRAN2 pre-processor may be regarded as a compiler whose object code is ANSI Standard FORTRAN. The MORTRAN2 language is dynamically defined by macros which are input at each use of the pre-processor.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** The pre-processor output must be accepted by a FORTRAN compiler.
6. **TYPICAL RUNNING TIME -** Processing of the sample problem used about 2 seconds.
7. **UNUSUAL FEATURES OF THE PROGRAM -** The MORTRAN2 pre-processor is written in ANSI Standard FORTRAN, and the output also is FORTRAN so that transportability of both the pre-processor and its generated programs is assured. By changing the input macros, a knowledgeable user can tailor MORTRAN2 to a specific need, or he can develop an entirely new high-level language and still preserve portability.
8. **RELATED AND AUXILIARY PROGRAMS -** MORTRAN2 is an extension of the earlier MORTRAN language used for SLAC high energy physics applications.
9. **STATUS -** Abstract first distributed October 1975.
IBM360 version submitted July 1975, sample problem executed by NESC August 1975 on an IBM370/195.
10. **REFERENCES -** A. James Cook and L. J. Shustek, A User's Guide to MORTRAN2, SLAC CTGM No. 165, June 1975.
A. James Cook and L. J. Shustek, MORTRAN2, A Macro-based Structured FORTRAN Extension, SLAC-PUB-1527, January 1975.
11. **MACHINE REQUIREMENTS -** 170K bytes of memory
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/360,370.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** MORTRAN2 should be readily adaptable for use on non-IBM computers. It is expected that the version being distributed will be integrated into the operating system via cataloged procedures. MORTRAN2 can, however, be implemented as a stand-alone batch job. The MORTRAN2 user's guide and a system programmer's guide are included as files on the transmittal tape.
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
A. James Cook and L. J. Shustek
Computation Research Group
Stanford Linear Accelerator Center
Stanford, California 94305
16. **MATERIAL AVAILABLE -** Magnetic Tape Transmittal
Source decks (file 4-reserved word macros 87 cards, file 6-bracketed keyword macros 90 cards, file 8-MORTRAN2 792 cards)
Object decks (file 3-393 cards)

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Sample problem input (file 5-reserved word version 54 cards, file 7-bracketed keyword version 54 cards)
Auxiliary information (file 1-tape description 291 cards, file 2-user's guide 2233 cards, file 10-system programmer's guide 764 cards, file 11-bootstrap 465 cards)
Control information (file 9-JCL 803 cards)
Sample problem output (4 pages)
Reference reports and Installation Guide Tape Description

17. **CATEGORY - P**
KEYWORDS - FORTRAN, structured programming, programming languages
18. **SPONSOR -**

1. NAME OR DESIGNATION OF PROGRAM - RANDOM SAMPLING TABLE(RND424RQ)
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - This program is designed to generate a uniformly random sequence of numbers for ordering laboratory test samples to eliminate any bias from the testing.
4. METHOD OF SOLUTION - The program can be used to randomize any set of consecutive non-repeating integers between the starting and ending numbers prescribed by the input data. A basic assumption is made that the same set of test samples will not need to be reordered more often than once a day. The program uses the current day in selecting the initial numbers for the random sequencing procedure.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The starting number must be less than the ending number, and all numbers must be less than 2,147,483,648.
6. TYPICAL RUNNING TIME - 0.5 to 5 minutes CPU time is required on the IBM360/50.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed July 1975.
IBM360 version submitted January 1975.
10. REFERENCES - Frank L. Conkle, User Guide and System Documentation for Job RND424RQ, Monsanto Research Corporation Mound Laboratory Report, February 1974.
11. MACHINE REQUIREMENTS - A 64K region is required and 1 IBM2314 disk is used.
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and COBOL
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Subroutine RANDU from the IBM/360 Scientific Subroutine Package Version 3, August 1970 (reference GH20-0205-4) is used to generate the random numbers. The Mound Laboratory's COBOL DATE routine supplies the current date from the system and the standard IBM SORT is employed to accomplish the sorting prior to printing the output.
15. NAME AND ESTABLISHMENT OF AUTHORS -
Frank L. Conkle and Thomas C. Bishop
Mound Laboratory
Monsanto Research Corporation
Miamisburg, Ohio 45342
16. MATERIAL AVAILABLE -
Source deck (164 cards including JCL and a single input data card)
Auxiliary program source decks (RANDU 61 cards)
Object decks (RANDU 10 cards, DATE 19 cards)
Sample problem output (11 pages)
Reference report
17. CATEGORY - M
KEYWORDS - statistics, sampling, randomness
18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - MARLOWE
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360,370, CDC7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - MARLOWE generates atomic displacement cascades in crystalline solids and analyzes many of their properties. Analyses available include primary recoil range distributions, replacement sequence directions and length distributions, distributions of pair separations, and various detailed cascade reports.
4. **METHOD OF SOLUTION** - Particle trajectories are constructed as series of isolated classical binary collisions, using the Moliere or the Born-Mayer potential to describe the interactions.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The program is limited to ten crystallographically or chemically nonequivalent atoms and 2000 displaced atoms in a single cascade in the IBM REAL-8 version of the program. The IBM REAL-4 and the CDC versions have four nonequivalent atoms and 5000 displaced atoms in a single cascade. These limits are readily altered, depending on the problem requirements and machine size available.
6. **TYPICAL RUNNING TIME** - Less than 2 minutes is required to compile and execute a typical sample problem.
7. **UNUSUAL FEATURES OF THE PROGRAM** - A displacement cascade is developed in a crystalline solid as a series of isolated classical binary collisions, using a conservative central potential to describe the interatomic interactions. An approximate treatment of nearly simultaneous collisions is provided. Either local or nonlocal inelastic (electronic) energy losses may be included. A simple model of uncorrelated Gaussian thermal displacements of the lattice atoms is available.

The target crystal may be unbounded, have a specified plane surface, or two parallel plane surfaces at a specified separation. It may be perfect or it may contain either vacancies or interstitials at specified locations. The crystal may have any structure describable by orthorhombic coordinates and may contain several kinds of atoms. The lattice sites may be occupied statistically by different kinds of atoms or by vacancies. If desired, the target crystal may be either polycrystalline or amorphous. Angular divergence of an incident beam may be included.

Lattice atoms enter the cascade if they receive a kinetic energy greater than a threshold energy 'EDISP'. Optionally, a binding energy may be subtracted from the initial kinetic energy of a displaced lattice atom. Cascade atoms are followed collision by collision until their energies fall below a specified limit 'EQUIT' or until certain other conditions are met. At each collision priority is normally given to the highest speed particle currently in the cascade. If a target atom is displaced and the kinetic energy of the projectile falls below the lesser of 'EDISP' and 'EQUIT', the projectile either replaces that target atom on its lattice site or returns to its own original site, whichever is nearer. Information about replacing atoms proper to a lattice site may be either preserved or suppressed (to save storage). Stopped cascade atoms are left at the turning points of their last collisions. Optionally, stopped cascade atoms may become targets in later collisions.

At the end of the development of a collision cascade, the atoms and lattice sites involved are paired and classified as 'close', 'near', or 'distant' pairs, depending on their separation distances.

Several types of analyses of the calculated results can be obtained automatically and other procedures are easily constructed. The program is constructed in a modular manner which permits the replacement of many parts or the omission of unnecessary ones.
8. **RELATED AND AUXILIARY PROGRAMS** -
9. **STATUS** - Abstract first distributed December 1975.

IBM360,370 version submitted April 1975, replaced by revised edition November 1975, replaced by Edition B March 1976, replaced December 1978 by Edition D submitted July 1978, sample problems executed by NESC November 1978 on an IBM370/195 and an IBM3033.

CDC7600 version submitted July 1978, sample problems executed by NESC November 1978 on a CDC7600.

10. **REFERENCES** - Mark T. Robinson and Ian M. Torrens, Computer Simulation of Atomic-Displacement Cascades in Solids in the Binary-Collision Approximation, Physical Review B, Vol. 9, No. 12, pp. 5008-5024, June 15, 1974.
 Marc Fou and Mark T. Robinson, Computer Studies of Low Energy Scattering in Crystalline and Amorphous Targets, Nuclear Instruments and Methods, Vol. 132, pp. 641-645, 1976.
 Ordean S. Oen and Mark T. Robinson, Computer Studies on the Reflection of Light Ions from Solids, Nuclear Instruments and Methods, Vol. 132, pp. 647-653, 1976.
11. **MACHINE REQUIREMENTS** - The IBM version requires 550K bytes (REAL*4 form) and 440K bytes (REAL*8 form). The CDC7600 version requires 46,000 (octal) words of SCM and 365,000 (octal) words of LCM storage.
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV (97%) and BAL (3%) (IBM360,370), FORTRAN IV (CDC7600)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360,370 (IBM360,370), SCOPE 2.1 (CDC7600).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The IBM version exists in two forms--the single-precision form called 'REAL*4' and the double-precision form, 'REAL*8'. Slightly different test results may occur on different IBM models with different arithmetic or using different mathematical subroutine libraries. In NESC testing the author's results were duplicated using the IBM370/195 and the AMDLIB subroutines. Differences were noted on the IBM3033 execution of the sample problems.
 The IBM Assembly language routines include RANF, a random number generator, DATE, a routine to provide the date in MM-DD-YY format, SECOND, a routine to supply the time in seconds, and MODEL, a routine to determine the IBM machine model used.
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
 Mark T. Robinson
 Solid State Division
 Oak Ridge National Laboratory
 P. O. Box X
 Oak Ridge, Tennessee 37830
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
 Source decks (360-FORTRAN 6395 and 6342 cards, BAL 198 cards, 7600-6314 cards)
 Sample problems (360-69 cards, 7600-77 cards)
 Sample problems output (360-50 selected pages, 4069 tape records*, 7600-51 selected pages)
 Machine-readable documentation (1992 cards)
 *RECFM=FBA,LRECL=133,BLKSIZE=2660
17. **CATEGORY** - Q
KEYWORDS - collisions, particle interactions, radiation effects, solids, crystals
18. **SPONSOR** - DOE Office of Basic Energy Sciences,
 Division of Materials Sciences

1. **NAME OR DESIGNATION OF PROGRAM - ACCEL MOD2**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
UNIVAC1108, CDC6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** ACCEL is a set of computer programs designed to aid in the construction of electronic printed circuit boards. The ACCEL system performs the following tasks -
 - (1) edits the engineers' data, resolves the schematic into a node component-list, looks up physical and electrical data for the parts used in the circuit, and notes any errors in the data;
 - (2) locates the components on the board by an iterative process;
 - (3) lays out the interconnection pattern between components; and
 - (4) generates the output plots.
4. **METHOD OF SOLUTION -** Input information is furnished by the circuit designer in the form of a circuit schematic drawing and information on the parts used in the circuit. This information is then transcribed onto punched cards. The computer output is graphical in the form of several plots. These include (1) a schematic drawing, (2) a parts list, (3) an assembly drawing showing the location of parts on the printed circuit board, (4) a hole-drilling coordinate list, and (5) masks to be used in etching the circuit board layers.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -**
6. **TYPICAL RUNNING TIME -**
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -** This program is the ALO-00199 and ALO-00200 programs transferred from the ALO-COSMIC collection.
9. **STATUS -** Abstract first distributed October 1975.
UNIVAC1108 version submitted October 1973.
CDC6600 version submitted October 1973, re-submitted December 1974.
10. **REFERENCES -** C. J. Fisk and D. L. Caskey, User's Manual for ACCEL System (Mod 2), SC-M-69-G01, November 1969.
C. J. Fisk and D. L. Caskey, Program Documentation for ACCEL MOD 2, SC-M-69-602, December 1969.
11. **MACHINE REQUIREMENTS -** 45,000 decimal words of storage, 10 separate files (3 tape, the rest drum or disk), and a machine word length of 36 bits or greater
12. **PROGRAMMING LANGUAGES USED -** FORTRAN and Assembly language
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** EXEC2 (UNIVAC1108) and SCOPE 3.1.5 (CDC6600).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** The primary output format of ACCEL is a series of plots, and the current plotter device is the Stromberg Datagraphix SC-4020. The standard package of routines for this device called SCORS, Stromberg-Carlson Output Recorder System, is contained in the program. SCORS packages for other machines are available through:

UAIDE Librarian
c/o Stromberg-Carlson
P. O. Box 2449
San Diego, California 92112

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15. NAME AND ESTABLISHMENT OF AUTHORS -

C. J. Fisk and D. L. Caskey
Advanced Techniques Division
Sandia Laboratories
P. O. Box 5800
Albuquerque, New Mexico 87115

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (6600-16,596 cards, 1108-CUR format 1346 source and relocatable records)
Sample problems (6600-3715 cards, 1108-CUR format 3715 records)
Absolute form (1108-CUR format 278 binary records)
Reference reports

17. CATEGORY - T

KEYWORDS - electronic circuits, computer aided design, computer graphics

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - GNATS/MESH2/GPRINT
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - GNATS is a finite element computer program designed for nonlinear analysis of axisymmetric and two-dimensional static structures.
4. **METHOD OF SOLUTION** - The GNATS program is based on a total Lagrangian description of the displaced equilibrium configuration. The complete strain-displacement equations are used to include the effects of large displacements and large strains. Elastic-plastic material behavior, with either isotropic or kinematic hardening, may be selected. All solution options included in GNATS contain an equilibrium check which assures that the structure satisfies equilibrium to a specified tolerance at each stage of loading.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - All large arrays in GNATS, MESH2, and GPRINT are dynamically dimensioned to minimize storage requirements.
6. **TYPICAL RUNNING TIME** - For GNATS, running time is highly dependent on the problem to be analyzed. Running times for MESH2 and GPRINT are nominal.
7. **UNUSUAL FEATURES OF THE PROGRAM** - GNATS is designed for the general nonlinear analysis of two-dimensional structures. The MESH2 preprocessor enables the user to generate either a four node or eight node quadrilateral element and compute several parameters which are useful in evaluating the mesh. Mesh generation is accomplished by simultaneously defining the boundary of the domain in two spaces: the r-z plane which contains the plane to be analyzed, and an integer i-j plane which controls the density of the subdivisions. The integer i-j mesh is then mapped onto the r-z domain using Laplace's equation in second-difference form to determine the coordinates of interior nodal points. The GPRINT postprocessor provides users with considerable flexibility in selecting the most appropriate data to be printed. Variable FORMAT statements provide additional printing flexibility.
8. **RELATED AND AUXILIARY PROGRAMS** - MESH2 was developed as a preprocessor mesh generator for GNATS; GPRINT as a postprocessor output editor. VIEW is a graphic display program for finite element code output data. MESH2 and GPRINT are supplied in the GNATS package; VIEW is not yet available.
9. **STATUS** - Abstract first distributed November 1975.
CDC6600 version submitted March 1975.
10. **REFERENCES** - M. L. Callabresi and R. C. Young, GNATS - A Finite Element Computer Program for the General Nonlinear Analysis of Two-dimensional Structures, SLL-74-0023, October 1974.
M. L. Callabresi and R. C. Young, Organization of GNATS - A General Nonlinear Analysis Computer Program for Two-dimensional Structures, SLL-74-0022, October 1974.
11. **MACHINE REQUIREMENTS** - Approximately 54,000 (octal) words of SCM plus a problem-dependent amount of ECS is used normally. Disk storage can replace ECS if one subroutine is changed.
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV (98%) and COMPASS (2%)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 3.4.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Some plotting and system-dependent utility subroutines must be supplied by the user, as noted in comments at the beginning of each main program. Some parallel coding must be removed from the COMPASS subroutines, depending on whether the FTN or the RUN compiler will be used. MESH2, GNATS, and GPRINT were compiled by NESC, but they were not executed because of the missing subroutines.

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15. NAME AND ESTABLISHMENT OF AUTHORS -

M. L. Callabresi and R. C. Young
Sandia Laboratories
P. O. Box 969
Livermore, California 94550

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (MESH2 1225 cards, GNATS 7730 cards, GPRINT 1814 cards, COMPASS subroutines 278 cards)

Problem 1 input (MESH2 8 cards, GNATS 12 cards, GPRINT 4 cards)

Problem 2 input (MESH2 25 cards, GNATS 15 cards, GPRINT 7 cards)

Sample problem output (78 selected pages)

Reference reports

17. CATEGORY - 1

KEYWORDS - two-dimensional, finite element method, mesh generation, nonlinear problems, difference equations, VIEW codes

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM - NUFUEL**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM370**
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** Given a forecast of nuclear electric generating capacity, it is important to know the consequent time-related materials and services required to support it. These requirements depend on a number of parameters such as reactor types, plant operating capacity factor, expected availability of spent fuel reprocessing, policies concerning plutonium utilization (as breeder fuel and LWR recycle). These and other conditions are simulated by NUFUEL which calculates and prints annual requirements for separative work and uranium related to a schedule of nuclear plant additions. Related fuel cycle quantities such as plutonium production and requirements, requirements for conversion to UF₆, for fuel fabrication, and for spent fuel reprocessing are also calculated and reported on a real-time basis.
4. **METHOD OF SOLUTION -** Besides a schedule of plant additions by reactor type, reactor characteristics and fuel cycle data are needed as input data. They are provided for several common reactor types. Calculations assume that uranium enrichment plants approximate ideal cascade conditions and that the supporting facilities are available when needed. A spent fuel reprocessing capability limitation feature which delays the reuse of uranium and plutonium from spent fuel until it can be reprocessed may be used. Recycling plutonium to light water reactors and simultaneously providing for other plutonium uses including breeder reactor fuel is an optional feature. Calculations are made for each individual reactor. Materials and process requirements are time-phased by quarter-years according to assumed lead times and placed into accumulating arrays. The results of these accumulations are printed in the form of a report on an annual basis, either by calendar years or by fiscal years or both.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Array dimensions limit the forecasting to periods of 30 years at a time.
6. **TYPICAL RUNNING TIME -** About 1.5 minutes are required to execute the sample problem on the IBM370/165 Model 2.
7. **UNUSUAL FEATURES OF THE PROGRAM -** NUFUEL has been in use for a number of years for calculating materials requirements related to the Department of Energy nuclear power forecasts reported in the WASH-1139 document series.
8. **RELATED AND AUXILIARY PROGRAMS -**
9. **STATUS -** Abstract first distributed October 1975.
IBM370 version submitted August 1975, revised September 1975, replaced by Edition B February 1976, replaced by Edition C October 1977, sample problem executed by NESC October 1977 on an IBM370/195.
10. **REFERENCES -** Artha Jean Snyder, Computer Program NUFUEL for Forecasting Nuclear Fuel Requirements and Related Quantities, WASH-1348, October 1974.
Notes on WASH-1348 and Computer Program NUFUEL-#2, July 31, 1975.
Notes on WASH-1348 and Computer Program NUFUEL-#3, January 1, 1976.
Notes on WASH-1348 and Computer Program NUFUEL-#4, July 5, 1977.
Artha Jean Snyder, Methods of Calculating U-235 Outputs and Charges by Use of Ideal Cascade Theory, TID-8522, February 1960.
W. H. McVey, E. H. Davidson and G. E. McTigue, Calculating U-235 Outputs and Charges, TID-8539, June 30, 1963.
11. **MACHINE REQUIREMENTS -** The program requires 350K bytes to compile, 340K bytes to execute.
12. **PROGRAMMING LANGUAGE USED - FORTRAN IV**
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/370 MVT.**

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14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHOR -

Arlha Jean Snyder
Division of Nuclear Energy Programs
U. S. Department of Energy
Washington, D.C. 20545

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (2939 cards)
Sample problems (443 cards)
Control information (JCL 64 cards)
Sample problems output (47 selected pages)
Reference report WASH-1348, and Notes

17. CATEGORY - D

KEYWORDS - fuel cycle, uranium, plutonium, nuclear power plants, enrichment, fabrication, reprocessing, forecasting

18. SPONSOR - DOE Division of Nuclear Energy Programs

1. **NAME OR DESIGNATION OF PROGRAM - GEOCOST**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC6600, CYBER74
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** GEOCOST calculates the cost of generating electricity from geothermal energy. The version of GEOCOST in this release simulates the production of electricity using a steam power conversion cycle based upon either a dry steam or hydrothermal resource. Future extensions to the model will simulate the production of electricity using other power conversion technologies, particularly the binary fluid cycle.
4. **METHOD OF SOLUTION -** GEOCOST is a simulation model which combines both technical processes and economic factors into one systematic framework. The simulation is composed of two principal parts: a reservoir model which simulates the exploration, development, and operation of a geothermal reservoir, and a power plant model which simulates the design, construction, and operation of the power plant. Each of these parts is composed of several submodels which treat fluid transmission and disposal, heat rejection, gas extraction, and power conversion for the steam power cycle. Seven different design options for steam separation and flashing are simulated. A wide variety of financial and tax structures can be simulated through varying the rates of return on equity and debt, the debt-equity ratios, and tax rates. Using discounted cash flow analyses, GEOCOST calculates the cost of energy by equating the present worth of the revenues and expenses over the economic life of the plant or reservoir.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Current array dimensions provide for a maximum well field size of 625 wells and maximum operating period of 50 years from reservoir exploration through the economic life of the power plant.
6. **TYPICAL RUNNING TIME -** From 15 seconds to 2 minutes are required for the majority of simulation cases.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -**
9. **STATUS -** Abstract first distributed June 1976.
CDC6600 version submitted November 1975, sample problem executed by NESC April 1976 on a CDC7600 via remote terminal to Brookhaven National Laboratory.
10. **REFERENCES -** H. D. Huber, C. H. Bloomster, and R. A. Walter, User Manual for GEOCOST: A Computer Model for Geothermal Cost Analysis, BNWL-1942, November 1975.
C. H. Bloomster, P. D. Cohn, J. G. Desteese, H. D. Huber, P. N. Lamori, D. W. Shannon, J. R. Sheff, and R. A. Walter, GEOCOST: A Computer Program for Geothermal Cost Analysis, BNWL-1888, February 1975.
C. H. Bloomster, An Economic Model for Geothermal Cost Analysis, BNWL-SA-5378, May 1975.
H. A. Walter, C. H. Bloomster, and S. E. Wise, Thermodynamic Modeling of Geothermal Powerplants, BNWL-1911, May 1975.
11. **MACHINE REQUIREMENTS -** At least 46K (decimal) memory is required.
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** SCOPE 3.4.2.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -**
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
H. D. Huber, C. H. Bloomster, and R. A. Walter
Pacific Northwest Laboratories
Battelle

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Battelle Boulevard
Richland, Washington 99352

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (12,165 cards)
Sample problem (4 cards)
Sample problem output (3115 records)
Sample problem output (29 selected pages)
Reference report, BNWL-1942

17. CATEGORY - D

KEYWORDS - geothermal energy, simulation, cost, geothermal power plants, electricity, working fluids, equations of state, hydrothermal systems, steam

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - EMERALD-NORMAL
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - EMERALD-NORMAL is designed for the calculation of radiation releases and exposures resulting from normal operation of a large pressurized water reactor. The approach used is similar to an analog simulation of a real system. Each component or volume in the plant which contains a radioactive material is represented by a subroutine which keeps track of the production, transfer, decay, and absorption of radioactivity in that volume. During the course of the analysis, activity is transferred from subroutine to subroutine in the program as it would be transferred from place to place in the plant. Some of this activity is then released to the atmosphere and to the discharge canal. The rates of transfer, leakage, production, cleanup, decay, and release are read as input to the program. Subroutines are also included which calculate the off-site radiation exposures at various distances for individual isotopes and sums of isotopes. The program contains a library of physical data for the forty isotopes of most interest in licensing calculations, and other isotopes can be added or substituted. Because of the flexible nature of the simulation approach, the EMERALD-NORMAL program can be used for most calculations involving the production and release of radioactive material. These include design, operation, and licensing studies.
4. **METHOD OF SOLUTION** - Explicit solutions of first-order linear differential equations are included. In addition, a subroutine is provided which solves a set of simultaneous linear algebraic equations.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Many parameters and systems included in the program, particularly the radiation waste-treatment system, are unique to the PG&E Diablo Canyon PWR plant.
 - Maxima of -
 - 50 isotopes
 - 9 distances
 - 16 angular sectors
 - 1 operating period
 - 1 reactor power level
6. **TYPICAL RUNNING TIME** - Less than 2 minutes is required to compile and execute the sample problem.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The use of FORTRAN IV language, modular design, generic variable names, and extensive internal comments makes EMERALD-NORMAL easily adaptable to the user's particular models and problems.
8. **RELATED AND AUXILIARY PROGRAMS** - Subroutine SIMQ, which is documented in IBM System 360 Scientific Subroutine Package (360A-CM-30X), Version III, Program Manual H20-0205-3, is included. In 1974 an earlier code, EMERALD, was divided into EMERALD (Revision 1). (NESC Abstract 546), used to assess accidental releases; and EMERALD-NORMAL, for assessing conditions and releases during normal or near-normal operation of a PWR. New features include an expanded library with isotopes of interest in liquid releases, a detailed model of a radiation waste-treatment system, and a routine for calculation of doses from liquid releases.
9. **STATUS** - Abstract first distributed January 1976.
IBM360 version submitted January 1975, sample problem executed by NESC December 1975 on an IBM370/195.
10. **REFERENCES** - S. G. Gillespie and W. K. Brunot, EMERALD-NORMAL: A Program for the Calculation of Activity Releases and Potential Doses from the Normal Operation of a Pressurized Water Reactor Plant, Revision 1, Volume 1 - Program Description, Pacific Gas and Electric Company, December 1974.
11. **MACHINE REQUIREMENTS** - 576K bytes of memory

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12. **PROGRAMMING LANGUAGE USED - FORTRAN IV**
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360,370.**
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -**
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
S. G. Gillespie and W. K. Brunot
Mechanical and Nuclear Engineering Department
Pacific Gas and Electric Company
77 Beale Street
San Francisco, California 94106
16. **MATERIAL AVAILABLE - Magnetic Tape Transmittal**
Source deck (4508 cards)
Sample problem input (461 cards)
Sample problem output (74 selected pages and 1 microfiche)
Reference report
17. **CATEGORY - G**
KEYWORDS - dose rates, fission products, gamma radiation, power plants, radioactivity, PWR reactors, EMERALD codes
18. **SPONSOR -**

1. **NAME OR DESIGNATION OF PROGRAM - VENTURE**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360/91, 75, 195
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** VENTURE solves the usual neutronics eigenvalue, adjoint, fixed source, and criticality search (direct and indirect) problems, treating up to three geometric dimensions, maps power density and does first-order perturbation analysis at the macroscopic cross section level.
4. **METHOD OF SOLUTION -** An inner, outer iteration procedure is used with several different data handling schemes programmed in parallel. Restrained line overrelaxation is used, and succeeding iterate flux sets may be accelerated by the Chebyshev process and asymptotic extrapolation done when distinct error modes establish. Normally the eigenvalue of a problem is estimated at each outer iteration from an over-all neutron balance; however, source ratios are used in some situations. The difference equation is mesh centered point. Advanced capability is incorporated, as to treat direction-dependent diffusion coefficients and zone-dependent fission source distribution functions. Macroscopic nuclear properties are calculated from microscopic cross sections and zone and sub-zone nuclide concentrations.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -**
6. **TYPICAL RUNNING TIME -** Running time is directly related to problem size and inversely proportional to some measure of central processor and data transfer speeds. The basic rate of solution of eigenvalue problems is about 200 space energy points per second of central processor time on an IBM360/91; this rate falls off approximately as $(10/n)^{0.7}$ where n is the average number of points in one dimension, less when the amount of data I/O is low, and more when it is high, except for one-dimensional problems. Thermal reactor lattice and cell problems normally require more time by perhaps a factor of two. Problems involving significant upscatter (multi-thermal-group treatment) require additional computer time by a factor of two or three.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -** Standard interface file specifications adopted in the ERDA Reactor Physics code coordination effort are used for external files. Input data are supplied from a code-dependent external file generated by a separate processor. Other codes meeting interface specifications will couple directly with this one.
9. **STATUS -** Abstract first distributed June 1976.
IBM360 version submitted July 1975, sample problem executed by NESC May 1976 on an IBM370/195.
10. **REFERENCES -** D. R. Vondy, T. B. Fowler, and G. W. Cunningham, VENTURE: A Code Block for Solving Multigroup Neutronics Problems Applying the Finite-difference Diffusion-theory Approximation to Neutron Transport, ORNL-5062, October 1975.
B. M. Carmichael, Standard Interface Files and Procedures for Reactor Physics Codes, Version III, LA-5486-MS, February 1974, Revised.
D. R. Vondy, T. B. Fowler, and G. W. Cunningham, Input Data Descriptions for the Special Processors in the VENTURE Code Package and Implemented Data File Specifications, ORNL Notes, July 10, 1975, Revised February 10, 1976.
D. R. Vondy, Programming Practices and Computer Code Development, ORNL-TM-5065, Appendix I, December 1975.
VENTURE Transmittal Tape Description, ACC Programming Note 76-36, June 1976.
VENTURE, ACC No. 686.360, ACC Programming Note 76-38, June 1976.
11. **MACHINE REQUIREMENTS -** A 32K word memory is needed, and one much larger is preferable; auxiliary storage of the disk or drum type is essential, preferably several on different data channels. The programming for three-level hierarchy data storage is included to permit efficient use of an extended slow memory for large three-dimensional problems when such a memory is available. Typically, the code uses 27 logical I/O units.

12. PROGRAMMING LANGUAGES USED - FORTRAN IV and Assembly language
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Programming is in the Standard ANSI FORTRAN 1966 language except for extensions as required for unindexed block data transfers and direct access. Arrays are limited to 3 dimensions, subroutines to 60 arguments, and no use is made of subscripted subscripts. Standard routines developed in the ERDA Reactor Physics code coordination effort are employed for processing input data and data file management. Local system environment routines for computing elapsed time, allocating memory, and setting up direct access file specifications dynamically will require replacement.
15. NAME AND ESTABLISHMENT OF AUTHORS -
D. R. Vondy and T. B. Fowler
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830
G. W. Cunningham
Computer Sciences Division
Union Carbide Corporation Nuclear Division
Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (VENTURE 28,550 cards, cross section code 5888 cards, reaction rate code 2862 cards, DVENTR input processor 3146 cards, DCRSPR input processor 417 cards, DUTLIN input processor 110 cards, DCMACR input processor 196 cards, driver source 598 cards, common FORTRAN routines 1493 cards, common BAL routines 1246 cards)
Sample problem (139 cards)
Sample problem output (61 pages)
Control information (JCL 376 cards)
Load modules (2314 VNTRF 77 blocks, VNTRLD 134 blocks, BLDVN 2069 blocks)
Reference report, ORNL-5062, ORNL Note, ORNL-TM-5065 Appendix I, and ACC Programming Notes
17. CATEGORY - C
KEYWORDS - perturbation theory, multigroup, diffusion equations, one-dimensional, two-dimensional, three-dimensional, CCCC, r-theta, r-theta-z, slabs, cylinders, triangular configuration, hexagonal configuration
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SITE2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - SITE2 is designed to (1) screen candidate energy facility sites or areas within an electric utility region, based on the region's physical and socioeconomic attributes, the planned facility's characteristics, and impact assessments, and (2) evaluate the cumulative regional impacts associated with alternate energy supply options and interregional energy import/export practices, specifically, comparison of different energy technologies and their regional distribution in clustered or dispersed patterns
4. METHOD OF SOLUTION - The SITE2 methodology is based on the quantification of three major site-related vectors. A cost vector is determined which identifies site-specific costs, such as transmission costs, cooling costs as related to water availability, and costs of specific controls needed to protect the surrounding environment. An impact vector is also computed for each potential site, using models of health and environmental impacts incurred in areas adjacent to the site. Finally, a site attribute vector is developed which reflects such characteristics as population, seismic conditions, meteorology, land use, and local ecological systems. This vector can be used to eliminate certain sites because of their inability to satisfy specific constraints. These three vectors can be displayed as density maps and combined in a simple overlay approach, similar to that developed by I. L. McHarg in reference 2, to identify candidate sites. Alternatively, the vector elements can be computationally combined into a weighted sum to obtain quantitative indicators of site suitability.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - The sample problem requires 4.5 minutes of CPU time on an IBM370/195.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed June 1976.
IBM360 version submitted March 1976, sample problem executed by NESC May 1976 on an IBM370/195.
10. REFERENCES - N. A. Frigerio, L. J. Habegger, R. F. King, L. J. Hoover, N. A. Clark, and J. M. Cobian, SITE: A Methodology for Assessment of Energy Facility Siting Patterns, ANL/AA-2, August 1975.
I. McHarg, Design with Nature, Natural History Press, New York, NY, and Falcon Press, Philadelphia, PA, 1969.
11. MACHINE REQUIREMENTS - 480K bytes of core storage are needed for compilation and execution
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - In addition to normal printed output, density plots are generated on the printer for all input data and all computed output. Optionally, the density plots may also be written to an IBM2280 (film) output recorder if the computer is so equipped.
15. NAME AND ESTABLISHMENT OF AUTHORS -
N. A. Frigerio
Environmental Impact Studies
L. J. Habegger, R. F. King, and L. J. Hoover
Energy and Environmental Systems Division

N. A. Clark
Applied Mathematics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
J. M. Cobian
Northwestern University
Evanston, Illinois 60201

• Contact

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (443 cards)
Sample problem (2240 cards)
Reference report, ANL/AA-2
17. CATEGORY - R
KEYWORDS - site selection, regional analysis, environmental impacts, power plants
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - OMCST
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - OMCST estimates annual operating and maintenance expenses of steam-electric power plants exclusive of fuel. Base load nuclear and fossil-fueled plant types are included. Costs are adjusted for various waste heat rejection methods. Plants containing one through four units with unit net electrical output from 400 through 2000 MW(e) may be evaluated. OMCST includes the option of a limestone wet scrubbing system for flue gas desulfurization for coal- and oil-fired plants.
4. METHOD OF SOLUTION - A base operating and maintenance cost model for a given plant type is selected and adjusted for desired size, heat rejection method, year of operation, etc. Cost models are based on early 1975 costs, but separate escalation rates are included for wages, materials and supplies, fuel oil, government and commercial liability insurance, operating fees, sludge disposal, and limestone. Heat rejection methods include natural-draft evaporative cooling towers, mechanical-draft evaporative cooling towers, and run-through or run-of-river cooling. Wage rates, operator fringe benefits, and plant supervision expenses may be included as input data.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - Execution time for a dozen cases is less than 0.5 second on the IBM370/91.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed June 1976.
IBM360 version submitted May 1976, sample problem executed by NESC May 1976 on an IBM360/195.
10. REFERENCES - S. T. Brewer, H. I. Bowers, M. L. Myers, and L. C. Fuller, A Procedure for Estimating Nonfuel Operating and Maintenance Costs for Large Steam-Electric Power Plants, ERDA 76-37, October 1975.
11. MACHINE REQUIREMENTS - 52K bytes
12. PROGRAMMING LANGUAGES USED - FORTRAN IV (85%) and BAL (15%)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - OMCST is written in FORTRAN; routines IDAY, ICOMPARE, and TIME are written in Assembly language. All data input is handled through the NAMELIST feature.
15. NAME AND ESTABLISHMENT OF AUTHORS -
L. C. Fuller and M. L. Myers
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE -
Source decks (OMCST 790 cards, IDAY 63 cards, ICOMPARE 39 cards, TIME 28 cards)
Sample problem (8 cards)
Reference report
17. CATEGORY - D

NESC ABSTRACT 688

04/79

KEYWORDS - economics, maintenance, operation, PWR reactors, BWR reactors, HTGR reactors, nuclear power plants, fossil-fuel power plants

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM -** FLANGE-ORNL
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360/91
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** FLANGE-ORNL calculates appropriate loads, stresses, and displacements for the flanges, bolts, and gaskets that comprise a flanged piping joint for internal pressure or moment loading on the pipe, temperature difference between the flange hub and ring, and variations in bolt load that result from pressure, hub-ring temperature gradient and/or bolt-ring temperature differences. Flanges considered may be tapered-hub, straight or blind.
4. **METHOD OF SOLUTION -** The solution is based on discontinuity analysis and the theory of plates and shells.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -**
6. **TYPICAL RUNNING TIME -** Program compilation required 19.4 seconds CPU time. Total execution time for six sample flanged joints required 1.15 seconds.
7. **UNUSUAL FEATURES OF THE PROGRAM -** FLANGE-ORNL has a unique set of user-controlled options which allow for calculating ASME boiler and pressure vessel code design criteria and/or more extensive stress analysis, and also for specifying various different flange design combinations for the joint. In addition, the program calculates values for various ASME code variables that would otherwise have to be extracted manually from curves and used as input.
8. **RELATED AND AUXILIARY PROGRAMS -**
9. **STATUS -** Abstract first distributed June 1976.
IBM360 version submitted April 1976, replaced by revised Edition B February 1979, sample problem executed by NESC February 1979 on an IBM370/195.
10. **REFERENCES -** E. C. Rodabaugh, F. M. O'Hara, Jr., and S. E. Moore, FLANGE, A Computer Program for the Analysis of Flanged Joints with Ring-type Gaskets, ORNL-5035, January 1976.
11. **MACHINE REQUIREMENTS -** 80K bytes memory for extraction and 270K bytes for compilation with standard system I/O units
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/360.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -**
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
E. C. Rodabaugh
Columbus Laboratories
Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201
S. E. Moore
Oak Ridge National Laboratory
P. O. Box Y
Oak Ridge, Tennessee 37830
16. **MATERIAL AVAILABLE -** Magnetic Tape Transmittal
Source deck (1586 cards)
Sample problems (36 cards)
Reference report

17. CATEGORY - I

KEYWORDS - deformation, design, elasticity, pipe joints, flanges, pressure, shells, stresses

18. SPONSOR - NRC Division of Reactor Safety Research

1. **NAME OR DESIGNATION OF PROGRAM** - SEPHIS/MOD4
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - SEPHIS/MOD4 simulates the solvent extraction portions of either the Purex or the Thorex process. The program iteratively applies an unsteady state mass balance to a series of ideal mixer settler stages to follow the changes in solute concentrations. Reasonably good agreement has been found between the calculated and experimental concentrations. The components considered by SEPHIS/MOD4 are nitric acid, thorium, uranium, plutonium (IV), plutonium (III), a plutonium reductant, and inextractable nitrate salts.
4. **METHOD OF SOLUTION** - The mass balance differential equation is integrated over time by a single step Runge-Kutta or finite difference method.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - A maximum of 100 stages is allowed. SEPHIS/MOD4 does not deal with fission product or solvent degradation product behavior. Perfect mixing is assumed to occur in the mixers and in each zone of the settlers. Entrainment is not considered.
6. **TYPICAL RUNNING TIME** - One to 300 seconds are required, depending on the problem complexity.
7. **UNUSUAL FEATURES OF THE PROGRAM** - SEPHIS/MOD4 simulates the time lags present in process equipment and the kinetic reduction of plutonium.
8. **RELATED AND AUXILIARY PROGRAMS** - The SEPHIS program was developed to simulate the countercurrent solvent extraction process and implemented initially by W. S. Groenier, ORNL, to study the application of a 15% tributyl phosphate (TBP) solvent extraction system for recovering irradiated LMFBR fuel. G. L. Richardson, HEDL, adapted SEPHIS to the conventional Purex process, and S. B. Watson and R. H. Rainey, ORNL, modified Richardson's code and contributed the program to NESC. SEPHIS/MOD4 supercedes all earlier editions of SEPHIS. SOLVEX (NESC Abstract 662) is another solvent extraction program.
9. **STATUS** - Abstract first distributed June 1976.
IBM360 version of SEPHIS submitted March 1976, replaced by SEPHIS/MOD4 March 1979, replaced by revised edition May 1979, sample problems executed by NESC May 1979 on an IBM370/195.
10. **REFERENCES** - A. D. Mitchell, SEPHIS-MOD4: A User's Manual to a Revised Model of the Purex Solvent Extraction System, ORNL-5471, May 1979.
A. D. Mitchell, A Comparison between SEPHIS-MOD4 and Previous Models of the Purex Solvent Extraction System, ORNL/TM-6565, February 1979.
A. D. Mitchell, Modification of the SEPHIS-MOD4 Computer Program to Simulate the Thorex Solvent Extraction Process, ORNL/TM-6825, March 1, 1979 (draft).
S. B. Watson and R. H. Rainey, Modifications of the SEPHIS Computer Code for Calculating the Purex Solvent Extraction System, ORNL-TM-5123, December 1975.
G. L. Richardson, Effect of High Solvent Irradiation Exposures on TBP Processing of Spent LMFBR Fuels, HEDL-TME 73-51, June 1973.
W. S. Groenier, Calculation of the Transient Behavior of a Dilute-Purex Solvent Extraction Process Having Application to the Reprocessing of LMFBR Fuels, ORNL-4746, April 1972.
S. B. Watson and R. H. Rainey, Modeling the Effect of Temperature on Thorium and Nitric Acid Extraction and the Formation of Third Phase for Modification of the SEPHIS-Thorex Computer Program, ORNL/CSD/TM-69, January 1979.
11. **MACHINE REQUIREMENTS** - 145K bytes of storage are required.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360.

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHOR -

A. D. Mitchell
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830

16. MATERIAL AVAILABLE - Restricted Distribution

Magnetic Tape Transmittal
Source deck (1887 cards)
Sample problems (87 cards)
Reference reports, ORNL-5471, ORNL/TM-6565, and ORNL/TM-6825

17. CATEGORY - U

KEYWORDS - fuel cycle, solvent extraction, Purex process, Thorex process, reprocessing, plutonium, uranium, nitric acid, thorium, SEPHIS codes, SOLVEX codes

18. SPONSOR - DOE Division of Nuclear Power Development

1. NAME OR DESIGNATION OF PROGRAM - LASIP3
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - LASIP3 processes Version III standard interface data files specified by the Reactor Physics Committee on Computer Code Coordination (CCCC). This processor performs two distinct tasks: namely, transforming free-field format, BCD data, into well-defined binary files and providing for printing and punching data in the binary files.
4. METHOD OF SOLUTION - The LASIP3 code contains two basic modules: one (input) for converting free-field format BCD data into binary files, and one (file-print) for printing the binary-file data. Standard routines for file management (SEEK) and I/O (REED and RITE) are used.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM - Instead of maintaining two versions of LASIP3 for long- and short-word computers, one version containing coding for both systems is made available. Unnecessary coding for a specific system is made nonexecutable by comment cards.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed August 1976.
IBM360 version submitted March 1976, sample problem executed by NESC July 1976 on an IBM370/195.
10. REFERENCES - G. E. Bosler, R. D. O'Dell, and W. M. Resnik, LASIP-III, A Generalized Processor for Standard Interface Files, LA-6280-MS, April 1976, and Errata, June 1976.
B. M. Carmichael, Standard Interface Files and Procedures for Reactor Physics Codes, Version III, LA-5486-MS, February 1974.
11. MACHINE REQUIREMENTS - 25 logical units besides the standard input/output units
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
G. E. Bosler, R. D. O'Dell, and W. M. Resnik
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87544
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (8748 cards)
Sample problem (107 cards)
Control information (JCL 63 cards)
Reference report, LA-6280-MS with Errata
17. CATEGORY - M
KEYWORDS - data processing, libraries, nuclear engineering, CCCC, REED codes, RITE codes, SEEK codes
18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM - SOLSYS**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC6600,7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** SOLSYS simulates the transient response of solar energy systems. It can be used to predict performance characteristics of a system; parametric studies can be performed for optimization and to determine auxiliary fuel requirements.
The program consists of a component subroutine library, an information subroutine library, a control-component subroutine library, and an executive program.
4. **METHOD OF SOLUTION -** Component subroutines modeling the performance of fluid-handling components can be connected to construct almost any desired energy system. This library presently contains 21 routines modeling collectors, storage units, power-generation cycles, transmission and distribution hardware, heat exchangers, house equipment, and auxiliary energy components. The library of information subroutines supplies time-dependent solar, weather, and load parameters to the appropriate components. Time is incremented in steps, and at each step, simple iteration is used to achieve convergence of component outlet temperatures.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** A maximum of 80 components can be used in a system. Two dummy subroutines, EXSUB1 and EXSUB2, may be replaced by subroutines which describe components which are not already modeled in the subroutine library.
6. **TYPICAL RUNNING TIME -** The sample problem required less than 1 CP minute for compilation and execution. Very large systems with 60 or more components can be simulated using one-hour time-steps for a four-week period in approximately 30 minutes of CP time.
7. **UNUSUAL FEATURES OF THE PROGRAM -** Nearly any component configuration defining a solar energy system may be studied. Parametric changes or system revisions can be studied by changing only pertinent data in a single sequence of cases.
8. **RELATED AND AUXILIARY PROGRAMS -**
9. **STATUS -** Abstract first distributed August 1976.
CDC6600 version submitted December 1975, replaced by revised Edition B December 1977, sample problem executed by NESC November 1977 on a CDC7600 at BNL.
10. **REFERENCES -** M. W. Edenburn and N. R. Grandjean, Energy System Simulation Computer Program - SOLSYS, SAND75-0048, June 1975, and Errata November 1975.
M. W. Edenburn, Sandia Laboratories Energy System Simulation Computer Program, Proceedings of the 1975 ISES Meeting, Los Angeles, California, July 1975.
M. W. Edenburn, Performance of a Focusing Cylindrical Parabolic Solar Energy Collector, Analysis and Computer Program, SLA-74-0031, April 1974.
J. P. Abbin and W. R. Leuenberger, Program CYCLE: A Rankine Cycle Analysis Routine, SAND74-0099, October 1974.
Norman R. Grandjean, PLOT40, A Routine Using Disk Storage for Input, SLA-73-0148, April 1973.
ACC Programming Note 76-50, Revised December 2, 1977.
ACC Programming Note 77-25, Revised December 6, 1977.
11. **MACHINE REQUIREMENTS -** SOLSYS requires 135K (octal) words for program storage. An additional 45K (octal) of ECS is needed for data storage. Two tape drives are used, one for a solar data tape and one for a weather data tape, and a disk or tape file is generated if the plotting option is exercised.
12. **PROGRAMMING LANGUAGE USED -** FORTRAN Extended
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** SCOPE 3.3, 3.4 (CDC6600), SCOPE 2.1 (CDC7600).

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** Logical unit 60 is equivalenced to input. Solar data are read from logical unit 7. Weather data are read from logical unit 6. Information for subsequent plotting is written to logical unit 40. The program uses end-of-file checks to determine end of input data or end of information read from tapes.

Solar data and weather data files normally will be supplied to CDC users as binary data. Non-CDC users will receive BCD or EBCDIC versions of the same information to allow them to make the necessary conversion to their machine. Specify machine and tape format with package request.

At present, no documentation is available for the component subroutines ADOBEHL, AIRCOL, and ROKSTOR. If the plotting option is elected, an alternative for SKPFIL, a local file-positioning subroutine, must be supplied. A dummy SKPFIL, supplied with the package, allows execution of the sample problem. Report SLA-73-0148 describes PLOT40, which the authors used to interface with the local SCORS plotting package for the SC-4020 plotter.

15. **NAME AND ESTABLISHMENT OF AUTHORS -**

M. W. Edenburn
Solar Total Energy Program Division
N. R. Grandjean
System Studies Division
Sandia Laboratories
P. O. Box 5800
Albuquerque, New Mexico 87115

16. **MATERIAL AVAILABLE -** Magnetic Tape Transmittal (2 tapes)

Source decks (SOLSYS 7549 cards, SKPFIL 8 cards)

Sample problem (43 cards)

Sample problem output (9 pages)

For 6600 use:

Data libraries (binary)

For non-6600 use:

Data libraries (7-track BCD or 9-track EBCDIC)

Reference reports, SAND75-0046 with Errata and SLA-74-0148, and ACC Programming Note appropriate to machine and tape format

17. **CATEGORY - R**

KEYWORDS - solar energy, simulation, design, performance, solar ir conditioning, solar space heating, solar power plants

18. **SPONSOR -**

1. **NAME OR DESIGNATION OF PROGRAM -** SOLDATABQ62
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** SOLDATABQ62 is a data collection consisting of readings of direct and total solar radiation intensities and related parameters for solar energy systems studies. The solar data measurements are for Albuquerque, New Mexico for the year 1962. The items presented are: hour, wind direction, wind speed, dry bulb temperature, wet bulb temperature, dew point, atmospheric pressure, sky cover, visibility, atmospheric precipitable water vapor content, hourly integral of direct-normal radiation, hourly integral of total-horizontal radiation, six readings of direct-normal intensity at 10-minute intervals, and six readings of total-horizontal radiation at 10-minute intervals. These data were compiled from strip-chart recordings of the National Climatic Center, Asheville, North Carolina.
4. **METHOD OF SOLUTION -**
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** The data apply to Albuquerque, New Mexico for the year 1962.
6. **TYPICAL RUNNING TIME -**
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -** SOLDATABQ62 is a general-purpose data library. No related programs are available currently.
9. **STATUS -** Abstract first distributed August 1976.
CDC6600 binary edition submitted August 1975.
CDC6600 BCD Edition B submitted April 1976.
10. **REFERENCES -** E. C. Boes, Solar Data Albuquerque 1962, SOLDATABQ62, Documentation, August 1975.
ACC Programming Note 76-51 for Binary Edition, August 20, 1976.
ACC Programming Note 76-56 for BCD Edition, August 20, 1976.
11. **MACHINE REQUIREMENTS -**
12. **PROGRAMMING LANGUAGE USED -**
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** SCOPE.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** SOLDATABQ62 will be supplied to CDC users on tape in SCOPE internal format. Non-CDC users can receive a BCD version of the same information.
15. **NAME AND ESTABLISHMENT OF AUTHOR -**
Eldon C. Boes
Sandia Laboratories
P. O. Box 5800
Albuquerque, New Mexico 87115
16. **MATERIAL AVAILABLE -** Magnetic Tape Transmittal
Reference document and Programming Note appropriate to edition
6600:
Binary data (variable-length records 300-word maximum length)
6600B for non-6600 use:
BCD data (9125 140-character records)
17. **CATEGORY -** Z
KEYWORDS - solar radiation, energy, meteorology, atmospheric precipitations

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - FRAP-S1/FRAP-S3
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360,370, CDC7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - THE FRAP-S program predicts the thermal, mechanical, internal gas pressure, and material properties response of a water-cooled oxide fuel rod during steady-state reactor operation. The code considers the coupled effects of the response parameters by iterating to convergence at each power-time step. Fission gas generation and release are calculated as a function of burnup. Multi-axial elasto-plastic analysis included in the FRAP-S3 cladding deformation model and creep is taken into account. Also included in FRAP-S3 is a fuel rod failure subcode which checks for various modes-of failure based on operating conditions.
4. **METHOD OF SOLUTION** - The fuel rod to be analyzed is divided into axial and radial nodes. A one-dimensional radial heat conduction solution using the integration method to determine the radial temperature distribution at each axial node is used. Fuel and clad temperatures are used in conjunction with internal and external pressure forces to calculate mechanical deformation. Mechanical deformation effects on fuel clad gap and internal volume are fed back to the conduction solution and the internal pressure calculation. An iterative solution considering all the coupled effects is carried out for each power-time step.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The code is limited to a single rod analysis with up to 15 axial and 11 radial nodes, assuming thermal reactor fuel rods with water coolant.
6. **TYPICAL RUNNING TIME** - The running time varies with the time-step selected and the number of nodes. For a typical power analysis, the FRAP-S1 running time on the IBM360 is approximately 0.5 minute of CPU time per 1000 hours of reactor operation. The FRAP-S3 version executed the sample problem in 26 seconds on a CDC7600 computer.
7. **UNUSUAL FEATURES OF THE PROGRAM** - Each succeeding edition of FRAP-S incorporates the most recent advancements that have been made in fuel rod response analysis.
8. **RELATED AND AUXILIARY PROGRAMS** - FRAP-S3 contains improvements over the earlier FRAP-S1 and FRAP-S2 editions. The IBM360 version of FRAP-S1, however, remains the most recent IBM version. FRAP-S3 generates a set of initial conditions used by FRAP-T (NESC Abstract 658) to initiate analysis of transient accidents such as loss-of-coolant accidents, power coolant mismatch, and reactivity initiated accidents. The codes contain common subcodes and compatible input-output features.
9. **STATUS** - Abstract first distributed August 1976.
IBM360 version of FRAP-S1 submitted September 1975, sample problem executed by NESC July 1976 on an IBM370/195.
CDC7600 version of FRAP-S2 submitted December 1976, replaced by FRAP-S3 submitted July 1978, sample problem executed without the plotting option by NESC October 1978 on a CDC7600.
10. **REFERENCES** - J. A. Dearien, G. A. Berna, D. R. Coleman, P. E. MacDonald, and J. M. Broughton, FRAP-S: A Computer Code for the Steady State Analysis of Oxide Fuel Rods, Volume 1 FRAP-S Analytical Models and Input Manual, Aerojet Nuclear Company, Interim Report I-309-13.1, August 1975.
R. L. Miller, R. R. Hobbins, V. F. Baston, W. A. Yuill, and P. E. MacDonald, FRAP-S: A Computer Code for the Steady State Analysis of Oxide Fuel Rods, Volume 2 MATPRO Material Properties Subcode, Aerojet Nuclear Company Interim Report, August 31, 1975.
D. R. Coleman, FRAP-S: A Computer Code for the Transient Analysis of Oxide Fuel Rods, Volume 3 Model Verification Report, Aerojet Nuclear Company Interim Report, Revised October 1975.
J. A. Dearien, G. A. Berna, M. P. Bohn, J. D. Kerrigan, and D. R. Coleman, FRAP-S3 Analytical Models and Input Manual, FRAP-S3 A Computer Code for the Steady-State Analysis of Oxide Fuel Rods, Volume 1, TFBP-TR-164, Revision 2, October 1977.

P. E. MacDonald and L. B. Thompson, Ed., MATPRO: A Handbook of Materials Properties for Use in the Analysis of Light Water Reactor Fuel Rod Behavior, ANCR-1263, NRC-3, February 1976.

Philip E. MacDonald and Loren B. Thompson, Ed., MATPRO-Version 09-A Handbook of Materials Properties for Use in the Analysis of Light Water Reactor Fuel Rod Behavior, TREE-NUREG-1005, December 1976.

11. **MACHINE REQUIREMENTS** - 260K bytes of memory are required for execution of FRAP-S1 (IBM360); 143,000 (octal) words of storage are required for FRAP-S3 (CDC7600).
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV (85%) and BAL(15%) (IBM360), FORTRAN IV (CDC7600)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360 (IBM360) and SCOPE 2.1 (CDC7600).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The FRAP-S3 plot option requires graphics routines not supplied with the package. The INEL library and IGS graphics system routines EXITG, GRIDG, LABELG, LEGNDG, LINESG, MODESG, NUMBRG, OBJCTG, PAGEG, RSETMG, SETSMG, SETUPG, SUBJEG, and TITLEG will have to be replaced with locally-equivalent routines. The hardware used for INEL plot output is the Information International Incorporated FR80 microfilm recorder.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
360 J. A. Dearien, G. A. Berna, D. R. Coleman,
P. E. MacDonald, and J. M. Broughton

7600 J. A. Dearien, G. A. Berna, M. P. Bohn,
J. D. Kerrigan, and D. R. Coleman
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (360 FRAP-S1-4149 cards, PLOT-1243 cards, 7600 FRAP-S3-9007 cards,
MATPRO9-2392 cards, PLOT-230 cards)
Sample problems (360 FRAP-S1-14 cards, 7600 FRAP-S3-118 cards)
Sample problems output (360 FRAP-S1-45 pages, 7600 FRAP-S3-57 selected pages, PLOT-1
microfiche)
Reference reports, FRAP-S Interim Reports (3 volumes) for FRAP-S1, TFBP-TR-164 for FRAP-
S3
17. **CATEGORY** - H
KEYWORDS - temperature, deformation, pressure, fuel rods, LWR reactors, mechanical
properties, steady-state conditions, FRAP-T codes
18. **SPONSOR** - NRC Division of Reactor Safety Research

1. **NAME OR DESIGNATION OF PROGRAM - NMMSS**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** Three basic programs in the Nuclear Materials Management and Safeguards System (NMMSS) for processing incoming transaction data and maintaining the current transaction data file are: TJEDIT, TJUPDT, and COMPAT. TJEDIT prepares, verifies, and maintains the integrity of data as it is introduced into the data base. TJUPDT maintains the current transaction data file on a daily basis. COMPAT maintains consistency between related data sets on the transaction data master file.
4. **METHOD OF SOLUTION -** TJEDIT examines input data and, depending on data specifications, accepts or rejects it, passing the accepted data to the TJUPDT program, and producing reports on all data submitted and data found to be in error. TJUPDT edits incoming data sets in relation to those already on the master file and rejects any invalid updating attempts. Data sets that pass the editing phase cause new data to be added to the master file, and existing data sets to be deleted or replaced depending upon the updating action indicated in the data. COMPAT examines all combinations of data sets within each transfer series and transfer number, suspends those that are incompatible from the file, and produces an error report when necessary.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** No specific limits are imposed on the number of data sets that can be processed in any given execution since only those sets within a given transfer series and transfer number are stored simultaneously.
6. **TYPICAL RUNNING TIME -** On the 360/195, TJEDIT takes about 10 seconds for 2000 data items. A typical run of TJUPDT takes about 17 seconds of CPU time, and a typical daily compatibility edit using COMPAT takes about 7 minutes of CPU time.
7. **UNUSUAL FEATURES OF THE PROGRAM -** The IBM SORT routine is used by the three programs. TJUPDT selects toll enriching transaction data and creates a file of these records for interfacing with an external system.
8. **RELATED AND AUXILIARY PROGRAMS -**
9. **STATUS -** Abstract first distributed August 1976.
IBM370 version submitted November 1975.
10. **REFERENCES -** ERDA Manual Chapter Appendix 7401-C.
Instructions to ERDA and Agreement State Licensees for Reporting Nuclear Material Transfers on Form ERDA 741 - Nuclear Material Transaction Report.
E. H. Foreman, W. G. Gregg, and D. A. Hyde, Nuclear Materials Information System Transaction Data Base, UCCND-CSD-INF-63, September 1975.
11. **MACHINE REQUIREMENTS -** The three programs require utility input and output units for the IBM SORT procedure and a printer. TJEDIT requires 260K bytes for execution and two input/output devices (tape and direct-access). TJUPDT requires 158K bytes of storage for execution and four input/output devices. COMPAT requires 238K bytes of storage for execution, three input/output devices (two of which must be direct-access), and one card punch unit.
12. **PROGRAMMING LANGUAGE USED -** ANS COBOL Version 3
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/370.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** The two routines IDAY and ITIME are routines local to the UCCND/CSD environment.
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
E. H. Foreman and W. G. Gregg
Computer Sciences Division

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Union Carbide Corporation, Nuclear Division
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- 16. MATERIAL AVAILABLE -** Magnetic Tape Transmittal
Source deck (TJEDIT 3668 cards, TJUPDT 1060 cards, COMPAT 2652 cards)
Control language for execution (JCL 105 cards)
Reference report, UCCND-CSD-INF-63
- 17. CATEGORY - M**
KEYWORDS - nuclear materials management, specifications, errors, data base systems
- 18. SPONSOR -**

1. **NAME OR DESIGNATION OF PROGRAM - ENERGY**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM370**
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** This package consists of four independent programs, ENERGY1, ENERGY2, ENERGY3, and SUPERENERGY developed for predicting coolant temperature distributions in wire wrapped fuel and blanket assemblies of a liquid-metal-cooled, fast breeder reactor.
4. **METHOD OF SOLUTION -** The rod array in a LMFBR is divided into two regions, the central and wall regions, each treated as a continuum by viewing the wire-wrapped bundle as a porous body; energy generation by the rods is modeled by a continuous volumetric heat source distribution. The energy transfer in the transverse direction is modeled by the effective eddy diffusivity including fluid oscillations due to the presence of wire wraps and other means of energy transport, like natural turbulence. The finite difference equations are solved explicitly. That is, once temperatures at a given level are known, the temperatures in the next are calculated uniquely.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Since two empirical constants used by the ENERGY codes were obtained from available data, these computer programs should not be used outside these ranges, which are summarized by E. Khan in the C00-2245-17TR report. The ENERGY1 code must be used for predicting temperature distributions in bundles in forced convections only. ENERGY2 and ENERGY3 can be used for bundles in forced or mixed convection. Each of the ENERGY codes has an option permitting subchemical analysis. The ENERGY1, 2, and 3 codes do not include interassembly heat transfer, which is computed for the forced convection flow-regime only in the SUPERENERGY code.
6. **TYPICAL RUNNING TIME -** ENERGY2 should take more time than ENERGY1, but less than ENERGY3. Observed times for compiling and executing test cases on the Argonne IBM370/195 were about 68 seconds for SUPERENERGY, 6 seconds for ENERGY1, 48 seconds for ENERGY2, and more than 15 minutes for ENERGY3.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -**
9. **STATUS -** Abstract first distributed October 1976.
IBM370 version submitted August 1975, revised August 1976, sample problems executed by NESC August through October 1976 on an IBM370/195.
10. **REFERENCES -** E. U. Khan, W. M. Rohsenow, A. A. Sonin, and N. E. Todreas, Manual for ENERGY I, II, III Computer Programs, C00-2245-18TR, Revision 1, July 1976.
E. U. Khan, W. M. Rohsenow, A. A. Sonin, and N. E. Todreas, Input Parameters to the ENERGY Code (to be used with the ENERGY Codes Manual), C00-2245-17TR, Revision 1, December 1976.
Brian Cheng-Jean Chen and Neil E. Todreas, Prediction of Coolant Temperature Field in a Breeder Reactor Including Interassembly Heat Transfer, C00-2245-20TR, May 1975.
11. **MACHINE REQUIREMENTS -** Compilation and execution required approximately 250K bytes storage for ENERGY1, 2, and 3; approximately 360K for SUPERENERGY.
12. **PROGRAMMING LANGUAGE USED - FORTRAN IV**
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/370.**
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -**
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
B. Cheng-Jean Chen, E. U. Khan,
W. M. Rohsenow, A. A. Sonin, and
N. E. Todreas

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Department of Mechanical and Nuclear Engineering
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- 16. MATERIAL AVAILABLE -** Magnetic Tape Transmittal
Source decks (ENERGY1 626 cards, ENERGY2 963 cards, ENERGY3 1047 cards, SUPERENERGY 828 cards)
Sample problems (ENERGY1 112 cards, ENERGY2 112 cards, ENERGY3 108 cards, SUPERENERGY 417 cards)
Reference reports
- 17. CATEGORY - H**
KEYWORDS - coolants, temperature distribution, heat transfer, fuel element clusters, LMFBR reactors
- 18. SPONSOR -**

1. **NAME OR DESIGNATION OF PROGRAM** - F0355
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC6600,7600, IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - Program F0355 produces a plot which shows the geometry of the cutter required to produce a given external circular spur gear or ratchet wheel. It is particularly applicable for non-involute tooth forms. In addition, the program can provide a comparator chart for inspecting cutters, indicate whether a given geometry can be shaped, and be used to determine the effects of changes in pitch diameter and related variables. The output of the program is a magnified drawing of the shaper cutter, the workpiece, and the paths of the cutter teeth. The program does not print a numerical description of the cutter profile.
4. **METHOD OF SOLUTION** - Essentially, the program rolls the workpiece around a round cutter blank. All portions of the cutter blank which fall within the workpiece contour as it is rotated around the cutter are removed. The resulting information is the contour of a cutter which can be used to produce the workpiece.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Only one plot is drawn per computer run. Current dimensioning allows for a maximum of 2000 points to describe the complete profile of the workpiece. These restrictions are not difficult to remove. Only the points for one tooth need to be specified as input.
6. **TYPICAL RUNNING TIME** - The sample problem required approximately 500 seconds of CP time on a CDC6600 and 180 seconds on an IBM370/195 CPU. Plotting took 15 minutes on a CalComp 780 plotter.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The output is entirely graphical.
8. **RELATED AND AUXILIARY PROGRAMS** -
9. **STATUS** - Abstract first distributed November 1976.
CDC6600 version submitted February 1976, sample problem executed by NESC, using dummy plot routines, on a CDC7600.
IBM360 version converted from the CDC6600 version August 1976, sample problem executed by NESC September 1976 on an IBM370/195 with plotting on a CalComp 780 plotter.
10. **REFERENCES** - L. K. Gillespie, F0355 - A Program for Generating Shaper Cutter Contours, Bendix Corporation, Kansas City Division, May 9, 1974.
R. W. Stiles, Shaping Ratchet Teeth, BDX-613-973, Bendix Corporation, Kansas City Division, August 1973.
G. E. Volkland, Computer Designed Shaper Cutters, SME Paper MR74-193, 1974.
G. E. Volkland, Shaper Cutters Generated by Computers, Tooling & Production, pp. 36-39, February 1976.
ACC Programming Note 77-2, October 11, 1976.
11. **MACHINE REQUIREMENTS** - Approximately 55,000 (octal) words (CDC6600) or 126K bytes (IBM370) storage are required and auxiliary plotting equipment is used.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 3.4 (CDC6600), SCOPE 2.1 (CDC7600), OS/360,370 (IBM360,370).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The revised input deck format is described in NESC Programming Note 77-2. The program uses the CalComp plotting package and subroutine CIRCL from the CalComp functional software. The sample problem, which calls CIRCL with a zero radius, may be executed by use of the dummy CIRCL subroutine supplied with the package.

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15. NAME AND ESTABLISHMENT OF AUTHOR -

6600 L. K. Gillespie and D. Wantoch
Kansas City Division
Bendix Corporation
P. O. Box 1159
Kansas City, Missouri 64141

360 H. S. Edwards
National Energy Software Center
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

16. MATERIAL AVAILABLE -

Source decks (6600-209 cards, 360-212 cards)
Sample problem input (182 cards)
Sample problem output (a single plot)
Reference reports and ACC Programming Note

17. CATEGORY - T

KEYWORDS - cutting, gears, manufacturing, inspection, computer aided design

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - DUMP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6200,6400,6600,7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - DUMP is a user-oriented program dumping routine which provides diagnostics in English. It can be used to print a job's exchange package (operating registers) and part or all of its memory. It will print messages telling where the program was executing when it quit, why DUMP thinks it quit, and what routines have been called.
4. METHOD OF SOLUTION - DUMP includes tracebacks for routines, and gives addresses in absolute and in relative positioning in the block. It has the ability to minimize long printouts by selective dumping of only those routines used. System routines are ignored. DUMP will not abort unless given a control card without a termination.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed September 1976.
CDC DUMP V9 submitted May 1976.
10. REFERENCES -
11. MACHINE REQUIREMENTS - 12,000 (octal) words of storage, a disk and printer are used.
12. PROGRAMMING LANGUAGES USED - FTN V.3 and COMPASS V3
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - BKY software.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Some system library routines, the exchange package, core image and load map are required. Adaptation to local environment will be required.
15. NAME AND ESTABLISHMENT OF AUTHOR -
Thomas H. Strong, Bldg. 50A
Lawrence Berkeley Laboratory
Berkeley, California 94720
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (UPDATE format 57 records, maximum size of 512 words)
Sample problem (232 cards)
Computer listings for documentation, structure description, and regression test cases (170 pages)
17. CATEGORY - P
KEYWORDS - diagnostic techniques, programming, testing
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ORSIM
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - ORSIM is an electric power generating system integration model which simulates the multi-year operation of a mixed power system consisting of fossil, nuclear, hydro, and pumped-storage units. For any specified refueling schedule for nuclear units and forecast of future load, the model determines a plan of operation for the system which attempts to minimize the total discounted operating cost over a specified study period.

The analysis considers the effects of forced outages, spinning reserve operating constraints, and scheduled introduction and retirement of generating stations. The model determines a maintenance schedule for the non-nuclear stations (nuclear stations are maintained during refueling outages) and the optimum allocation of energy-fixed nuclear and hydro resources. It calculates the expected energy generated by each station in the system, period by period over the planning horizon, based on input or calculated incremental operating cost. It also calculates the expected loss-of-load probability and unserved energy demand for each period in the planning horizon. An optimum operating plan, designed to minimize the discounted total production cost, is then calculated, as are the costs of operating each station in the system and the discounted total production cost for the derived plan of operation.
4. METHOD OF SOLUTION - ORSIM searches for a particular mode of operation which, over a multi-year planning horizon, will minimize the total system operating cost of a particular electric power generation system, discounted to the beginning of the planning horizon. It does this by:
 - (a) calculating the planned maintenance outages for all units;
 - (b) estimating the incremental discounted cost of energy produced by each station in the system for every subinterval of the planning horizon;
 - (c) utilizing the incremental discounted costs of energy generation to calculate, via probabilistic simulation, the economic optimum energies generated by each station in the system in each subinterval of the planning horizon;
 - (d) utilizing these expected energies in a feedback loop to calculate the total discounted operating cost and to produce a new set of incremental discounted costs, thereby setting the stage for the next iteration.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - The sample problem provided requires about 10 minutes on an IBM370/195. A one-year simulation problem is executed in approximately 7 minutes on an IBM360/91, printing nearly 5000 lines and issuing about 6000 I/O requests.
7. UNUSUAL FEATURES OF THE PROGRAM - Applications of ORSIM to utility planning problems demonstrate that the model is well suited for investigating (1) exploration of preselected strategic operating plans over a range of conditions, (2) economic interpretation of restrictions and policies, and (3) sensitivity analyses to determine critical system parameters. Some examples include:
 - (a) evaluation of alternative plant addition schedules to meet system growth,
 - (b) evaluation of the cost effects of construction delays, nuclear plant deratings, and changes in refueling schedules, and
 - (c) assessment of the effects of proposed fuel policy changes on utility costs.
8. RELATED AND AUXILIARY PROGRAMS -

9. **STATUS** - Abstract first distributed September 1976.
IBM360,370 version submitted July 1976, sample problem executed by NESC September 1976 on an IBM370/195.
10. **REFERENCES** - J. C. Turnage, B. E. Prince, D. J. Joy, and L. L. Bennett, The Oak Ridge System Integration Model (ORSIM) for Optimization of Utility Generation Planning, ORNL-TM-4506, October 1975, and Errata, February 1976.
B. E. Prince and J. C. Turnage, Use of Incremental Energy Costs and Loading Order Rules in the ORSIM Procedure for Midrange Optimization of Electric Utility Operations, ORNL-TM-4507, October 1975.
11. **MACHINE REQUIREMENTS** - 750K bytes storage are required for execution and card as well as printer output is generated.
12. **PROGRAMMING LANGUAGES USED** - Approximately 95 percent is written in FORTRAN IV. Two subprograms are written in Assembly language.
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360,370.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The Assembly language subprograms IPACK and IFLD are used for packing storage files. No use is made of external functions. The ORSIM package consists of 19 subroutines in addition to the main program, IPACK, and IFLD.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
J. C. Turnage
Yankee Atomic Electric Company
20 Turnpike Road
Westboro, Massachusetts 01581
B. E. Prince, 9104-1
Nuclear Division
Union Carbide Corporation
P. O. Box Y
Oak Ridge, Tennessee 37830
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (3986 cards)
Sample problem (591 cards)
Sample problem output (450 blocks)
Reference reports and Errata
17. **CATEGORY** - D
KEYWORDS - planning, power generation, power plants, electric utilities, optimization, economics, nuclear power plants, fossil-fuel power plants, hydroelectric power plants
18. **SPONSOR** -

1. **NAME OR DESIGNATION OF PROGRAM - MELT3**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC CYBER74,6600,7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** MELT3 is a multichannel, neutronics, thermal-hydraulics digital computer program developed to investigate the transient behavior of a fast reactor during postulated transient overpower conditions. Reactivity feedback resulting from Doppler broadening, coolant density change and expulsion, bulk core expansion, and fuel movement are explicitly taken into account. The bulk of the modeling detail has been addressed to the in-vessel portion of the reactor plant, although the friction and inertial aspects of up to three separate closed primary loops can be simulated. A wide variety of accident conditions may be investigated. Particular modeling emphasis has, however, been placed on the simulation capabilities required for an unprotected transient overpower accident sequence.
4. **METHOD OF SOLUTION -** The energy equations are solved by a Crank-Nicholson type implicit scheme. The momentum equations are solved by an iterative implicit scheme.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Calculations for up to 20 channels (e.g., 20 pins representative of subassembly clusters) and 20 axial segments within the fuel region may be performed simultaneously. A total of 10 different axial coolant flow zones having different flow areas (comprising a total of 75 nodes) can be explicitly modeled in the axial direction. Radial heat transfer calculations within each pin axial segment are performed using up to 12 radial fuel nodes (including one surface node), 3 cladding nodes (including inner and outer surface nodes), a coolant node, and a structural node.
6. **TYPICAL RUNNING TIME -** Typical CDC7600 run times for cases using essentially full geometric detail are approximately 0.6 second per channel for steady-state calculations, 0.2 second per channel per time-step up to the time of cladding failure, and 0.4 second per channel per time-step after cladding failure. These time estimates appear to increase by about a factor of two for the CDC CYBER74.
7. **UNUSUAL FEATURES OF THE PROGRAM -** A zero neutron lifetime approximation is available to allow large time-steps to be taken during slow-moving portions of the transient. Protection is included, however, to assure that failure criteria levels are not overshoot.
8. **RELATED AND AUXILIARY PROGRAMS -** MELT3 is a continuation of the MELT code series with MELT1 and MELT2 being its predecessors. MELT3 has significant modeling improvements over the two previous codes, particularly with regard to system hydraulics. It also has incorporated as a subroutine, the SIEX code (NESC Abstract 673) for steady-state fuel pin simulation.
9. **STATUS -** Abstract first distributed December 1976.
CDC CYBER74 version submitted October 1975, sample problem executed with dummy plot routines by NESC November 1976 on a CDC6600.
10. **REFERENCES -** Alan E. Waltar, et al., MELT-III, A Neutronics, Thermal-hydraulics Computer Program for Fast Reactor Safety Analysis, HEDL-TME 74-47, December 1974.
D. S. Dutt and R. B. Baker, SIEX, A Correlated Code for the Prediction of Liquid Metal Fast Breeder Reactor (LMFBR) Fuel Performance, HEDL-TME 74-55, September 1974.
11. **MACHINE REQUIREMENTS -** With dummy plot routines, the steady-state program requires 111,000 (octal) words of storage and 4 logical units. The transient program requires 161,000 (octal) words of storage and approximately 300K (decimal) words of peripheral storage on 9 logical units for wrapup and plotting.
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** SCOPE 3.4 (CDC6600,CYBER74), SCOPE 2.1 (CDC7600).

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - File STEADY, which is written by the steady-state program, is mandatory input for the transient program. The transient program requires the FORTRAN Extended Record Manager File Processing System. Plotting capability is provided to supplement the printed output, but plots are not necessary for MELT3 operation. The sample problems may be executed while using the dummy CalComp plot routines supplied with the package. A more efficient alternative is to supply dummy subroutines for PLOT, PLOTS, and DRAW in the steady-state program, and a dummy subroutine for XPLOTX in the transient program. Both the steady-state and the transient program assume that the operating system will zero the memory at load time.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
Alan E. Waltar, et al.
Hanford Engineering Development Laboratory
Westinghouse Hanford Company
Richland, Washington 99352
Richard J. Shields
Computer Sciences Corporation
Richland, Washington 99352
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (steady-state 3171 cards, transient 8559 cards, dummy plot routines 44 cards)
Sample problems (steady-state 181 cards, transient 73 cards, restart 31 cards)
Control information (JCL 49 cards)
Sample problems output (3 microfiche)
Reference report, HEDL-TME 74-47
17. **CATEGORY** - F
KEYWORDS - accidents, excursions, feedback, LMFBR reactors, MELT codes, SIEX codes
18. **SPONSOR** -

1. **NAME OR DESIGNATION OF PROGRAM - BEAMCRP**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC6600,76Q0
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** BEAMCRP is a finite-element computer program which solves for stresses and total strains (elastic plus creep) in beams. The beams may have variable cross sections along the length (x-direction). However, the cross sections must be symmetrical about the y-axis. Besides prescribed displacements and tractions, the boundary conditions may also include limited free travel and elastic spring supports. Time-dependent variations in applied loads, thermal gradients and material swelling can also be analyzed. Arbitrary creep and material swelling laws can be used.
4. **METHOD OF SOLUTION -** The solution algorithm consists of an incremental procedure. Initially, the elastic stress distribution is calculated for the applied loads. A small time-step is selected wherein the stresses remain constant. However, creep strains develop according to the material law. The resulting creep strains are used to calculate an equivalent change in applied loads. The incremental changes in total strains and in stresses are then calculated from the equivalent change in applied load. The incremental stress change is then added to the initial stress value and the new stress level is assumed to remain constant during the next time-step. This procedure is repeated until the stresses converge to a steady-state solution or until a preselected total elapsed time is reached. Structural boundary condition and temperature gradients can be changed at any point in time.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** For beam bending in the x-y plane only, a maximum of 100 elements and 101 nodes can be used. A beam can be constructed of as many as 10 layers of different materials and may have up to 15 changes in cross section along its length. For combined beam bending in the x-y and x-z planes, the maxima of elements and nodes are 50 and 51, respectively.
6. **TYPICAL RUNNING TIME -**
7. **UNUSUAL FEATURES OF THE PROGRAM -** BEAMCRP has subroutines that allow circular and hexagonal cross section properties to be calculated using a single input card. The user may suppress the printout by specifying the elements to be included in the stress report. The program automatically calculates the maximum allowable time-step to insure that the stress change remains negligibly small and that the creep strain change is not excessive. The program has a restart feature to permit analysis of thermal cycles. The user may specify times when selected beam supports are to be removed and when the beam is to be cooled instantaneously to a uniform temperature.
8. **RELATED AND AUXILIARY PROGRAMS -** The initial two-dimensional version (x-y plate) was known as CRASIB.
9. **STATUS -** Abstract first distributed November 1976.
CDC6600 version submitted January 1974, documentation received October 1976, sample problem executed by NESC October 1976 on a CDC7600 via remote terminal to Brookhaven National Laboratory.
10. **REFERENCES -** W. H. Sutherland, A Finite Element Computer Code (AXICRP) for Creep Analysis, BNWL-1142, October 1969.
W. H. Sutherland and V. B. Watwood, Jr., Creep Analysis of Statically Indeterminate Beams, BNWL-1362, June 1970.
W. H. Sutherland and J. D. Rector, CRASIB, Creep Analysis of Statically Indeterminate Beams, User's Guide and Program Manual, BNWL Report, March 23, 1970.
R. B. Stallwood, BEAMCREEP, A Creep Analysis Program for Statically Indeterminate Beams, CSC Report, October 31, 1974.
11. **MACHINE REQUIREMENTS -** 145,000 (octal) words of storage, a tape unit for plot output, and 7 input/output files besides the system input/output units.

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- 12. PROGRAMMING LANGUAGE USED - FORTRAN IV**
- 13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE.**
- 14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -**
- 15. NAME AND ESTABLISHMENT OF AUTHOR -**
 - W. H. Sutherland
 - Hanford Engineering Development Laboratory
 - Westinghouse Hanford Company
 - P. O. Box 1970
 - Richland, Washington 99352
- 16. MATERIAL AVAILABLE - Restricted Distribution**
 - Magnetic Tape Transmittal
 - Source deck (2237 cards)
 - Sample problem (101 cards)
 - Sample output (43 selected pages)
 - Reference reports
- 17. CATEGORY - I**
 - KEYWORDS -** finite element method, stresses, beams, swelling, x-y, CRASIB codes, AXICRP codes
- 18. SPONSOR -**

1. **NAME OR DESIGNATION OF PROGRAM - COMPARE**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC6600,7600, IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** COMPARE performs transient calculation of the thermodynamic conditions in volumes connected by flowing junctions with provision for mass and energy addition. Volume thermodynamics and junction flows are for homogeneous mixtures of: steam, two-phase water, any three perfect gases, or combinations of the above. Critical vent flow is based on the Moody equation. Subcritical flow is based on compressible orifice flow of an ideal gas-like mixture with inlet and exit losses resulting in a polytropic flow process. Flow with inertia is calculated on the basis of an incompressible subelement relationship. The program was written to perform transient subcompartment analysis of nuclear power plants.
4. **METHOD OF SOLUTION -** Volume thermodynamics and junction flows are determined independently in a quasi-static explicit manner. Mass and energy inflow or outflow accounting for each volume is done first for each time increment, assuming vent flows are constant. Thermodynamic equilibrium is assumed and state points determined. The resulting thermodynamic conditions are assumed constant and used to calculate the new vent flows between volumes for the next time interval. Flow with inertia is calculated on the basis of a solution to the momentum equation with constant density and flow area.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** The program currently provides for maxima of:
100 volumes
200 junctions
5 mass and energy addition tables (blowdown sets)
Water temperature is restricted to the range 278-620 deg. K (40-656 deg. F).
6. **TYPICAL RUNNING TIME -** A two-volume, one-junction problem requires 0.002 second per time-step (CDC7600) or 0.012 second (IBM370/165).
7. **UNUSUAL FEATURES OF THE PROGRAM -** Ideal-like gas polytropic equations are used to calculate orifice flow, including losses. Two-phase water with air flow is calculated, and inertial effects are included.
8. **RELATED AND AUXILIARY PROGRAMS -**
9. **STATUS -** Abstract first distributed March 1977.
CDC7600 version submitted September 1976, sample problem executed by NESC February 1977 on a CDC7600.
IBM360 version submitted February 1977, sample problem executed by NESC March 1977 on an IBM370/195.
10. **REFERENCES -** R. G. Gido, R. G. Lawton, C. I. Grimes, and J. A. Kudrick, COMPARE: A Computer Program for the Transient Calculation of a System of Volumes Connected by Flowing Vents, LA-NUREG-6486-MS, September 1976.
11. **MACHINE REQUIREMENTS -** 35,000 (octal) words (CDC6600,7600) or 125K bytes (IBM360,370)
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** SCOPE 3.4 (CDC6600), SCOPE 2.1 (CDC7600), OS/360,370 (IBM360,370).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** Numerical output may show system-dependent variations, particularly for the small values printed for the early time-steps.

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15. NAME AND ESTABLISHMENT OF AUTHOR -

7600 R. G. Gido and R. G. Lawton
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87544

370 C. I. Grimes and J. A. Kudrick
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (7600-1749 cards, 370-1709 cards)
Sample problem (7600-66 cards, 370-66 cards)
Sample problem output (1 microfiche)
Reference report

17. CATEGORY - H

KEYWORDS - reactor safety, containment, fluid flow, compressible flow, thermodynamics, blowdown

18. SPONSOR - NRC Division of Systems Safety

1. NAME OR DESIGNATION OF PROGRAM - ORCENT
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - ORCENT performs full-load design point heat and mass balance calculations for steam turbine cycles supplied with throttle steam, characteristic of light water reactor plants. The program handles both condensing and back-pressure turbine exhaust arrangements. Turbine performance calculations are based on the General Electric Company method for large steam turbine-generators operating with saturated and low superheat throttle steam. Output includes all information normally shown on a turbine cycle heat balance diagram.
4. METHOD OF SOLUTION - The code follows the procedure outlined in General Electric Report GER-2454A. The efficiency calculation method is based on detailed consideration of the effect of expansion moisture on stage efficiency.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
12 feed-water heaters
5 moisture removal stages in the low-pressure turbine section
Throttle steam temperature should be between 0 and 200 degrees F above saturation temperature. Throttle steam pressure should be between 200 and 2000 psia. Generator rating may be between 100 and 1500 Mva. One, two, or three turbine sections in series (tandem-compound arrangement only) may be specified. Turbine speed should be 1800 or 3600 rpm.
6. TYPICAL RUNNING TIME - Execution time for a single case is approximately 1 second on the IBM360/91. NESC compiled and executed the sample problem in 1 minute on an IBM370/195.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed November 1976.
IBM360 version submitted June 1976, replaced by revised Edition B March 1979, sample problem executed by NESC March 1979 on an IBM370/195.
10. REFERENCES - H. I. Bowers, ORCENT: A Digital Computer Program for Saturated and Low Superheat Steam Turbine Cycle Analysis, ORNL-TM-2395, January 1969.
F. G. Baily, K. C. Cotton, and R. C. Spencer, Predicting the Performance of Large Steam Turbine-Generators Operating with Saturated and Low Superheat Steam Conditions, GER-2454A, American Power Conference, Chicago, Illinois, April 25-27, 1967.
11. MACHINE REQUIREMENTS - 166K bytes storage were needed for execution of the sample problem on an IBM370/195.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360,370.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
H. I. Bowers
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (4190 cards)
Sample problem (21 cards)

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Sample problem output (13 pages)
Reference report, ORNL-TM-2395

17. CATEGORY - H

KEYWORDS - heat, steam, turbines, power plants, LWR reactors, PWR reactors, BWR reactors, mass balance, fluid flow, coolant loops, water

18. SPONSOR - AEC Division of Reactor Development and Technology

1. **NAME OR DESIGNATION OF PROGRAM - COMCAN**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360**
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** COMCAN is designed to analyze complex systems, such as nuclear plants for common causes of failure. A common cause event, or common mode failure, is a secondary cause that may contribute to the development of more than one component malfunction. A significant common cause event is a secondary cause common to all basic events in one or more minimal cut sets. These minimal cut sets are common cause candidates. If all components represented by the basic events in a minimal cut set share a common location, that minimal cut set is called a prime common cause candidate. Components share a common location if no barriers capable of insulating them from the secondary cause are present.
4. **METHOD OF SOLUTION -** COMCAN searches the fault tree minimal cut sets for shared susceptibility to various secondary events (common causes) and common links between components. In the case of common causes, a location check may also be performed to determine whether barriers to the common cause exist between components. The program can locate common manufacturers of components having events in the same minimal cut set. A relative ranking scheme for secondary event susceptibility is included in the program.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Limited to the fault tree minimal cut sets.
6. **TYPICAL RUNNING TIME -** Less than 2 seconds is required to execute the sample problem on an IBM370/195.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -** The format used for COMCAN is compatible with the input format of programs for qualitative and quantitative reliability and safety analyses, such as MOCUS (NESC Abstract 653) and PREP,KITT (NESC Abstract 528). The cut set input deck can be punched by MOCUS.
9. **STATUS -** Abstract first distributed January 1977.
IBM360 version submitted October 1976, sample problem executed by NESC December 1976 on an IBM370/195.
10. **REFERENCES -** Gary R. Burdick, Neldon H. Marshall, James R. Wilson, COMCAN - A Computer Program for Common Cause Analysis, ANCR-1314, May 1976.
J. B. Fussell, G. R. Burdick, D. M. Rasmuson, J. R. Wilson, J. C. Zipperer, A Collection of Methods for Reliability and Safety Engineering, ANCR-1273, April 1976.
W. E. Vesely and R. E. Narum, PREP and KITT: Computer Codes for the Automatic Evaluation of a Fault Tree, IN-1349, August 1970.
J. B. Fussell, E. B. Henry, N. H. Marshall, MOCUS: A Computer Program to Obtain Minimal Sets from Fault Trees, ANCR-1156, August 1974.
11. **MACHINE REQUIREMENTS -** 140K bytes of memory
12. **PROGRAMMING LANGUAGES USED -** FORTRAN IV and Assembly language
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/360.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** The four Assembly language routines included in the package are the FORTRAN input-output and abnormal termination dump routines: FABEND, FIOCS, IBCOM# and INFILQ. These are a part of the NRTS Environmental Routines package (NESC Abstract 613).
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
G. R. Burdick, N. H. Marshall,
and J. R. Wilson
EG&G Idaho, Inc.

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P. O. Box 1625
Idaho Falls, Idaho 83401

- 16. MATERIAL AVAILABLE - Magnetic Tape Transmittal**
Source deck (FORTRAN-1882 cards, BAL-4080 cards)
Sample problem (211 cards)
Reference report, ANCR-1314
- 17. CATEGORY - G**
KEYWORDS - reliability, fault tree analysis, system failure analysis, MOCUS codes, PREP/KITT codes
- 18. SPONSOR -**

1. **NAME OR DESIGNATION OF PROGRAM** - EPISODEB
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360,370 (see item 14)
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - EPISODEB is a package of eight subroutines for the numerical solution of the initial value problem for systems of first order ordinary differential equations whose Jacobian matrices are banded or can be approximated by band matrices. The package can be used for either stiff or non-stiff systems whose Jacobians can be approximated by band matrices. It is especially suited to problems with intermittent high-speed transients or waves.
4. **METHOD OF SOLUTION** - EPISODEB contains both a variable-step, variable-order, backward differentiation method of orders one through five and a variable-step, variable-order, implicit Adams method of orders one through twelve. The user may select either method to solve a stiff or a non-stiff system. The user may also select from four nonlinear system solvers.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The Jacobian is assumed to be banded. Because the step-size is truly variable, EPISODEB is best suited to problems with intermittent high-speed transients or waves. Smooth or linear problems can lead to high overhead costs. Current dimensioning allows for 100 simultaneous equations. The documentation and comments in EDRIVB show how to alter the limit on the system size and the bandwidth. Limits on the bandwidth and total storage also are described in detail in UCID-30132.
6. **TYPICAL RUNNING TIME** - Less than 1 minute is needed to compile and execute the sample problem.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The user may select from two integration methods (for stiff and non-stiff problems), and from four nonlinear system solvers. A flexible driver (subroutine EDRIVB) returns output data at a previously-specified point by interpolation, provides output data by hitting the prescribed output point without interpolation, or returns data after each step. Absolute error, true relative error, or a quasi-relative error may be controlled. EDRIVB controls the integration process and prints any error messages.
8. **RELATED AND AUXILIARY PROGRAMS** - EPISODE (NESC Abstract 675) and GEAR (NESC Abstract 592) for systems with a full Jacobian. GEARB (NESC Abstract 661) for systems with a banded Jacobian matrix.
9. **STATUS** - Abstract first distributed March 1977.
IBM360 version submitted July 1976, sample problem executed by NESC January 1977 on an IBM370/195, converted to CDC single-precision and executed by NESC December 1976 on a CDC7600 at Brookhaven National Laboratory.
10. **REFERENCES** - G. D. Byrne and A. C. Hindmarsh, EPISODEB: An Experimental Package for the Integration of Systems of Ordinary Differential Equations with Banded Jacobians, UCID-30132, April 1976.
A. C. Hindmarsh and G. D. Byrne, EPISODE: An Experimental Package for the Integration of Systems of Ordinary Differential Equations, UCID-30112, May 1975.
A. C. Hindmarsh, Banded Linear Systems with Pivoting, UCID-30060, Rev. 1, May 1976.
A. C. Hindmarsh and G. D. Byrne, Applications of EPISODE: An Experimental Package for the Integration of Systems of Ordinary Differential Equations, in Numerical Methods for Differential Systems, L. Lapidus and W. E. Schiesser, Eds., Academic Press, 1976. (Also published as UCRL-75868, June 1975.)
G. D. Byrne and A. C. Hindmarsh, A Polyalgorithm for the Numerical Solution of Ordinary Differential Equations, Association for Computing Machinery Transactions on Mathematical Software, Vol. 1, pp. 71-96, March 1975. (Also in UCRL-75652, April 1974.)

A. C. Hindmarsh, GEARB: Solution of Ordinary Differential Equations having Banded Jacobian, UCID-30059, Rev. 1, March 1975.
G. D. Byrne, ACC Programming Note 76-3, Revised January 5, 1977.

11. **MACHINE REQUIREMENTS** - 102K bytes are used to execute the double-precision version of the sample problem.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360,370.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The code is heavily commented. An auxiliary routine, CONVRT, and its driver are provided to change precision from double to single. The user then need only change UROUND in subroutine EDRIVB as indicated in the code. CDC6000-7000, DEC PDP10, or UNIVAC1100 versions can be prepared from the IBM version with only minor changes. If EPISODEB is to be used on other systems, UROUND (the machine unit roundoff) may need to be evaluated and set in subroutine EDRIVB. The package contains an auxiliary subroutine, MACHIN, and its driver (supplied to NESC by L. F. Shampine and M. K. Gordon of SLA) which may be adapted to calculate or verify UROUND. Program-supplied error messages and the output of the sample problem are written on logical unit 3.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
G. D. Byrne
Department of Mathematics and Statistics &
Department of Chemical and Petroleum Engineering -
University of Pittsburgh
Pittsburgh, Pennsylvania 15260
A. C. Hindmarsh, L-310
Numerical Mathematics Group
Lawrence Livermore Laboratory
P. O. Box 808
Livermore, California 94550
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (1764 cards)
Sample problem (196 cards)
Auxiliary programs (157 cards)
Sample problem output (7 pages)
Reference report, UCID-30132, and ACC Programming Note 76-3
17. **CATEGORY** - P
KEYWORDS - ordinary differential equations, numerical solution, Adams method, initial-value problems, banded matrix, GEAR codes, GEARB codes, EPISODE codes
18. **SPONSOR** - ERDA Division of Military Application

1. **NAME OR DESIGNATION OF PROGRAM** - TH13D
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM370
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - TH13D is a computer program for steady-state, single-phase, thermal-hydraulic multichannel analysis. The model accounts for conservation of mass, energy, and momentum (both axial and transverse) subject to pressure-drop boundary conditions and leads to a nonlinear, multipoint boundary-value problem. Turbulent interchange, radial thermal conduction, and forced flow due to the wire wrap or grid between channels are explicitly taken into account. Temperature distributions in the coolant, cladding, fuel, and duct wall, and the size of the central void of the oxide fuel after thermal restructuring are computed. Three different thermal-hydraulic channel arrangements (square, hexagonal, and triangular) can be treated. Multipin analysis with transverse interactions, or multiassembly calculations without transverse interactions between the channels, can be performed. Problems of partial flow blockage (porous blockage) can be analyzed, and the effect on the redistribution of the inlet mass velocity can be taken into account.
4. **METHOD OF SOLUTION** - TH13D solves multipoint boundary-value rod-bundle thermal-hydraulic problems by means of mixed implicit and explicit finite differencing of conservation of mass, energy, and momentum equations. The Newton-Raphson method is employed for iteration on boundary conditions.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Maximum of 217-pin bundle problem with unlimited axial steps. Sonic-velocity propagation effects are not considered. A lumped-parameter approach is assumed valid, i.e., a reactor channel may be either a fuel pin or a fuel assembly with associated coolant. All system parameters within a channel at a given elevation are uniform and radially isotropic. Axial heat conduction is neglected.
6. **TYPICAL RUNNING TIME** - About 1.5 minutes are required to execute the sample problem (19-pin rod bundle) on an IBM370/195.
7. **UNUSUAL FEATURES OF THE PROGRAM** - TH13D features include -
 - (1) pressure-drop boundary condition,
 - (2) computation of cladding, fuel and duct wall temperature distributions,
 - (3) bypass fluid option,
 - (4) wire-wrap model.
- B. **RELATED AND AUXILIARY PROGRAMS** -
9. **STATUS** - Abstract first distributed January 1977.
IBM370 version submitted October 1976, replaced by revised version submitted May 1977, sample problem executed by NESC June 1977 on an IBM370/195.
10. **REFERENCES** - W. T. Sha and R. C. Schmitt, TH13D--A Computer Program for Steady-state Thermal-hydraulic Multichannel Analysis, ANL-8112, December 1975
William T. Sha, Robert C. Schmitt, and T. R. Huebotter, Boundary-Value Thermal-Hydraulic Analysis of a Reactor Fuel Rod Bundle, Nuclear Science and Engineering, Vol. 59, pp. 140-160, 1976.
11. **MACHINE REQUIREMENTS** - 260K bytes storage (for 19-pin bundle) and 2 scratch disks or tapes
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/MVT.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The package supplied is the 19-pin bundle overlay version. Other versions (61-pin and 217-pin) may be obtained by changing the common blocks in the BLOCK DATA subprogram as indicated by the output obtained

when attempting to run a case requiring more storage. The Argonne version uses three routines which may be deleted or replaced by similar routines used at other installations:

- ERRSET - A routine allowing user processing upon underflow, overflow, or divide check occurrences, used for debugging.
- TLEFT - Time function returning amount of time left in the run, used for timing and restart control.
- LOCF - Location function returning absolute address of argument, used for clearing large blocks of storage.

15. NAME AND ESTABLISHMENT OF AUTHORS -

W. T. Sha and R. C. Schmitt
 Components Technology Division
 Argonne National Laboratory
 9700 South Cass Avenue
 Argonne, Illinois 60439

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (7076 cards)
 Sample problem (57 cards)
 Control information (JCL 45 cards)
 Sample problem output (28 selected pages)
 Reference report, ANL-8112

17. CATEGORY - H

KEYWORDS - fluid flow, heat transfer, thermodynamics, fuel elements, temperature distribution, LMFBR reactors

18. SPONSOR - ERDA Division of Reactor Development and Demonstration

1. **NAME OR DESIGNATION OF PROGRAM - CREEP-PLAST**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** CREEP-PLAST is a two-dimensional finite-element program for creep and plasticity analysis of metal structures operating at high temperature. The technique employed considers instantaneous time-independent elastic-plastic and time-dependent creep simultaneously in an incremental procedure which requires the user to select his own discrete time and/or load increments. The method of calculation is based on the assumption that the total strain at any instant consists of elastic, plastic, and creep parts with essentially no interdependence between the plastic and creep components. CREEP-PLAST is capable of predicting deformations, stresses, and total accumulated strains as functions of time and/or load for user-specified thermal and mechanical loadings which can be varied independently. The program can be used to analyze plane or axisymmetric structures.
Two postprocessor graphics programs use plot output files from CREEP-PLAST to display the time and/or mechanical load histories of nodal displacement, stress, strain, and temperature (HISTORY-PLOT) or contour lines of whole field deformations and stress, strain, or temperature (CONTOUR-PLOT).
4. **METHOD OF SOLUTION -** The plasticity formulation is based on kinematic hardening and on the von-Mises yield condition with the associated flow rule. The tangent stiffness approach is used and CREEP-PLAST is capable of utilizing either bilinear representations of the stress-strain curves or the actual nonlinear curves. Creep can be treated either by the equation-of-state theory with primary strain-hardening or the memory theory approach based on a modified superposition principle. In both approaches the creep strains modify the tangent stiffness in the equilibrium equations, rather than being included entirely through the initial strain concept. Kinematic descriptions are linear.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Maxima of -
900 nodes
1800 elements
200 solution increments
6. **TYPICAL RUNNING TIME -** CPU times vary from 1 minute to about 1 hour depending on the problem size. The two CREEP-PLAST sample problems required 83 and 184 seconds of CPU time on an IBM370/195, respectively. The postprocessor plot programs each ran in less than 10 seconds on the IBM370/195.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
 - (a) The analysis methods of RDT Standard F9-5 are incorporated.
 - (b) Creep descriptions for austenitic stainless steels are programmed.
 - (c) Memory integral description for nonlinear creep is included.
8. **RELATED AND AUXILIARY PROGRAMS -** CREEP-PLAST2 (NESC Abstract 810)
9. **STATUS -** Abstract first distributed July 1977.
IBM360,370 version submitted March 1977, replaced by revised Edition B March 1979, sample problems executed by NESC April 1979 on an IBM370/195.
10. **REFERENCES -** Y. R. Rashid, Part I, Theory Report for CREEP-PLAST Computer Program, GEAP-10546, January 1972.
J. A. Clinard and J. S. Crowell, ORNL User's Manual for CREEP-PLAST Computer Program, ORNL-TM-4062, November 1973.
P. G. Fowler, J. S. Crowell, and J. A. Clinard, User's Manual for ORNL CREEP-PLAST Graphics Package, ORNL-TM-4642, September 1974.
CREEP-PLAST Graphics, ORNL-TM-4642 Supplement, February 1975.

National Energy Software Center Note 79-46, CREEP-PLAST Tape Description and Implementation Information, NESC No. R707.360B, May 31, 1979.

11. **MACHINE REQUIREMENTS** - A maximum of 400K bytes of memory is required for cut-of-core solutions. Size may vary up to 1500K bytes for in-core solution of larger problems. An overlay system is used and significant scratch storage space is required for large problems.
CREEP-PLAST executed in approximately 750K bytes of storage, as it is presently configured, in a non-overlay format. The plotting programs HISTORY-PLOT and CONTOUR-PLOT each execute in less than 170K bytes of storage.
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV (95%) and BAL (5%)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360,370 Level 21.6.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - CREEP-PLAST calls an installation systems routine (ICTICK) which in the author's environment returns a measure of the elapsed CPU time. It is included as a dummy subroutine and will have to be replaced by the user for his environment.
CREEP-PLAST optionally produces as output a plot file (FT12F001) suitable for use as input to the postprocessor graphics programs HISTORY-PLOT and CONTOUR-PLOT. The plotting programs require the proprietary CalComp system routines PLOT, NUMBER, and SYMBOL.
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
Author Y. R. Rashid
General Electric Company
Nuclear Fuel Department
San Jose, California 95114

Contact J. A. Clinard
Oak Ridge National Laboratory
Engineering Technology Division
P. O. Box Y
Oak Ridge, Tennessee 37830
16. **MATERIAL AVAILABLE** - Restricted Distribution
Magnetic Tape Transmittal
Source decks (CREEP-PLAST FORTRAN 3674 cards, BAL 150 cards, HISTORY-PLOT 817 cards, CONTOUR-PLOT 995 cards)
Sample problems (CREEP-PLAST 300 cards, output file 25 blocks*, HISTORY-PLOT 30 cards, CONTOUR-PLOT 16 cards)
Sample problem output (CREEP-PLAST 25 pages, HISTORY-PLOT 8 pages, CONTOUR-PLOT 2 pages)
Reference reports and Note
* RECFM=VBS,BLKSIZE=7294
17. **CATEGORY** - I
KEYWORDS - two-dimensional, deformation, finite element method, stresses, static loads, mechanical structures, plasticity, creep, HISTORY-PLOT codes, CONTOUR-PLOT codes
18. **SPONSOR** - ERDA Division of Reactor Development and Demonstration

1. **NAME OR DESIGNATION OF PROGRAM - WIGL3**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600**
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** WIGL3 is a program for the steady-state and transient solution of the one-dimensional, two-group, space-time diffusion equations. The program will treat slab, cylindrical, and spherical geometries and includes nonboiling heat transfer. Control rod motion and control system feedback based on total core power or outlet coolant temperature can be simulated. Transients may be excited by prescribed changes in inlet coolant temperature, coolant flow rate, or rod position. For the steady-state option, criticality may be achieved by adjusting control rod position, reference coolant density, or reference fuel temperature.
4. **METHOD OF SOLUTION -** The neutron equations along with the various feedback processes form a nonlinear system of equations. The solution is obtained by computing the changes in nuclear parameters during a given time-step by using the neutron fluxes at the beginning of the time-step. The time-difference form of the diffusion equations is obtained by replacing continuous time by a sequence of times and introducing a set of internally computed time-dependent parameters (thetas) to increase the stability and accuracy of the numerical method. The theta-method is discussed in detail in reference 1. At each time-step, the spatial equations are solved by a simultaneous inversion of the two-group operator; thus no spatial iteration is required. The coefficients of these equations are functions of local coolant temperature, fuel metal temperature, and control motion which for the transient solution are also obtained from a time-difference form of their representative equations. For the steady-state option, the no delayed precursor neutron balance equations are solved as transient equations but all other balance equations are solved as steady-state equations.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** No restrictions are placed on single parameters related to problem size. The total amount of storage set aside for all parameters is 14,000 memory locations. This allows the user to decide which area requires a more detailed representation.
6. **TYPICAL RUNNING TIME -** A problem with 50 spatial points, 20 thermal-hydraulic regions, and 20 nuclear regions would run less than one second per time-step. The time increases with an increase in these parameters. The amount of printing requested also affects running time. Typical computing times for 100 space point steady-state problems run from 20 to 100 seconds.
7. **UNUSUAL FEATURES OF THE PROGRAM -** The theta-method used in the difference equations is unique in WIGL2 and WIGL3. Also, the program performs an automatic critical rod search and contains rather complete feedback.
8. **RELATED AND AUXILIARY PROGRAMS -** WIGL3 is an extension of the WIGL2 program (NESC Abstract 274). WIGL3 has most of the features of WIGL2 with the addition of a steady-state calculation. WIGL3 uses many of the Bettis Environmental Routines (NESC Abstract 478).
9. **STATUS -** Abstract first distributed July 1977.
CDC6600 version submitted May 1977.
10. **REFERENCES -** A. V. Vota, N. J. Curlee, Jr., and A. F. Henry, WIGL3 - A Program for the Steady-state and Transient Solution of the One-dimensional, Two-group, Space-time Diffusion Equations Accounting for Temperature, Xenon, and Control Feedback, WAPD-TM-788, April 1968.
A. F. Henry and A. V. Vota, WIGL2 - A Program for the Solution of the One-dimensional, Two-group, Space-time Diffusion Equations Accounting for Temperature, Xenon, and Control Feedback, WAPD-TM-532, October 1965.
A. F. Henry and A. V. Vota, WIGL2 Addendum 1 - A Program for the Solution of the One-dimensional, Two-group, Space-time Diffusion Equations Accounting for Temperature, Xenon and Control Feedback, WAPD-TM-532 Addendum 1, January 1967.

C. J. Pfeifer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967.

11. **MACHINE REQUIREMENTS** - 154,000 (octal) central memory words and one disk for storage of permanent files. The number of central memory words required could be decreased by decreasing the amount of storage set aside for parameters. This would also further limit problem size. If the ability to store data on disk for succeeding WIGL3 problems is not desired, the disk is not needed.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 3.3.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The required software environment is described by Pfeifer (reference 4). It includes routines for program loading, input conversion, and the storage, retrieval, and processing of permanent files.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
Authors A. V. Vota, N. J. Curlee, Jr., and A. F. Henry

Contact L. D. Eisenhart
 Bettis Atomic Power Laboratory
 Westinghouse Electric Corporation
 Box 79
 West Mifflin, Pennsylvania 15122
16. **MATERIAL AVAILABLE** - Restricted Distribution
 Magnetic Tape Transmittal
 Source deck (5158 cards)
 Sample problem (79 cards)
 Reference report, WAPD-TM-788
17. **CATEGORY** - F
KEYWORDS - space-time, one-dimensional, diffusion equations, two-group, slabs, cylinders, spheres, heat transfer, temperature, control, feedback, WIGL2 codes
18. **SPONSOR** - DOE Division of Naval Reactors

1. NAME OR DESIGNATION OF PROGRAM - NIXLIN
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - NIXLIN performs a function minimization by a direct search iterative process that has the advantage of requiring no derivative evaluations. This particular version is well-suited to fitting nonlinear models to experimental data and to the solution of systems of nonlinear simultaneous equations.
4. METHOD OF SOLUTION - The program uses the Simplex method for function minimization.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The dimensions may be increased to accommodate larger problems.
6. TYPICAL RUNNING TIME - Less than 30 seconds is required for a typical problem.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed February 1977.
IBM360 version submitted November 1976, sample problems executed by NESC January 1977 on an IBM370/195.
10. REFERENCES - J. A. Nedler and R. Mead, A Simplex Method for Function Minimization, Computer Journal, Vol. 7, pp. 308-313, 1965.
11. MACHINE REQUIREMENTS - The program requires 240K bytes to compile, 76K bytes to execute.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
L. M. Arnett
Savannah River Laboratory
E. I. duPont de Nemours and Company, Inc.
Aiken, South Carolina 29801
16. MATERIAL AVAILABLE -
Source deck (400 cards)
Sample problems (39 cards)
Sample problems output (2 pages)
Reference reprint
17. CATEGORY - P
KEYWORDS - data processing, least square fit, nonlinear problems
18. SPONSOR - ERDA Office of Waste Management, Production and Reprocessing

1. **NAME OR DESIGNATION OF PROGRAM - HAMOC**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC6600, 7600, CYBER74-18
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** HAMOC determines the pressure transients in piping systems attached to a reactor vessel which has been perturbed, by a hypothetical core disruptive accident (HCDA) for example. The continuity and momentum equations are solved. The energy equation is not programmed, but simplified column separation logic is included to treat vapor pressures below saturation. This simplified approach has been checked against experimental data. HAMOC was written specifically for problems in which forcing pressures are known as a function of time at certain end boundary conditions, rather than as a general purpose code for the solution of pump coastdown or valve closing problems.
4. **METHOD OF SOLUTION -** The differential equations of continuity and momentum are solved by the method of characteristics. When column separation occurs, special internal boundary conditions are temporarily established which fix the pressure at the saturated vapor pressure during the existence of the cavity. Special equations give the pressure rise when the cavity collapses.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** The program currently provides for maxima of:
 - 56 legs
 - 50 nodes per leg
 - 15 three-way junctions
 - 50 plots
 - 1000 points per plot
 - 1 line per plotThe fluid properties are those for sodium, and the pipe properties are those for Type 304 stainless steel. The above restrictions should not be difficult to alter; the following restrictions are more stringent. There may be 1 or 2 pipe ends with prescribed pressure-time history. All pumps have the same set of characteristics. Fluid temperatures must be constant with time, must be the same for all points within a leg, and must be the same for all connecting legs at a pump, at a tee, or at a Y-junction. The minimum leg length must not be smaller than
 $(\text{time-step}) \cdot (\text{pressure-pulse-speed} + \text{fluid-velocity}).$
6. **TYPICAL RUNNING TIME -** The 45-leg sample problem requires about 110 seconds (CYBER74-18) or 21 seconds (CDC7600) execution time for a run of 0.1 seconds real time. Typically, execution time on the CYBER74-18 is about 0.00057 second per mesh-point per time plane. Running times can be reduced significantly, with little loss of accuracy, by using a constant friction factor.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -** WHAM6 (NESC Abstract 278).
9. **STATUS -** Abstract first distributed March 1977.
CDC6600 version submitted July 1976, sample problem executed with dummy plot routines by NESC February 1977 on a CDC7600.
10. **REFERENCES -** H. G. Johnson, HAMOC - A Computer Program for Fluid Hammer Analysis, HEDL-TME 75-119, December 1975.
11. **MACHINE REQUIREMENTS -** A 131K machine is required with dummy plot routines; HAMOC requires 101,000 (octal) words of storage. A tape is used to store data for offline plotting.
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** SCOPE 3.4.2 (CYBER74-18), SCOPE 3.4.4 (CDC6600), SCOPE 2.1.3 (CDC7600).

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- 14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** It is assumed that the operating system will zero the memory at load time. Plotting calls are to standard CalComp subroutines. The source file contains COMDECKs. It should be processed by the UPDATE utility before compilation.
- 15. NAME AND ESTABLISHMENT OF AUTHOR -**
H. G. Johnson
Hanford Engineering Development Laboratory
Westinghouse Hanford Company
P. O. Box 1970
Richland, Washington 99352
- 16. MATERIAL AVAILABLE -** Magnetic Tape Transmittal
Source decks (HAMOC-2115 cards, dummy plot routines-50 cards)
Sample problem input (70 cards)
Sample problem output (1 microfiche)
Reference report
- 17. CATEGORY - G**
KEYWORDS - liquid metals, pressure, reactor safety, transients, WHAM6 codes
- 18. SPONSOR -** ERDA Division of Reactor Development and Demonstration

1. **NAME OR DESIGNATION OF PROGRAM** - GEOCOST-BC
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC6600, CYBER74
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - GEOCOST calculates the cost of generating electricity from geothermal energy. The version of GEOCOST in this release, GEOCOST-BC, simulates the production of electricity using a binary fluid cycle based upon a hydrothermal resource.
4. **METHOD OF SOLUTION** - GEOCOST is a simulation model which combines both technical processes and economic factors into one systematic framework. The simulation is composed of two principal parts: a reservoir model which simulates the exploration, development, and operation of a geothermal reservoir, and a power plant model which simulates the design, construction, and operation of the power plant. Each of these parts is composed of several submodels which treat fluid transmission and disposal, geothermal fluid/working fluid heat exchangers, turbine, generators, working fluid condenser, pumps, heat rejection, and calculation of thermodynamic state points in basic subcritical and supercritical Rankine cycles for a variety of working fluids. Working fluids which are now in the model include isobutane, n-butane, R-11, R-12, R-22, R-113, R-114, and ammonia. Thermodynamic properties of the working fluids at the state points are calculated using empirical equations of state. The Starling equation of state is used for hydrocarbons and the Martin-Hou equation of state is used for fluorocarbons and ammonia. A wide variety of financial and tax structures can be simulated through varying the rates of return on equity and debt, the debt-equity ratio, and tax rates. Using discounted cash flow analyses, GEOCOST calculates the cost of energy by equating the present worth of the revenues and expenses over the economic life of the reservoir and plant.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Current array dimensions provide for a maximum well field size of 625 wells and maximum operating period of 50 years from reservoir exploration through the economic life of the power plant.
6. **TYPICAL RUNNING TIME** - From 15 seconds to 2 minutes are required for the majority of simulation cases.
7. **UNUSUAL FEATURES OF THE PROGRAM** -
8. **RELATED AND AUXILIARY PROGRAMS** -
9. **STATUS** - Abstract first distributed July 1977.
CDC6600 version submitted September 1976, sample problem executed by NESC June 1977 on a CDC7600.
10. **REFERENCES** - H. D. Huber, R. A. Walter, and C. H. Bloomster, User Manual for GEOCOST: A Computer Model for Geothermal Cost Analysis, Volume 2, Binary Cycle Version, BNWL-1931-V2, March 1976.
C. H. Bloomster, P. D. Cohn, J. G. Desteese, H. D. Huber, P. N. Lamori, D. W. Shannon, J. F. Sheff, and R. A. Walter, GEOCOST: A Computer Program for Geothermal Cost Analysis, BNWL-1888, February 1975.
C. H. Bloomster, An Economic Model for Geothermal Cost Analysis, BNWL-SA-5378, May 1975.
P. D. Cohn, and C. H. Bloomster, Capital Cost Models for Geothermal Power Plants, BNWL-1990, July 1976.
R. A. Walter, C. H. Bloomster, and S. E. Wise, Thermodynamic Modeling of Geothermal Power Plants, BNWL-1911, May 1975.
CYBER Control Information for GEOCOST, BNWL Note, 1976.
11. **MACHINE REQUIREMENTS** - At least 55K (decimal) memory
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 3.4.3.

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14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Users without access to the CDC Math Sciences Library will have to supply a replacement for the subroutine RQNWT used to solve systems of nonlinear equations. The GEOCOST-BC source includes the 1967 ASME Steam Table data.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
H. D. Huber, C. H. Bloomster, and R. A. Walter
Pacific Northwest Laboratories
Battelle
Battelle Boulevard
Richland, Washington 99352
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (15,218 cards)
Sample problem input (4 cards)
Sample problem output (60 selected pages, 3591 tape records)
Reference report, BNWL-1942-V2, and BNWL Note
17. **CATEGORY** - D
KEYWORDS - geothermal energy, simulation, cost, electricity, working fluids, hydrothermal systems, equations of state, heat exchangers, Rankine cycle power systems, binary-fluid systems
18. **SPONSOR** - ERDA Division of Geothermal Energy

1. NAME OR DESIGNATION OF PROGRAM - WREM-TOODEE2/MOD3
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - WREM-TOODEE2 is a two-dimensional, time-dependent, fuel-element thermal analysis program. Its primary purpose is to evaluate fuel-element thermal response during post-LOCA refill and reflood in a pressurized water reactor (PWR).
4. METHOD OF SOLUTION - TOODEE2 calculations are carried out in a two-dimensional mesh region defined in slab or cylindrical geometry by orthogonal grid lines. Coordinates which form order pairs are labeled x-y in slab geometry, and those in cylindrical geometry are labeled r-z for the axisymmetric case and r-theta for the polar case. Conduction and radiation are the only heat transfer mechanisms assumed within the boundaries of the mesh region. Convective and boiling heat transfer mechanisms are assumed at the boundaries. The program numerically solves the two-dimensional, time-dependent, heat conduction equation within the mesh region.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - WREM-TOODEE2 considers only axisymmetric geometry although the equations for slab and polar geometry are included in the program.
6. TYPICAL RUNNING TIME - The sample problem executes in 6 or 7 minutes on an IBM370/195.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - WREM-TOODEE2 was developed from the earlier TOODEE program. It is part of the Water Reactor Evaluation Model (WREM) package which also includes the RELAP4/MOD5 (NESC Abstract 369) and MOXY-EM (NESC Abstract 551) programs.
9. STATUS - Abstract first distributed February 1977.
IBM360 version submitted September 1976, sample problem executed by NESC February 1977 on an IBM370/195.
10. REFERENCES - WREM: Water Reactor Evaluation Model (Revision 1), NUREG-75/056, May 1975.
G. N. Lauben, TOODEE2: A Two Dimensional Time Dependent Fuel Element Thermal Analysis Program, NUREG-75/057, May 1975.
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360,370.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
G. N. Lauben
Division of Systems Safety
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (6968 cards)
Sample problems (118 cards)
2314 and 3330 load modules (TOODEE 395 blocks)
Control information (JCL 74 cards)
Sample problem output (44 selected pages, 1 microfiche)
Reference report, NUREG-75/057
17. CATEGORY - G

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KEYWORDS - fuel elements, two-dimensional, x-y, r-z, r-theta, heat transfer, space-time, thermal reactors, RELAP4/MOD5 codes, MOXY-EM codes

18. SPONSOR - NRC Office of Nuclear Reactor Regulation

1. **NAME OR DESIGNATION OF PROGRAM** - SYN3D
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM370/195, CDC7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - SYN3D solves the direct and adjoint, diffusion theory, static eigenvalue equations in two and three dimensions. The geometries available are x-y, r-z, x-y-z and triangular-z.
4. **METHOD OF SOLUTION** - SYN3D uses single-channel spatial flux synthesis to calculate approximate solutions to the three-dimensional (or two-dimensional) diffusion theory difference equations. Synthesis expansion functions must be supplied by the user from two-dimensional (or one-dimensional) finite-difference calculations performed by some other code. SYN3D sets up the synthesis equations and solves them by power iteration with Wielandt acceleration. Each iteration is an exact inversion of the block-tridiagonal synthesis equations by forward-elimination, backward-substitution.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The only serious limitation is on the product of the number of groups and the maximum number of expansion functions used at any particular axial elevation.
6. **TYPICAL RUNNING TIME** - Exclusive of the time required to generate expansion functions, SYN3D will solve an 11-group, 12,000 mesh point model with two expansion functions in 0.9 minutes of Model 195 CPU time. A 28-group, 30,000 mesh point model with three expansion functions requires 8.9 minutes of CPU time on the Model 195. Each 370 sample problem was executed in 1 minute of CPU time on an IBM3033. All four 7600 sample problems were executed in less than 1 minute of CP time on a CDC7600.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The difference equations SYN3D solves are the mesh-interval-centered type. Expansion functions should be generated using diffusion theory codes solving the same equations. The code is designed with restart capabilities which reduce, on the average, the running times for individual problems when a series of similar problems is to be run. SYN3D requires input cross sections, expansion functions, and geometry descriptions in the Version III formats defined by the ERDA RDD Reactor Physics Branch Computer Code Coordination Committee (CCCC). Special options include group collapsing and the use of different expansion functions in different axial zones of the model.
8. **RELATED AND AUXILIARY PROGRAMS** - SYN3D requires binary input files containing cross sections, expansion functions, and geometry descriptions. Although a small program is provided with the code to read these data from cards, the user may wish to use other programs which generate CCCC files. LASIP3 (NESC Abstract 691) can be used to generate CCCC standard interface files from specially formatted card input. A finite-difference, diffusion theory program is required to generate expansion functions. VENTURE (NESC Abstract 686) is one such program.
9. **STATUS** - Abstract first distributed February 1977.
IBM370 version submitted April 1976, replaced by revised Edition B November 1978, sample problems executed by NESC October 1978 on an IBM3033.
CDC7600 version submitted April 1976, sample problems executed by NESC October 1978 on a CDC7600.
10. **REFERENCES** - C. H. Adams, SYN3D - A Single-Channel, Spatial Flux Synthesis Code for Diffusion Theory Calculations, ANL-76-21, July 1976.
B. M. Carmichael, Standard Interface Files and Procedures for Reactor Physics Codes, Version III, LA-5486-MS, February 1974.
11. **MACHINE REQUIREMENTS** - The 370 version requires as a minimum 35K full-word storage to execute small problems and runs more efficiently with increased storage capacity. Depending on the complexity of the problem, SYN3D may require up to 45 logical units. To execute the 370's sample problems, 470K words of memory are needed. The 7600 version requires 55,000 (octal) words of small core memory (SCM).

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- 12. PROGRAMMING LANGUAGES USED -** FORTRAN IV (H Extended compiler) and Assembly language (IBM370), FORTRAN IV and COMPASS (CDC7600)
- 13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/370 (IBM370) and SCOPE (CDC7600).
- 14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -**
- 15. NAME AND ESTABLISHMENT OF AUTHOR -**
C. H. Adams
Applied Physics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
- 16. MATERIAL AVAILABLE -** Magnetic Tape Transmittal
Source decks (SYN3D 370-19,216 cards, 7600-19,216 cards, CDFILE 370-665 cards, 7600-665 cards, BPOINTER 370-501 cards, 7600-130 cards)
Sample problems (370-73 cards, 7600-73 cards)
Auxiliary information (370-1418 cards, 7600-1418 cards)
Control information (370-JCL 137 cards, 7600-100 cards)
Reference report, ANL-76-21
- 17. CATEGORY - C**
KEYWORDS - two-dimensional, three-dimensional, diffusion equations, CCCC, synthesis, x-y, r-z, x-y-z, triangular-z, LASIP3 codes, VENTURE codes
- 18. SPONSOR -** ERDA Division of Reactor Development and Demonstration

1. **NAME OR DESIGNATION OF PROGRAM** - SPOOL-FIRE
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM370
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - SPOOL-FIRE calculates the pressure and temperatures within a containment building as a result of a sodium fire. The fire is assumed to occur in two distinct phases: a spray and a pool. The spray fire is conservatively assumed to occur instantaneously. The code calculates all important temperatures, accounting for heat loss from the building to the environment, as well as leakage of the containment atmosphere under conditions of internal overpressure.
4. **METHOD OF SOLUTION** - The pool fire model used is the SOFIRE-II model developed by Atomics International which is based on computing a sodium burning rate proportional to the rate of diffusion of oxygen to the pool surface. Conventional equations of heat transfer by conduction, convection, and radiation are used to perform heat balances and compute temperatures. The IBM Continuous System Modeling Program (CSMP) is used to solve the set of applicable differential equations. The KAPL ROPE program is treated as a subroutine to solve for the 'equilibrium' gas temperature following the spray fire.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** -
6. **TYPICAL RUNNING TIME** - The sample problem required approximately 5.5 minutes to execute.
7. **UNUSUAL FEATURES OF THE PROGRAM** - With the IBM CSMP, the user can make code modifications relatively simply by adding or modifying differential equations to describe a particular physical situation not considered in the present model.
8. **RELATED AND AUXILIARY PROGRAMS** - SPOOL-FIRE uses the pool-burning model incorporated in the code SOFIRE2 (NESC Abstract 559) and includes the ROPE program (NESC Abstract 444).
9. **STATUS** - Abstract first distributed April 1977.
IBM370 version submitted February 1976, sample problem executed by NESC March 1976 on an IBM370/195.
10. **REFERENCES** - Ira Charak and Lucy W. Person, SPOOL-FIRE -- An IBM 370/195 Code for the Analysis of Combined Spray and Pool Burning of Sodium (draft).
11. **MACHINE REQUIREMENTS** - 178K bytes of memory
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV and CSMP
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/370.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** -
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
I. Charak and L. W. Person
Reactor Analysis and Safety Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. **MATERIAL AVAILABLE** - Restricted Distribution
Source deck and sample input parameters (984 cards)
Sample problem output (11 pages)
Reference draft
17. **CATEGORY** - G
KEYWORDS - sodium, fires, pressure, temperature, CSMP codes, ROPE codes, SOFIRE2 codes

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18. SPONSOR - ERDA Division of Reactor Research and Development

1. NAME OR DESIGNATION OF PROGRAM - IMPAC2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - IMPAC2 solves the equations of motion for a one-dimensional, lumped-mass, nonlinear spring mathematical container model. The program was designed to analyze the dynamic response of metallic shipping containers impacting an unyielding surface. The container may consist of several hollow concentric cylinders, each of a different material and length.
4. METHOD OF SOLUTION - An iteration technique (Newmark-Beta) is used to solve the equations of motion for displacement, velocity, and acceleration of the masses at each time-step.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The maximum number of masses is 100. The program is written for a maximum of 10 different materials. The first seven have been given the following designations:
 - 1 steel
 - 2 clad lead
 - 3 uranium
 - 4 pine
 - 5 lead
 - 6 balsa
 - 7 marine plywoodStress-strain characteristics for materials 1, 3, 4, and 6 are approximated by a bilinear curve fit which requires as input the modulus of elasticity, the stress at the intersection of the two lines and the slope of the second line.
6. TYPICAL RUNNING TIME - The sample problem took less than 2 minutes of CDC7600 time.
7. UNUSUAL FEATURES OF THE PROGRAM - The input is specifically written to accommodate shipping container geometry and requires only overall dimensions, rather than the dimensions of each mass and spring.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed April 1977.
CDC7600 version submitted January 1977, sample problem executed by NESC March 1977 on a CDC7600 at Brookhaven National Laboratory.
10. REFERENCES - J. Counts and J. B. Payne, IMPAC2--A Lumped-Mass Nonlinear Spring Computer Program to Analyze Type B Shipping Container Impact Problems, LA-6643-MS, January 1977.
11. MACHINE REQUIREMENTS - CDC7600 with card input and printer
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - LASL CROS Operating System and CDC SCOPE.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
 - J. B. Payne, MS 312
 - Los Alamos Scientific Laboratory
 - P. O. Box 1663
 - Los Alamos, New Mexico 87545
 - J. Counts
 - Division of Environmental Control Technology
 - U. S. Department of Energy
 - Washington, D.C. 20545

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16. MATERIAL AVAILABLE -

Source deck (999 cards)
Sample problem input (7 cards)
Sample problem output (6 pages)
Reference report

17. CATEGORY - I

KEYWORDS - containers, equations of motion, stresses, impact shock

18. SPONSOR - ERDA Division of Energy Control Technology

1. **NAME OR DESIGNATION OF PROGRAM** - SPRAY3
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC CYBER74, 6600, 7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - SPRAY3 performs the calculations of thermodynamics, heat and mass transfer, and combustion of sodium spray droplets released in an LMFBR cell as a result of postulated piping failure. Droplet motion and large sodium surface area combine to produce rapid heat release and pressure rise within the enclosed volume.
4. **METHOD OF SOLUTION** - The calculation method utilizes gas convection, heat transfer, and droplet combustion theory to compute the pressure and temperature effects within the enclosure. Nodal temperature solutions are obtained from instantaneous heat and mass balances by the explicit forward-difference method.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Present verification of the code against experimental evidence limits the droplet size range to 0.01-0.30 inch with oxygen concentrations ranging from 0 to 21 percent. The number of space increments should be in the range of 1 to 50 for stability and accuracy.
6. **TYPICAL RUNNING TIME** - Approximately 200 seconds running time is required for a typical 45 second problem with 50 space increments and 20 seconds running time with 10 increments.
7. **UNUSUAL FEATURES OF THE PROGRAM** - SPRAY3 treats short-term heat and mass transfer and combustion of sodium droplets, differing in this respect from the SOFIRE code which treats sodium pools. The simplified one-dimensional gas convection model in the cell atmosphere differs from the more exact convection model utilized in the SOMIX code. SPRAY3 includes forced or free-convection heat transfer to the cell walls, differing from the NARX code which is adiabatic on the gas space.
8. **RELATED AND AUXILIARY PROGRAMS** - The SPRAY3 code is an advanced version of the original SPRAY code developed at HEDL but never documented for release to the Energy Software Center and the more recent SPRAY2 code.
9. **STATUS** - Abstract first distributed May 1977.
CDC7600 version of SPRAY2 submitted July 1976, replaced December 1978 by CDC CYBER74 version of SPRAY3 submitted August 1977, sample problem executed by NESC October 1978 on a CDC7600.
10. **REFERENCES** - P. R. Shire, SPRAY Code User's Report, HEDL-TME 76-94, March 1977.
P. R. Shire, A Combustion Model for Hypothetical Sodium Spray Fire within Containment for an LMFBR, M.S. Thesis, University of Washington, 1972.
P. R. Shire, et al., A Sodium Droplet Combustion Model for Reactor Accident Analysis, American Nuclear Society Transactions, Vol. 15, No. 2, p. 812, November 1972.
P. R. Shire, Reactor Sodium Coolant Hypothetical Spray Release for Containment Accident Analysis: Comparison of Theory with Experiment, American Nuclear Society Topical Conference on Fast Reactor Safety, CONF-740401-P1, 1974.
11. **MACHINE REQUIREMENTS** - An input device to read cards or card-image input data and output devices for paper and microfiche copy of digital information and micrographic for plot output are utilized. These requirements may be easily modified.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 3.4.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Some initially-undefined variables require that the memory be set to zero before execution. The proprietary ISSCO DISSPLA package is utilized for SPRAY3 plotting. Dummy routines (BGNPL, CURVE, DONEPL, ENDPL, GFR80, GRAPH, HEIGHT, LEGEND, LINES, MESSAG, PAGE, REALNO, TITLE) included in the package will have to be replaced by the appropriate routines for the local environment.

15. NAME AND ESTABLISHMENT OF AUTHOR -

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Hanford Engineering Development Laboratory
Westinghouse Hanford Company
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Idaho Falls, Idaho 83401

16. MATERIAL AVAILABLE -

Source deck (1243 cards)
Sample problem (15 cards)
Sample problem output (51 selected pages, 3 plots)
Reference report, HEDL-TME 76-94

17. CATEGORY - G

KEYWORDS - sodium, droplets, sprays, thermodynamics, mass balance, reactor safety, convection, LMFBR reactors, SOFIRE codes, SOMIX codes, NARX codes

18. SPONSOR - DOE Division of Reactor Research and Technology

1. **NAME OR DESIGNATION OF PROGRAM - NAHAMMER**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360,370, CDC6600,7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** NAHAMMER analyzes short-term pressure-pulse transients in a closed hydraulic system consisting of series or parallel piping, pipe junctions, diameter discontinuities, elbows, junctions of three to six branches, orifices, acoustic-impedance discontinuities, dummy junctions, dead ends, and free surfaces in surge tanks. The working fluid is assumed to be sodium without cavitation.
4. **METHOD OF SOLUTION -** NAHAMMER considers a simplified one-dimensional linear inviscid set of governing equations. Classical fluid-hammer theory was linearized by neglecting the viscosity and recognizing that convective terms are negligible when the ratio of flow velocity to sonic speed is less than 0.01. Numerical solutions are obtained by a simple superposition technique for tracing the waves traveling along each characteristic and for extending the solution from one constant time line to the next.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** The program currently provides for maxima of:
 - 50 legs
 - 120 nodes per leg
 - 50 junctions
 - 10 plenums (surge tanks)

The assumption of linearity restricts the maximum pressure at any propagating wave front in sodium to about 5800 psi. Calculations are limited to liquid sodium in the absence of cavitation. Friction-free fluid motion maintains its energy within any pipe section, but conventional energy losses based on steady-state incompressible fluid flow are taken into account for elbows, diameter discontinuities, and orifice-like restrictions. To specify a working fluid other than sodium, the source coding must be changed.
6. **TYPICAL RUNNING TIME -** Execution of the 48-leg sample problem requires about 16 CPU seconds on an IBM370/195 or about 4 CP seconds on a CDC7600.
7. **UNUSUAL FEATURES OF THE PROGRAM -** In NAHAMMER the initial transient is followed by a pressure pulse from a molten-fuel coolant interaction (MFCI) that produces a local pressure generation in the fuel (heat-producing) region of the system. At the user's option, the pressure-time history during the MFCI either is calculated in subroutine DIFFUN according to an ANL rate-limited parametric model or is input. The source region is a special region through which the waves are not allowed to travel.
8. **RELATED AND AUXILIARY PROGRAMS -** WHAM6 (NESC Abstract 278), COMPARE (NESC Abstract 702), HAMOC (NESC Abstract 710), NATRANSIENT (NESC Abstract 718), and NATRAN2 (NESC Abstract 719).
9. **STATUS -** Abstract first distributed April 1977.
IBM360 version submitted June 1975, sample problem executed by NESC March 1977 on an IBM370/195.
CDC7600 version converted by NESC from the IBM360 version, sample problem executed by NESC March 1977 on a CDC7600.
10. **REFERENCES -** W. L. Chen, D. H. Thompson, and Y. W. Shin, NAHAMMER, A Computer Program for Analysis of One-dimensional Pressure-pulse Propagation in a Closed Fluid System, ANL-8059, May 1974.
11. **MACHINE REQUIREMENTS -** 362K bytes (IBM360,370), or 126,000 (octal) words (CDC6600,7600) of storage
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV

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- 13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/360,370 (IBM360,370), SCOPE 3.4.3 (CDC6600), or SCOPE 2.1.2 (CDC7600).
- 14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -**
- 15. NAME AND ESTABLISHMENT OF AUTHORS -**
360	W. L. Chen and D. H. Thompson
Reactor Analysis and Safety Division
Y. W. Shin
Components Technology Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
7600	H. S. Edwards
National Energy Software Center
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
- 16. MATERIAL AVAILABLE -**
Source decks (360-1013 cards, 7600-904 cards)
Sample problem input (360-75 cards, 7600-75 cards)
Sample problem output (360-28 pages, 7600-27 pages)
Reference report
- 17. CATEGORY - G**
KEYWORDS - liquid metals, pressure, reactor safety, transients, one-dimensional, LMFBR reactors, WHAM codes, COMPARE codes, HAMOC codes, NATRANSIENT codes, NATRAN2 codes
- 18. SPONSOR -** AEC Division of Reactor Research and Development

1. **NAME OR DESIGNATION OF PROGRAM - NATRANSIENT**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** NATRANSIENT analyzes short-term pressure-pulse transients in a closed hydraulic system consisting of series or parallel piping, pipe junctions, diameter discontinuities, junctions of three to six branches, closed ends, surge tanks, far ends, dummy junctions, acoustic impedance discontinuities, and rupture disks. The working fluid is assumed to be liquid sodium without cavitation. The source pressure pulse is assumed to be generated by a sodium-water reaction according to the dynamic model of Zaker and Salmon.
4. **METHOD OF SOLUTION -** The governing partial differential equations for one-dimensional unsteady flows are reduced to a set of ordinary differential equations by the method of characteristics. The governing equations include the complete Navier-Stokes equation in which the viscous term is written in terms of the Darcy-Weisbach friction factor. By appropriate matching of the boundary conditions at the pipe junctions, the flow conditions following a sodium-water reaction can be determined for the entire network. The resulting characteristics and compatibility conditions are reduced to finite difference equations which are solved by stepwise numerical integration.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** The program currently provides for maxima of:
 - 50 legs
 - 120 nodes per leg
 - 50 junctions
 - 10 surge tanksCavitation is assumed to be absent. To specify a working fluid other than sodium, the source program must be changed.
6. **TYPICAL RUNNING TIME -** Execution of the 48-leg sample problem requires about 4 seconds of CPU time on the IBM370/195.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -** NATRANSIENT is included as a subroutine in the NATRAN2 program (NESC Abstract 719). Related codes are WHAM6 (NESC Abstract 278), COMPARE (NESC Abstract 702), HAMOC (NESC Abstract 710), and NAHAMMER (NESC Abstract 717).
9. **STATUS -** Abstract first distributed April 1977.
IBM360 version submitted June 1975, sample problem executed by NESC March 1977 on an IBM370/195.
10. **REFERENCES -** Yong Woo Shin, The Method of Characteristics for Analysis of Pressure Transients Resulting from Sodium-Water Reaction in Hydraulic Networks, ANL-8049 with Errata, December 1973.
T. A. Zaker and M. A. Salmon, Effects of Tube Rupture in Sodium Heated Steam Generator Units, ASME Publication 69-WA/NE-18, November 1969.
11. **MACHINE REQUIREMENTS -** 166K bytes of storage are required.
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/360,370.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -**
15. **NAME AND ESTABLISHMENT OF AUTHOR -**
Y. W. Shin
Components Technology Division
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Argonne, Illinois 60439

16. MATERIAL AVAILABLE -

Source deck (757 cards)
Sample problem input (107 cards)
Sample problem output (8 pages)
Reference report, ANL-8049 with Errata

17. CATEGORY - G

KEYWORDS - liquid metals, pressure, reactor safety, transients, one-dimensional, NATRAN2 codes, WHAM6 codes, COMPARE codes, HAMOC codes, NAHAMMER codes

18. SPONSOR - ERDA Division of Reactor Development and Demonstration

1. **NAME OR DESIGNATION OF PROGRAM - NATRAN2**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** NATRAN2 analyzes short-term pressure-pulse transients in a closed hydraulic system consisting of a two-dimensional axisymmetric domain connected to a one-dimensional piping network. The one-dimensional network may consist of series or parallel piping, pipe junctions, diameter discontinuities, junctions of three to six branches, closed ends, surge tanks, far ends, dummy junctions, acoustic impedance discontinuities, and rupture disks. By default, the working fluid is assumed to be liquid sodium without cavitation; but another working fluid can be specified in terms of its density, sonic speed, and viscosity. The source pressure pulse can arise from one of the following: a pressure-time function specified at some point in the two-dimensional domain, a pressure-time function or a sodium-water reaction specified at some point in the one-dimensional domain. The pressure pulse from a sodium-water reaction is assumed to be generated according to the dynamic model of Zaker and Salmon.
4. **METHOD OF SOLUTION -** For the two-dimensional region, NATRAN2 uses a numerical integration technique, based on the method of characteristics and formulated for the system of quasi-linear hyperbolic equations describing fluid-hammer phenomena in a closed two-dimensional axisymmetric domain. The set of nonlinear partial differential equations is first converted to a system of integral equations written along bicharacteristics. The solution is constructed in a step-by-step procedure by approximating the integral equations by the trapezoidal formula and using the resulting difference relations along four bicharacteristics and one streamline through each point. Spatial derivatives of the dependent variables are eliminated from the difference relations. The solution at any point then is obtained explicitly by a linear combination of the remaining difference relations.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** The program currently provides for maxima of:
 - 1 two-dimensional cylindrical region
 - 30 grid points in the r-direction
 - 60 grid points in the z-direction
 - 50 one-dimensional pipe branches
 - 120 nodes per pipe branch
 - 50 junctions
 - 10 surge tanksCavitation is assumed to be absent. In the two-dimensional analysis, viscosity effects are neglected. A sufficiently large length-to-diameter ratio must be allowed for extended regions both upstream and downstream of the two-dimensional domain, since the matching of the boundary conditions at the interfaces neglects any two-dimensionality close to the interface.
6. **TYPICAL RUNNING TIME -** Execution of the sample problem requires approximately 135 CPU seconds on an IBM370/195.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -** The NATRANSIENT code (NESC Abstract 718) is used as a subroutine within NATRAN for one-dimensional system calculations. Related programs include WHAM6 (NESC Abstract 278), COMPARE (NESC Abstract 702), HAMOC (NESC Abstract 710), and NAHAMMER (NESC Abstract 717).
9. **STATUS -** Abstract first distributed April 1977.
IBM360 version submitted June 1975, sample problem executed by NESC March 1977 on an IBM370/195.
10. **REFERENCES -** Y. W. Shin and Richard A. Valentin, Two-dimensional Fluid-hammer Analysis by the Method of Characteristics in a Closed Axisymmetric Cylindrical Domain, ANL-8090, August 1974.

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T. A. Zaker and M. A. Salmon, Effects of Tube Rupture in Sodium Heated Steam Generator Units, ASME Publication 69-WA/NE-18, November 1969.

11. **MACHINE REQUIREMENTS** - 452K bytes of storage are required. If plotting information is to be written on logical unit 10, a disk or tape unit is needed for this purpose.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360,370.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - To execute the sample problem, specify file FT10F001 as dummy, or with RECFM=FB, LRECL=40, and a BLKSIZE appropriate to the storage unit being used.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
Y. W. Shin and R. A. Valentin
Components Technology Division
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9700 South Cass Avenue
Argonne, Illinois 60439
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (2085 cards)
Sample problem input (21 cards)
Sample problem output (1 microfiche)
Reference report, ANL-8090 with Errata
17. **CATEGORY** - G
KEYWORDS - liquid metals, pressure, reactor safety, transients, one-dimensional, two-dimensional, NATTRANSIENT codes, WHAM6 codes, COMPARE codes, HAMOC codes, NAHAMMER codes
18. **SPONSOR** - ERDA Division of Reactor Development and Demonstration

1. **NAME OR DESIGNATION OF PROGRAM - RICE-LASL**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC7600,6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** The fluid dynamics of chemically reactive mixtures are calculated at arbitrary flow speeds with the RICE-LASL program. Application is made to continuous wave HF chemical lasers to compute the supersonic mixing and chemical reactions that take place in the lasing cavity.
4. **METHOD OF SOLUTION -** The dynamics are governed by the two-dimensional, time-dependent Navier-Stokes equations together with the species transport equations and the mass-action rate equations for the chemical reactions. The mass and momentum equations for the mixture are solved implicitly by the Implicit Continuous-fluid Eulerian (ICE) technique. The equations for total energy and species transport are solved explicitly while the chemical rate equations are solved implicitly with a time-step that may be a submultiple of the hydrodynamic time-step.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -**
6. **TYPICAL RUNNING TIME -** 0.0006 seconds of CDC7600 time/cell/cycle for single component fluids is required. This varies with increased species and chemical reaction.
7. **UNUSUAL FEATURES OF THE PROGRAM -** RICE-LASL allows triangular and rectangular obstacles, with or without inflow boundaries, in the computing mesh.
8. **RELATED AND AUXILIARY PROGRAMS -**
9. **STATUS -** Abstract first distributed August 1977.
CDC7600 version submitted July 1975, sample problem executed by NESC July 1977 on a CDC7600.
10. **REFERENCES -** W. C. Rivard, O. A. Farmer, T. D. Butler, RICE: A Computer Program for Multicomponent Chemically Reactive Flows at All Speeds, LA-5812, March 1975.
Note to LA-5812, User Information, July 23, 1975.
11. **MACHINE REQUIREMENTS -**
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** LASL CROS system.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** Calls to DATAREL and to most plotting routines have been changed to comments.
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
W. C. Rivard, O. A. Farmer, and T. D. Butler
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87544
16. **MATERIAL AVAILABLE -** Magnetic Tape Transmittal
Source deck (2818 cards)
Sample problem (30 cards)
Auxiliary program (PREP 24 cards)
Reference report and Note
17. **CATEGORY - U**
KEYWORDS - two-dimensional, chemical reactions, ICE method, fluid mechanics, time dependence, Navier-Stokes equation, chemical lasers

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18. SPONSOR - USAF Air Force Weapons Laboratory

1. **NAME OR DESIGNATION OF PROGRAM -** WFLLL2B
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -** CDC7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** WFLLL2B solves the problem of electromagnetic radiation from wire structures in free space or in the presence of a lossy half-space, including structures penetrating the interface. Antenna structures may be composed of many interconnected wires of differing radii, which may be impedance loaded. Electric space and surface wave fields may be evaluated.
4. **METHOD OF SOLUTION -** The solution is effected in the frequency domain via the application of the thin-wire electric-field integral equation. A moments method is applied to obtain the numerical solution. Four methods used for the ground treatment include two derived from a geometric optics approach with either the normal incidence or specular plane-wave reflection coefficients accounting for the reflected fields, a third applying Norton's formulas when the distances and ground parameters are in the applicable range, and the fourth, most rigorous approach, involving two representations for Sommerfeld integrals. The program automatically chooses the more efficient of the two forms: Hankel or Bessel function. The integrals are evaluated by performing numerical complex contour integration using an adaptive Romberg integration scheme.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** At least six current samples/wavelength should be used in setting up a numerical model, and the segment-length to wire-radius ratio should be greater than 5 for the thin-wire approximations to be valid. The two geometric optics ground treatment methods and Norton's formulas are valid only for structures located in the upper half-space. No more than 300 segments can be processed.
6. **TYPICAL RUNNING TIME -** The running time varies depending on the number of segments, the ground treatment, and the inherent symmetry of the structure. The test case run by NESC took approximately 62 seconds to execute.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -** WFLLL2B represents a replacement of WFLLL2A as described in UCRL-51821; the errata sheet contains these changes. The code was originally developed at MB Associates, San Ramon, California. At LLL, F. J. Deadrick and E. K. Miller made extensive improvements, including development of the capability for allowing complex wave numbers in both the upper and lower half-space. D. L. Lager and R. J. Lytle added the Sommerfeld and Norton ground treatments. G. A. Burrell, The Ohio State University, converted the code to FORTRAN.
9. **STATUS -** Abstract first distributed May 1977.
CDC7600 version submitted October 1976, sample problem executed by NESC March 1977 on a CDC7600 at Brookhaven National Laboratory.
10. **REFERENCES -** Darrel L. Lager, R. Jeff Lytle, FORTRAN Subroutines for the Numerical Evaluation of Sommerfeld Integrals Under Anderem, UCRL-51821, May 21, 1975.
F. J. Deadrick, WAMP-A User's Manual for the Wire Antenna Modelling Program, UCID-30084, December 10, 1973.
R. J. Lytle, Numerical Evaluation of Sommerfeld integrals, UCRL-52688, October 23, 1974.
11. **MACHINE REQUIREMENTS -**
12. **PROGRAMMING LANGUAGES USED -** The program was written originally in LRLTRAN and converted to FORTRAN.
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** SCOPE.

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Subroutine SCLOCK1 used to start the CP time clock and function RCLOCK1, which is used to return CP time in seconds, are dummy routines which will have to be replaced with the appropriate ones for the local environment. The program is run at Ohio State on the IBM370/168.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
D. L. Lager and R. J. Lytle
Lawrence Livermore Laboratory
P. O. Box 808
Livermore, California 94550
G. A. Burrell
Electroscience Laboratory
Ohio State University
1320 Kinnear Road
Columbus, Ohio 43212
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (5132 cards)
Sample problem input (31 cards)
Sample problem output (9 pages)
Reference report, UCRL-51821
17. **CATEGORY** - T
KEYWORDS - antennas, electromagnetic radiation, Sommerfeld integrals, numerical solution, wires, WAMP codes, WFLLL2A codes
18. **SPONSOR** - DOD Advanced Research Projects Agency

1. **NAME OR DESIGNATION OF PROGRAM - CRAC**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** The CRAC code was developed in support of the Reactor Safety Study (WASH-1400) to assess the risk from potential accidents at nuclear power plants.
4. **METHOD OF SOLUTION -** The assessment of accident risk entails the coupling of a series of mathematical and statistical models. CRAC requires as input an inventory of radioisotopes released from the reactor containment to the environment and a description of the accident conditions. It (1) models the meteorological dispersion of the cloud of radioactive material; (2) determines the health effects of the material upon the surrounding population; and (3) estimates the costs to the public from the accident. CRAC samples specific meteorological conditions from a set of representative reactor locations and probabilistically combines the results to form frequency distributions of consequence from a reactor accident. The code includes detailed meteorological, population, economic, and health data. In addition CRAC models emergency planning procedures, such as evacuation. Detailed parametric and sensitivity studies can be simply accomplished in one computer run.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -**
6. **TYPICAL RUNNING TIME -** One trial (one postulated accident occurrence) modeled for one wind direction and a spatial mesh of 34 intervals required 7.6 seconds on an IBM370/168.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -** Two utility routines are included in the CRAC package. They are used to move the data libraries from tape to disk and to edit these libraries.
9. **STATUS -** Abstract first distributed May 1977.
IBM360 version submitted February 1977, sample problem executed by NESC April 1977.
10. **REFERENCES -** Calculations of Reactor Accident Consequences - CRAC Computer Code User's Manual, U. S. Nuclear Regulatory Commission Draft Report, February 1977.
Reactor Safety Study, U. S. Nuclear Regulatory Commission, WASH-1400 Appendix VI, October 1975.
11. **MACHINE REQUIREMENTS -** The program requires 190K when overlayed on the IBM360/370, and over 300K if not overlayed. Disk files should be available. Tapes may be substituted but will degrade the execution time substantially.
12. **PROGRAMMING LANGUAGE USED - FORTRAN IV**
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/VS2 Release 3.7A (IBM370), OS/MVT (IBM360).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** The CRAC site and dose libraries are in unformatted form suitable only for IBM360,370 usage. Formatted libraries will be made available for non-370 usage.
15. **NAME AND ESTABLISHMENT OF AUTHOR -**
R. M. Blond
Office of Nuclear Regulatory Research
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555
16. **MATERIAL AVAILABLE -** Magnetic Tape Transmittal

Source decks (CRAC (main)-660 cards, CRAC (other routines)-4878 cards, utility routines-115 cards)
Sample problems (642 cards)
Libraries (site data-102 blocks of maximum length 3124, health data-11 blocks of maximum length 3036)
Sample problem output (58 selected pages, 4561 records of maximum length 133)
Draft report

17. CATEGORY - G

KEYWORDS - accidents, nuclear power plants, emergency plan, dispersions, radioisotopes, containment, reactor safety

18. SPONSOR - NRC Office of Nuclear Regulatory Research

1. **NAME OR DESIGNATION OF PROGRAM** - SOLA-ICE
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC7600, 6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - SOLA-ICE is a numerical solution algorithm for transient, arbitrarily compressible fluid flows.
4. **METHOD OF SOLUTION** - SOLA-ICE uses a finite-difference technique, which includes the Implicit Continuous-fluid Eulerian (ICE) method as an optional feature, to solve the Navier-Stokes equations in two-dimensional plane or cylindrical coordinates. A wide variety of boundary conditions are possible, including free-slip, no-slip, specified inflow-outflow, continuative outflow, and periodic boundaries. Implicit pressure gradients are used to eliminate the Courant condition as a stability requirement, making the code useful at all Mach numbers.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - A simple equation of state and constant diffusion coefficients are assumed, and there is no provision for internal obstacles. However, the code is designed to make it easy to remedy any such deficiencies for particular problems.
6. **TYPICAL RUNNING TIME** - The 'grind' time, or time to advance the solution in one cell by one time-step, is typically 0.7 ms on a CDC7600.
7. **UNUSUAL FEATURES OF THE PROGRAM** - SOLA-ICE is designed to be easy to understand and modify so it can serve as a foundation for developing other codes. Examples of possible additions are species transport equations, internal obstacles, and a self-consistent gravitational field.
8. **RELATED AND AUXILIARY PROGRAMS** - SOLA and SOLA-SURF (NESC Abstract 651).
9. **STATUS** - Abstract first distributed June 1977.
CDC7600 version submitted September 1976, sample problem executed by NESC May 1977 on a CDC7600 via I/O terminal to Brookhaven National Laboratory.
10. **REFERENCES** - L. D. Cloutman, C. W. Hirt, and N. C. Romero, SOLA-ICE: A Numerical Solution Algorithm for Transient Compressible Fluid Flows, LA-6236, July 1976.
C. W. Hirt, B. D. Nichols, and N. C. Romero, SOLA - A Numerical Solution Algorithm for Transient Fluid Flows, LA-5852, April 1975.
F. H. Harlow and A. A. Amsden, A Numerical Fluid Dynamics Method for All Flow Speeds, Journal of Computational Physics, Vol. 8, p. 197, 1971.
11. **MACHINE REQUIREMENTS** -
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - CROS, SCOPE, KRONOS, and NOS.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - SOLA-ICE calls a number of LASL plotting subroutines. These will have to be replaced or deleted by the user.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
L. D. Cloutman, C. W. Hirt, and N. C. Romero
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87545
16. **MATERIAL AVAILABLE** -
Source deck (460 cards)
Sample problem (10 cards)
Reference report, LA-6236

NESC ABSTRACT 723

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17. CATEGORY - H

KEYWORDS - fluid flow, Navier-Stokes equation, two-dimensional, ICE method, SOLA codes, SOLA-SURF codes

18. SPONSOR - ERDA Division of Military Application

1. **NAME OR DESIGNATION OF PROGRAM - MOBY**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360/75,360/91
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** MOBY calculates daily heating and cooling energy requirements for a mobile home, or other structure of light construction and box-like shape, using hourly weather data from tapes available from NOAA, the National Oceanographic and Atmospheric Administration.
4. **METHOD OF SOLUTION -** Heat gains and losses are evaluated using algorithms from the ASHRAE Fundamentals Handbook and from the NBS Loads Determination program NBSLD (reference 3). The heating or cooling required is obtained from a heat balance. Energy required is calculated using assumed equipment performance characteristics and required output.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** The interior of the building must be considered as a single space. The building must be rectangular in horizontal cross section.
6. **TYPICAL RUNNING TIME -** Six seconds per year of time simulated are required on an IBM360/91.
7. **UNUSUAL FEATURES OF THE PROGRAM -** MOBY is intended to run rapidly by omitting refinements considered unnecessary for a very simple building.
8. **RELATED AND AUXILIARY PROGRAMS -** Portions of NBSLD may be required to generate transfer functions for use as MOBY input data.
9. **STATUS -** Abstract first distributed November 1977.
IBM360 version submitted October 1976, sample problem executed by NESC September 1977 on an IBM370/195.
10. **REFERENCES -** J. V. Wilson, Energy Usage and Conservation in Mobile Home Heating and Cooling, ORNL/NSF/EP-91, August 1976.
MOBY Sample Calculation, ORNL Note, October 1976.
T. Kusuda, NBSLD Heating and Cooling Loads Calculation Program, National Bureau of Standards publication, NBSIR 74-574, 1973.
ASHRAE Handbook of Fundamentals, American Society of Heating, Refrigerating and Air Conditioning Engineers, New York, 1972.
11. **MACHINE REQUIREMENTS -** 82K bytes of storage, a tape unit, card reader and printer are required for execution of the program as written.
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/360.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** A NOAA hourly weather data tape and transfer function data are required as input for a MOBY run. The program is no longer actively used or supported at the author's installation.
15. **NAME AND ESTABLISHMENT OF AUTHOR -**
J. V. Wilson
Building 9201-3
Oak Ridge National Laboratory
P. O. Box Y
Oak Ridge, Tennessee 37830
16. **MATERIAL AVAILABLE -**
Source decks (MOBY 709 cards, NBSLD 166 cards, transfer functions 11 cards)
Sample problem (27 cards, WEATHE 20 cards)
Sample problem output (9 pages)
Reference report ORNL/NSF/EP-92 and ORNL Note

NESC ABSTRACT 724

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- 17. CATEGORY - R**
KEYWORDS - heating load, cooling load, transfer functions, data, meteorology, mobile homes, NBSLD codes
- 18. SPONSOR -** ERDA Division of Buildings and Industry
FEA Office of Energy Conservation
NSF Research Applied to National Needs

1. **NAME OR DESIGNATION OF PROGRAM - JCLCROSS**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360/370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** The JCLCROSS program scans PROCLIBs and produces a cross-reference listing of DSN, PROGNAME, STEPNAME, DISP, UNIT, and PGM parameters. The list may be sorted as desired and passed to the JCLCROSP program for printing with page headings.
4. **METHOD OF SOLUTION -** PROC statements are scanned and symbolic parameter default values are recorded. Then an EXEC statement is scanned for the program name being executed and the STEPNAME. Individual DD cards are scanned for DSN, UNIT and DISP parameters. When these parameters are constructed, using symbolic parameters if necessary, a record is written to a work data set for sorting and the program continues the scan for another EXEC or DD card.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** 150 symbolic parameters defined in the PROC statement
6. **TYPICAL RUNNING TIME -** Running time on the IBM370/168 was 1000 PROCs per minute of CPU time. The NESC processed 66 PROCs in 11 seconds on an IBM370/195.
7. **UNUSUAL FEATURES OF THE PROGRAM -** The program resolves symbolic parameters. PROCs analyzed may be restricted to a subset of the complete library using the PARM parameter on the EXEC card.
8. **RELATED AND AUXILIARY PROGRAMS -** A system sort routine is necessary. JCLCROSP, a COBOL program to format and print the cross-reference list, is included in the package.
9. **STATUS -** Abstract first distributed January 1978.
IBM360 version submitted July 1977, program tested on an ANL procedure library by NESC November 1977 on an IBM370/195.
10. **REFERENCES -** JCLCROSS Program Information, Hallmark Memorandum, July 1, 1977.
11. **MACHINE REQUIREMENTS -** The NESC ran the program using 94K bytes of memory.
12. **PROGRAMMING LANGUAGES USED -** FORTRAN, Assembler, and COBOL are used. The MAIN and BUILD routines are written in FORTRAN. Subroutines FPARM, KOMSTR, STRMOV, GETDD, GETMEM, READL, FINDCH, and UVFW20 are written in BAL. JCLCROSP is an auxiliary COBOL routine.
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/VS/MVS, FORTRAN G or H, UTILITY SORT, ANS COBOL, Assembler.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** To list a subset of PROCs without a PARM field coded in the EXEC card, it is necessary to initialize the array PARM in the MAIN program to prefixes of PROCs to be scanned.
15. **NAME AND ESTABLISHMENT OF AUTHOR -**
J. Amick
Research 8-B
Hallmark Cards, Incorporated
2501 McGee
Kansas City, Missouri 64108
16. **MATERIAL AVAILABLE -**
Source decks (FORTRAN 312 cards, COBOL 68 cards, Assembler 304 cards)
Control information (JCL-66 cards)
Sample output (2 pages)
Reference memorandum

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- 17. CATEGORY - P**
KEYWORDS - sorting, data processing, operating systems
- 18. SPONSOR -** Hallmark Cards, Inc.

1. NAME OR DESIGNATION OF PROGRAM - NAIAD
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - NAIAD computes the transient (including LOCA) and steady-state flow of two-phase compressible light water in a network of heated channels. The momentum flux term is included and unequal phase velocities allowed. A lumped fuel model and detailed surface heat transfer are included. Thermodynamic equilibrium of the two phases is assumed. Discharge flow is calculated intrinsically from the hydraulic equations. The ANC pump model is included.
4. METHOD OF SOLUTION - The one-dimensional conservation equations of mass, momentum, and energy are solved in each channel by a numerically-stable, implicit finite-difference scheme. The network is then solved by an accelerated Gauss-Siedel iteration scheme.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Versions of the program can be easily generated to handle any size problem. The standard NAIAD code is limited to 50 axial nodes and 10 channels.
6. TYPICAL RUNNING TIME - The running time depends on the complexity of the problem. Approximately 15 milliseconds per time-step per node are required on the Model 65 CPU. The sample problem takes 1 minute on the Model 65.
7. UNUSUAL FEATURES OF THE PROGRAM - The user may supply special routines to set up and dynamically modify boundary conditions. These routines can also be used to control time-stepping, write supplementary output, and model hydraulic components not routinely allowed for in the standard code.
8. RELATED AND AUXILIARY PROGRAMS - Four supplementary programs are provided:
 - (a) A precompiler to expand COMMON blocks in the main code and the user's special routines.
 - (b) A prelinker to insert ALIAS and NAME cards into object modules for subroutine library creation.
 - (c) Program SSGEN to generate steam tables for the code.
 - (d) Program PUMLOAD to load pump characteristic data.The steam table generating program SSGEN requires the ASTEM package (NESC Abstract 580).
9. STATUS - Abstract first distributed April 1978.
IBM360 version submitted May 1977, modified August 1977, sample problem executed by NESC September 1977 on an IBM370/195.
10. REFERENCES - G. D. Trimble and W. J. Turner, NAIAD - A Computer Program for Calculation of the Steady State and Transient Behavior (including LOCA) of Compressible Two-Phase Coolant in Networks, AAEC/E378, April 1976.
G. D. Trimble and W. J. Turner, Modifications to NAIAD, AAEC Note, August 1977.
Instructions for Implementing the NAIAD System, AAEC Note, April 1977.
11. MACHINE REQUIREMENTS - 240K bytes of main storage and a 132-column printer are required.
12. PROGRAMMING LANGUAGES USED - FORTRAN IV (H OPT2) and Assembly language
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 MVT.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The FORTRAN system message data set is assumed to be unit 3.
15. NAME AND ESTABLISHMENT OF AUTHORS -
G. D. Trimble and W. J. Turner
Australian Atomic Energy Commission
Research Establishment

Private Mail Bag, Sutherland, N.S.W. 2232
Australia

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (NAIAD 2399 cards, Assembler routines 2888 cards, FORTRAN routines 69 cards, PRELINKER 214 cards, PRECOMPILER 220 cards, SSGEN 348 cards, PUMLOAD 37 cards)

Load modules (NAIAD.LIBRARY 3330-334 blocks*, 2314-342* blocks, NAIAD.PROGRAM 3330-126 blocks*, 2314-126 blocks*)

Sample problems (NAIAD 142 cards, SSGEN 18 cards, PUMLOAD 106 cards)

Libraries (NAIAD.COMMONS 3330-4 blocks*, 2314-4 blocks*, NAIAD. PUMPDATA 3330-25 blocks*, NAIAD.STABLE 62 blocks**)

Control information (JCL NAIAD-127 cards, SSGEN-8 cards, PUMLOAD-4 cards)

Sample problems output (8 pages, 373 133-character records)

Reference report and Notes

- * 800 bytes
- ** 1084 bytes

17. CATEGORY - G

KEYWORDS - compressible flow, finite difference method, heat transfer, transients, LOCA, two-phase flow, blowdown

18. SPONSOR - Australian Atomic Energy Commission

1. **NAME OR DESIGNATION OF PROGRAM - K-FIX**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** The transient dynamics of two-dimensional, two-phase flow with interfacial exchange are calculated at all flow speeds. Each phase is described in terms of its own density, velocity, and temperature. Separate sets of field equations govern the gas and liquid phase dynamics. The six field equations for the two phases couple through mass, momentum, and energy exchange.
4. **METHOD OF SOLUTION -** The equations are solved using an Eulerian finite difference technique that implicitly couples the rates of phase transitions, momentum, and energy exchange to determination of the pressure, density, and velocity fields. The implicit solution is accomplished iteratively using a point relaxation technique without linearizing the equations, thus eliminating the need for numerous derivative terms. Solutions can be obtained in one and two space dimensions in plane geometry and in cylindrical geometry with axial symmetry and zero azimuthal velocity. Solutions in spherical geometry can also be obtained in one space dimension. The geometric region of interest is divided into many finite-sized, space-fixed zones called cells which form the computing mesh. In plane geometry the cells are rectangular cylinders, in cylindrical geometry they are toroids with rectangular cross section, and in spherical geometry they are spherical shells.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -**
6. **TYPICAL RUNNING TIME -** The sample test problem took less than 11 seconds to compile and less than 31 seconds to calculate all variables for 140 time cycles.
7. **UNUSUAL FEATURES OF THE PROGRAM -** K-FIX is written in a highly modular form to be easily adaptable to a variety of problems.
8. **RELATED AND AUXILIARY PROGRAMS -** K-FIX uses the implicit multifield technique developed for the KACHINA program. K-FIX differs from KACHINA in that it implicitly couples phase transitions and interfacial heat transfer to the fluid dynamics in the pressure iteration.
9. **STATUS -** Abstract first distributed November 1977.
CDC7600 version submitted May 1977, revised May 1978, sample problem executed by NESC July 1978 on a CDC7600.
10. **REFERENCES -** W. C. Rivard, M. D. Torrey, K-FIX: A Computer Program for Transient, Two-dimensional, Two-Fluid Flow, LA-NUREG-6623, April 1977.
W. C. Rivard and M. D. Torrey, PERM: Corrections to the K-FIX Code, LA-NUREG-6623 Supplement, March 1978.
FORTRAN Function and System Subroutines in K-FIX, LASL Note, May 1977.
11. **MACHINE REQUIREMENTS -** The sample problem, excluding plotting routines, took less than 22,000 words of storage.
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** SCOPE.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** K-FIX makes use of the CDC7600 UPDATE program for variable dimensioning and for code modification for different model applications. These system-dependent features, together with the program's use of environment-dependent plotting routines and job card timing information, will require use of suitable replacement routines and extra programming effort for implementation of K-FIX at other installations or on different machines.
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
W. C. Rivard and M. D. Torrey
Los Alamos Scientific Laboratory

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P. O. Box 1663
Los Alamos, New Mexico 87545

- 16. MATERIAL AVAILABLE - Magnetic Tape Transmittal**
Source deck (K-FIX 2641 cards, UPDATE deck for test 195 cards)
Sample problem (16 cards)
Auxiliary program to test Cycle No. 0 of output (240 cards)
Auxiliary program to test Cycle No. 140 of output (240 cards)
Sample problem output (27 selected pages)
Reference reports and Note
- 17. CATEGORY - H**
KEYWORDS - interfaces, heat transfer, two-phase flow, finite difference method, simulation, two-dimensional, pressure, velocity, phase transformations
- 18. SPONSOR - NRC Division of Reactor Safety Research**

.. NAME OR DESIGNATION OF PROGRAM - SLIDES

1. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
IBM360,370

1. DESCRIPTION OF PROBLEM OR FUNCTION - The SLIDES program takes text and commands as input and prepares lettered slides and posters, utilizing the DISSPLA graphics subroutines to generate its output. The program automatically selects the character-size so that the text fills the designated area. The ANL-AMD plotter subroutines permit the output to be displayed on an interactive graphics terminal or alternatively directed to any AMD plotter.

1. METHOD OF SOLUTION - The program composes the slide or poster according to the user's input, data which consist of text for the slide or poster intermingled with commands. Fifty-eight commands are available; these fall into seven categories which are employed to permit the user to specify film sequence, control the output medium, designate size and position of the text, set the character style, alphabet, and hardware options, and provide special features.

3. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The SLIDES program does not limit the number of slides nor the number and complexity of posters produced in a single run; however, local system parameters may impose such limitations.

3. TYPICAL RUNNING TIME - Less than 1 minute was required to compile and produce the four slides of the sample problem.

7. UNUSUAL FEATURES OF THE PROGRAM - Lines of text are scaled to fit the allotted space.

8. RELATED AND AUXILIARY PROGRAMS -

9. STATUS - Abstract first distributed December 1977.

IBM370 version submitted June 1977, sample problem executed by NESC November 1977 on an IBM370/195.

0. REFERENCES - Richard Bertrand and John Schofield, SLIDES: A Program to Draw Slides and Posters, ANL-77-26, April 1977.

1. MACHINE REQUIREMENTS - 250K bytes of storage, DISSPLA software and appropriate plotting devices

2. PROGRAMMING LANGUAGE USED - FORTRAN IV

3. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 (IBM360), OS/370 (IBM370).

4. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The proprietary DISSPLA plotting package is required. The SLIDES program required the "XL" option of the FORTRAN H or FORTRAN H Extended compiler unless LOR, the logical OR function, is independently supplied. Heavily-shaded alphabets should be avoided if a pen-type plotter is used. The NESC-supplied file of sample control cards is intended to be more generally applicable than the ANL-oriented control samples given in the reference reports. Calls to LOGO will be ignored unless dummy subroutine LOGO is replaced with coding which will produce the desired emblem.

5. NAME AND ESTABLISHMENT OF AUTHORS -

R. Bertrand and J. Schofield
Applied Mathematics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60539

6. MATERIAL AVAILABLE -

Source deck (749 cards)
Sample problem (54 cards)

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Control information (JCL 84 cards)
Reference report

- 17. **CATEGORY** - P
KEYWORDS - computer graphics, diagrams, plotters, photographic films
- 18. **SPONSOR** - Argonne National Laboratory

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1. **NAME OR DESIGNATION OF PROGRAM -** DYNSDK
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** DYNSDK optimizes the placement of data sets on an IBM 3330/2314 disk pack to reduce seek time (arm travel) and forecast improvement expected after reorganization. Data sets are theoretically reordered based on size and number of references. With known percentages of seeks between data sets the program computes the average number of cylinders traveled per seek. Input data consists of addresses captured by a DYNAPROBE 8000 hardware monitor and specification of the present location of the data sets.
4. **METHOD OF SOLUTION -**
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Only one disk pack can be analyzed at a time.
6. **TYPICAL RUNNING TIME -** The sample test run on the Argonne IBM370/195 took less than ten seconds of CPU time to compile and execute.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -** COMRESS 8700 extraction software prepares the DYNAPROBE 8000 data tape.
9. **STATUS -** Abstract first distributed November 1977.
IBM360 version submitted March 1976, sample problem executed by NESC October 1977.
10. **REFERENCES -** F. C. Fortune, Monitoring Seeks on an IBM 3330, Report DP-MS-74-7, 1974.
F. C. Fortune, Instructions for Running Disk Analysis Program, SRL Technical Division Memorandum, November 7, 1975.
Record Format for DYNAPROBE 8048 Tape Written in 'STORE' Mode, SRL Note, March 1976.
11. **MACHINE REQUIREMENTS -** 58K core storage for execution
12. **PROGRAMMING LANGUAGES USED -** FORTRAN IV and BAL
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/VS2 Release 3.7A (IBM370), OS/MVT (IBM360).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** This package assumes a data tape produced by the COMRESS DYNAPROBE 8000 hardware monitor. This tape contains a series of cylinder addresses which are used as input.
15. **NAME AND ESTABLISHMENT OF AUTHOR -**
F. C. Fortune
Savannah River Laboratory
E. I. duPont de Nemours and Company, Inc.
Aiken, South Carolina 29801
16. **MATERIAL AVAILABLE -** Magnetic Tape Transmittal
Source Decks (FORTRAN-570 cards, BAL-179 cards)
DYNAPROBE 8000 hardware monitor data tape to be used as DYNSDK input (56 records of maximum length 413 bytes)
Sample problem (20 cards)
Control information (JCL 19 cards)
Sample problem output (10 pages)
Reference report, Memorandum, and Note

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17. CATEGORY - P

KEYWORDS - computers, optimization, magnetic disks, performance, data

18. SPONSOR - DOE Division of Energy Technology

1. NAME OR DESIGNATION OF PROGRAM - HETRAP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360/75,360/91
3. DESCRIPTION OF PROBLEM OR FUNCTION - HETRAP is a heat transfer analysis program developed for use in the evaluation of LOCA experiments. Its major application is calculation of heat flux and heat transfer coefficients at the surface of an electrically-heated rod during a fast transient, using measured temperatures in the rod. In addition, the code can be used to calculate the steady-state and transient temperature fields in fuel rods and electrically-heated rods for given heat transfer coefficients.
4. METHOD OF SOLUTION - The code uses a finite element method with an explicit integration scheme to calculate the transient temperature field within the rod. During the transient the following time-dependent variables are measured: rod power or current, sheath temperature, temperature inside the heater element, coolant pressure and temperature. These measured values are then used to calculate the time-dependent heat transfer coefficient, heat flux at the rod surface, surface temperature, and stored energy in the rod. The calculation is divided into two parts--the steady-state temperature profile and the transient calculation.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 10 cross sections
 - 50 nodes in each cross section
 - 50 materials in each cross section
 - 1000 variable pairs in transient calculations
6. TYPICAL RUNNING TIME - No study has been made as to typical running time. Four sample problems executed by the NESC took less than one minute on an IBM370/195, including compilation.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - THETA1-B (NESC Abstract 512).
9. STATUS - Abstract first distributed November 1977.
IBM360 version submitted October 1976, sample problems executed by NESC October 1977 on an IBM370/195.
10. REFERENCES - S. Malang, HETRAP: A Heat Transfer Analysis Program, ORNL-TM-4555, September 1974.
11. MACHINE REQUIREMENTS - Approximately 260K bytes storage, a tape unit, card reader, and printer are required.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - HETRAP assumes the availability of a CalComp plotting package. Since plotting packages are generally installation-dependent, the FORTRAN calls may require modification to the local computer environment.
It should be noted that the resulting graphs (plots) will not fit an 11 x 11 frame without a reduction factor. One plot is 11 x 15.
15. NAME AND ESTABLISHMENT OF AUTHOR -
 - S. Malang
 - Kernforschungszentrum Karlsruhe
 - 75 Karlsruhe
 - Postfach 3640
 - Germany

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Contact **Robert A. Hedrick**
 Engineering Technology Division
 Oak Ridge National Laboratory
 P. O. Box X
 Oak Ridge, Tennessee 37830

- 16. MATERIAL AVAILABLE - Magnetic Tape Transmittal**
 Source deck (1284 cards)
 Sample problem (166 cards)
 Reference report

- 17. CATEGORY - H**

KEYWORDS - heat transfer, finite element method, fuel elements, LOCA, THETA1-B codes

- 18. SPONSOR - NRC Division of Reactor Safety Research**

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1. **NAME OR DESIGNATION OF PROGRAM** - SUPORT
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC6000-7000, IBM370,303x
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - SUPORT solves a system of linear two-point boundary-value problems subject to general separated boundary conditions.
4. **METHOD OF SOLUTION** - The method of solution uses superposition coupled with an orthonormalization procedure and a variable-step Runge-Kutta-Fehlberg integration scheme. Each time the superposition solutions start to lose their numerical independence, the vectors are reorthonormalized before integration proceeds. The underlying principle of the algorithm is then to piece together the intermediate (orthogonalized) solutions, defined on the various subintervals, to obtain the desired solution.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The boundary-value problem must be linear and the boundary conditions must be separated. The number of equations which can be solved is dependent upon the main storage available.
6. **TYPICAL RUNNING TIME** - Examples in the reference report give CDC6600 running times from less than 0.1 to as long as 52 seconds. The sample problem executed by the NESC took 26 seconds on an IBM370/195.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The orthonormalization procedure is used to overcome the numerical instabilities normally associated with initial-value procedures for solving boundary-value problems.
8. **RELATED AND AUXILIARY PROGRAMS** - SUPORT is a stand-alone set of subroutines.
9. **STATUS** - Abstract first distributed November 1977.
CDC6600 version submitted December 1975, sample problem executed by NESC October 1977 on a CDC6600.
IBM370 version derived October 1977, replaced by revised Edition B April 1979, sample problem executed by NESC March 1979 on an IBM3033.
10. **REFERENCES** - M. R. Scott and H. A. Watts, SUPORT - A Code for Two-Point Boundary-Value Problems via Orthonormalization, SAND 75-0198, June 1975.
11. **MACHINE REQUIREMENTS** - 5500 (octal) words (CDC6600), 116K bytes (IBM370)
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 3.3 (CDC6600), OS/370 (IBM370).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The user must supply subroutines FMAT and GVEC to evaluate derivatives.
The CDC6600 version contains a COMPASS as well as a FORTRAN version of function DOTPRO. DOTPRO computes the inner product of two vectors. Whenever possible, an Assembly coded version of this subroutine should be used.
There are several machine-dependent constants used throughout the code. These are listed in the comment section of the code along with the suggested values for other computers. Except for these constants, the code is virtually machine-independent.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
6600 M. R. Scott and H. A. Watts
Applied Mathematics Division - 2642
Sandia Laboratories
Albuquerque, New Mexico 87115

370 L. Eyberger
National Energy Software Center
Argonne National Laboratory

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9700 South Cass Avenue
Argonne, Illinois 60439

16. **MATERIAL AVAILABLE** -- Magnetic Tape Transmittal
Source decks (6600-3458 cards, 370-3343 cards)
Sample problems (6600-6C cards, 370-62 cards)
Reference report
17. **CATEGORY** - P
KEYWORDS - boundary-value problems, orthogonal transformation, differential equations,
initial-value problems
18. **SPONSOR** - Sandia Laboratories, Albuquerque

1. NAME OR DESIGNATION OF PROGRAM - LOCK
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - FACOM230, IBM360.370
3. DESCRIPTION OF PROBLEM OR FUNCTION - LOCK was developed to study the problem of local blockage of coolant flow in a few channels in a fast breeder reactor. The program is designed to perform thermal calculations in the steady state and to calculate the transient behavior in temperature of the coolant and cladding. The heat transfer which is taken into account includes heat transmission mixing, thermal conduction, and cross flow.
4. METHOD OF SOLUTION - At time=0, a steady-state calculation is performed in the normal system. This calculation is performed by an iterative procedure using an initial guessed value. When convergence is obtained the value obtained is treated as the temperature distribution in the steady state of the normal system. This temperature distribution serves as the initial value in the calculation of transient temperature following insertion of the blocking matter. The coolant flowrate, caloric coefficient of the fuel pin in the steady state, and the distribution of coolant velocity subsequent to the blockage are prescribed input data for the subsequent heat transfer calculations along with the temperature distribution of the previous time-step.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 30 total number of channels, claddings, and fuels
 - 15 channels (NCH)
 - 15 claddings (NSF) -
 - 5 blocked channels (IBLOCK)
 - 100 mesh points in axial direction
 - 20 mesh points in flowrate restoring part (MSLX)
 - 10 print spaces (KPRINT)
 - 50 prints for arrangement
 - 100 time-steps
6. TYPICAL RUNNING TIME - The sample problem executed by the NESC took 6.5 CPU minutes.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed November 1977.
FACOM230 version submitted June 1976, sample problem executed by NESC October 1977 on an IBM370/195.
10. REFERENCES - Akira Ohtsubo. Analytical Code LOCK on a Few Channels-Blockage Accident, N251 74-32, December 1974.
11. MACHINE REQUIREMENTS - 240K memory, card reader, tape drive, line printer
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS2/VS (FACOM), OS/360 (IBM360).
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Restart facilities are incorporated in the program. The program can be initialized from data obtained from a previously-written tape. The sample problem executed by the NESC did not use such a tape.
15. NAME AND ESTABLISHMENT OF AUTHOR -
 - A. Ohtsubo
 - Power Reactor and Nuclear Fuel
 - Development Corporation
 - 9-13 1-Chome, Akasaka, Minato-Ku
 - Tokyo, Japan

NESC ABSTRACT 732

05/79

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (1870 cards)
Sample problem (23 cards)
Sample problem output (42 pages)
Reference report

17. CATEGORY - H

KEYWORDS - heat transfer, reactor channels, flow blockage, coolants, fuel-coolant interactions, flow rate, FBR reactors

18. SPONSOR - Japan Power Reactor & Nuclear Fuel Development Corp.

NESC ABSTRACT 733**07/78**

1. **NAME OR DESIGNATION OF PROGRAM** - RELAP3B/MOD110
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - RELAP3B describes the behavior of water-cooled nuclear reactors during postulated accidents or power transients, such as large reactivity excursions, coolant losses or pump failures. The program calculates flows, mass and energy inventories, pressures, temperatures, and steam qualities along with variables associated with reactor power, reactor heat transfer, or control systems. Its versatility allows one to describe simple hydraulic systems as well as complex reactor systems.
4. **METHOD OF SOLUTION** -
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - RELAP3B allows a maximum of 75 volumes connected by a maximum of 100 junctions, with no restrictions as to the order of these connections. However, these maxima may be increased to far greater limits on a large computer.
6. **TYPICAL RUNNING TIME** -
7. **UNUSUAL FEATURES OF THE PROGRAM** -
8. **RELATED AND AUXILIARY PROGRAMS** - RELAP3B/MOD110 is a modification of the RELAP3/MOD62 code developed by the Aerojet Nuclear Company for use on an IBM360. The additions to and/or modifications of RELAP3/MOD62 include -
 - (1) Doppler feedback dependence on moderator density;
 - (2) extended restart capability;
 - (3) capability to trip individual pumps on independent signals;
 - (4) automatic time-step selection;
 - (5) improved definition of the average fuel temperature;
 - (6) option to allow the fuel-rod gap size to vary during a transient;
 - (7) capability to modify the steam table mesh;
 - (8) inclusion of realistic steam generator models;
 - (9) calculation of reactivity weight factors;
 - (10) option to specify new fill curves at restart; and
 - (11) option to specify new feedback coefficients at restart.
9. **STATUS** - Abstract first distributed November 1977.
CDC7600 version of RELAP3B/MOD101 submitted April 1976, replaced by CDC7600 version of RELAP3B/MOD110 October 1976, sample problem executed by NESC October 1977 on a CDC7600.
10. **REFERENCES** - User's Manual for RELAP3B-MOD110, A Reactor System Transient Code, BNL-NUREG-22011.
11. **MACHINE REQUIREMENTS** - 65K (decimal) words of central memory are required
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - For best results
RELAP3B/MOD110 should be compiled with OPT=2 and ROUND=+-*//.
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
A. Aronson
Thermal Reactor Safety Division
Brookhaven National Laboratory
Upton, Long Island, New York 11973

NESC ABSTRACT 733

07/78

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (22,809 cards)
Sample problem (119 cards)
Sample problem output (35 pages, 1034 136-character tape records)
Reference report

17. CATEGORY - G

KEYWORDS - accidents, transients, hydrodynamics, power plants, reactor safety, LWR reactors, RELAP codes

18. SPONSOR - NRC Division of Systems Safety

0

1. NAME OR DESIGNATION OF PROGRAM - BOIL1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC CYBER73,7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - BOIL was developed for use in the Reactor Safety Study (WASH-1400) to calculate core heatup and meltdown sequences in coolant boiloff accidents.
4. METHOD OF SOLUTION - The calculational approach used is to divide the core into small volumes or nodes and for a time-step delta t to (1) calculate the heat produced in each node by decay heating and metal-water reaction, (2) perform heat balances between the core and coolant nodes, (3) calculate the water-steam mixture level in the core and the coolant boiloff rate, and (4) perform a meltdown calculation when the temperature of a core node exceeds the melting point.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The core is divided into a maximum of 50 axial and 10 radial zones. The core-coolant heat transfer models assume relatively slow transients in which the heat transfer is not conduction limited.
6. TYPICAL RUNNING TIME - Forty seconds are required for a typical problem with a 1.0 minute time-step size. The sample problem executed on a CDC7600 in 2.5 seconds.
7. UNUSUAL FEATURES OF THE PROGRAM - Three core meltdown model options are programmed.
8. RELATED AND AUXILIARY PROGRAMS - BOIL1 is a reprogrammed version of the BOIL code used in the WASH-1400 studies. The cladding-water reaction model is the same as used in NURLOC-1.0 (NESC Abstract 328).
9. STATUS - Abstract first distributed November 1977.
CDC CYBER73 version submitted November 1976, sample problem executed by NESC October 1977 on a CDC7600.
10. REFERENCES - R. O. Wooton, BOIL1, A Computer Program to Calculate Core Heatup and Meltdown in a Coolant Boiloff Accident, BCL Report, November 1976.
Reactor Safety Study, An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants, Appendix VIII-A, WASH-1400, August 1974.
11. MACHINE REQUIREMENTS - 31K (octal) words
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.4.4.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
R. O. Wooton
Columbus Laboratories
Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201
16. MATERIAL AVAILABLE -
Source deck (588 cards)
Sample problem (12 cards)
Reference BCL report
17. CATEGORY - G
KEYWORDS - coolant boiloff, meltdown, reactor cores, accidents, safety, water reactors, BOIL codes, NURLOC-1.0 codes

NESC ABSTRACT 734

05/79

18. SPONSOR - NRC Office of Nuclear Regulatory Research

1. NAME OR DESIGNATION OF PROGRAM - PIRAX2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6400
3. DESCRIPTION OF PROBLEM OR FUNCTION - PIRAX2 estimates displacements, stresses, and strains for spatially three-dimensional piping systems subjected to elastic-plastic-creep behavior.
4. METHOD OF SOLUTION - PIRAX2 is based on an elastic-inelastic flexibility approach. An initial strain, displacement-finite-element strategy is employed to solve for elastic-plastic-creep behavior of the piping system. Straight and circularly curved pipe-beam elements are available.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The piping system must not contain loops. Maxima of 100 nodal points, 10 materials, and 20 time-step intervals are permitted.
6. TYPICAL RUNNING TIME - Two minutes are required for the sample problem which contains 21 nodal points and 20 pipe elements. NESC execution of this problem on the CDC7600 required less than one minute.
7. UNUSUAL FEATURES OF THE PROGRAM -
 - (a) PIRAX2 allows for plasticity behavior in a Ramberg-Osgood form.
 - (b) Primary creep behavior can be included through the use of isochronous stress-strain curves.
 - (c) Steady-state time-dependent behavior is modeled as a one-term power law in stress similar in form to the Ramberg-Osgood plasticity equation.
 - (d) Thermal expansion is treated.
8. RELATED AND AUXILIARY PROGRAMS - The PIRAX1 and ELLAX programs, both developed at Battelle Columbus Laboratories, are related programs.
9. STATUS - Abstract first distributed November 1977.
CDC6400 version submitted March 1977, sample problem executed by NESC November 1977 on a CDC7600.
10. REFERENCES - G. H. Workman and E. C. Rodabaugh, User's Manual for PIRAX2, Inelastic Analysis of 3-Dimensional Piping Systems, ORNL/Sub-3651-3, Battelle-Columbus Laboratories, December 1974.
G. H. Workman and E. C. Rodabaugh, Summary Report on Development of a Simplified Analytical Procedure for Determining the Inelastic Response of Piping Systems, ORNL/Sub-3651-1, Battelle-Columbus Laboratories, September 1974.
11. MACHINE REQUIREMENTS - 100,000 (octal) words of memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.4.1 Level 373.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Extended core storage (ECS) is simulated through usage of fast memory with subroutine READDEC. For operation using ECS remove the READDEC subroutine. ECS is utilized to store the pipe element data and constants and the stiffness matrix associated with the problem.
15. NAME AND ESTABLISHMENT OF AUTHORS -

Author	E. C. Rodabaugh
	Columbus Laboratories
	Battelle Memorial Institute
	505 King Avenue
	Columbus, Ohio 43201

Contact J. A. Clinard
Engineering Technology Division
Oak Ridge National Laboratory
P. O. Box Y
Oak Ridge, Tennessee 37830

16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (2282 cards)
Sample problems (69 cards)
Reference reports

17. CATEGORY - I
KEYWORDS - stresses, pipes, strains, mechanical structures, finite element method, three-dimensional, plasticity, thermal expansion

18. SPONSOR - ERDA Division of Reactor Development and Demonstration

1. **NAME OR DESIGNATION OF PROGRAM** - BLOSSIM
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSIONS; PACKAGES AVAILABLE** - IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - BLOSSIM determines the time course of chemical reactions in chemical (or biochemical) systems. The user inputs a description of the chemical reactions of the system with initial chemical concentrations and reaction rate constants. The program calculates the concentrations of these chemicals as a function of time.

While the simulation program is designed for chemical systems, it has features which facilitate the ability to work with distribution equations for enzyme forms. The simulation program may also be applied to other areas where appropriate. It has been applied to compartmental analysis of radioactive tracer data in physiological modeling and interacting animals in ecological systems. In general, this program can be used as a differential equation solver for any set of simultaneous linear or nonlinear differential equations of first and higher orders.
4. **METHOD OF SOLUTION** - The computation involved in chemical simulation is the integration of the set of differential equations describing the time rate of change of the chemical concentrations, as formulated by the mass action law. The task of writing the differential equations is performed by a section of the simulation program called the "generator". The remainder of the simulation program, called the "simulator", numerically integrates these differential equations using the predictor-corrector method of C. W. Gear.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The generator and simulator programs are set up for:
 - 200 chemicals
 - 200 reactions
 - 50 stoichiometries
 - 12 chemicals per reaction
 - 50 enzyme formsIf the user wants to simulate larger systems, the appropriate array dimensions must be modified in the generator program.
6. **TYPICAL RUNNING TIME** - The sample input provided with the program took 7 seconds of CPU time on an IBM370/195 computer.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The methodology of program control restructuring is used in BLOSSIM. A programmer's guide which describes the basic philosophy of this programming technique is included with this package.
8. **RELATED AND AUXILIARY PROGRAMS** - There are a number of programs for solving systems of stiff differential equations in the NESC collection - GEAR (NESC Abstract 592), GEARB (NESC Abstract 661), EPISODE (NESC Abstract 675), and EPISODEB (NESC Abstract 705).
9. **STATUS** - Abstract first distributed December 1977.

IBM370 version received August 1976, sample problem executed by NESC October 1977 on an IBM370/195.
10. **REFERENCES** - Dr. David Garfinkel, BLOSSIM: A Biochemical Simulation Structure System, Moore School of Electrical Engineering report, August 1976.

G. C. Roman, David Garfinkel, and Carl B. Marbach, "Memory Concerning Efficient Methods for Solving Large Sets of Stiff Differential Equations", AFIPS Conference Proceeding, National Computer Conference, Vol. 45, pp. 973-978, 1976.

David Garfinkel, A Machine-Independent Language for the Simulation of Complex Chemical and Biochemical Systems, Computers and Biomedical Research, Vol. 2, pp. 31-44, 1968.

G. C. Roman and David Garfinkel, BLOSSIM: A Structured Machine-Independent Biological Simulation Language, Computers and Biomedical Research, (in press).
11. **MACHINE REQUIREMENTS** - 155K of memory for execution

12. **PROGRAMMING LANGUAGES USED** - FORTRAN (99%) and Assembler (1%)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360 (IBM360), OS/370 (IBM370).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** -
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
D. Garfinkel
Moore School of Electrical Engineering
University of Pennsylvania
Philadelphia, Pennsylvania 19104
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (10,920 cards)
Sample problem (27 cards)
Control information (JCL 442 cards)
Sample problem output (9 pages)
Reference report, MSEE report
17. **CATEGORY** - U
KEYWORDS - differential equations, numerical solution, chemical reactions, biochemistry, simulation
18. **SPONSOR** - National Institutes of Health

1. NAME OR DESIGNATION OF PROGRAM - DIFFUSER
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM370
3. DESCRIPTION OF PROBLEM OR FUNCTION - The DIFFUSER program uses a turbulent-flow model to calculate the performance of two-dimensional subsonic diffusers and of three-dimensional diffusers under the assumption of similarity of the top, bottom, and side wall boundary layers.
4. METHOD OF SOLUTION - The analytical model used is the Patankar and Spalding two-dimensional boundary layer computer code modified to handle internal channel flows. The numerical algorithm employed is a variable grid implicit finite difference scheme used to solve the von Mises form of the conservation of momentum and energy equations for turbulent flow. At each integration step an iteration procedure is performed to predict the pressure gradient such that the mass flow is conserved.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The code cannot handle properly 1) the modeling of the turbulent Reynolds stress in an adverse pressure gradient with large boundary layers, 2) interaction corner effects of the boundary layers on the four walls of the channel, 3) transitional stall and 4) separated flow.
6. TYPICAL RUNNING TIME - Running time is dependent on the number of grid points and maximum step sizes as well as the geometry input specified. With 77 grid points across the diffuser the execution time is about 7.5 seconds for every 100 integration steps (2 meters for a 2 cm step size). The sample problem executed in 21 CPU seconds on an IBM370/195.
7. UNUSUAL FEATURES OF THE PROGRAM - The code calculates the solution of the conservation equations from wall to wall rather than separating core flow from boundary layer flow; thereby yielding better results on the calculated pressure fields.
8. RELATED AND AUXILIARY PROGRAMS - The code as presented is self-contained.
9. STATUS - Abstract first distributed December 1977.
IBM370 version submitted October 1977, sample problem executed by NESC November 1977 on an IBM370/195.
10. REFERENCES - S. V. Patankar and D. B. Spalding, Heat and Mass Transfer in Boundary Layers, Margon-Grampian, London, 1967.
Ezzat Doss and Howard Geyer, Two-dimensional Subsonic Diffuser Code, ANL/MHD-77-1, July 1977.
11. MACHINE REQUIREMENTS - 125K bytes of memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/370 MVT/ASP system with ANL-AMD function library, SYS1.FORTLIB2.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
E. Doss and H. Geyer
Engineering Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60539
16. MATERIAL AVAILABLE -
Source deck (1327 cards)
Sample problem (10 cards)
Reference report, ANL/MHD-77-1

17. CATEGORY - H

KEYWORDS - open-cycle MHD generators, two-dimensional, three-dimensional, diffusers, performance, pressure gradients, subsonic flow, power plants

18. SPONSOR - DOE Office of Fossil Energy Programs

1. **NAME OR DESIGNATION OF PROGRAM - ARSTEC**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** The ARSTEC program was written to solve nonlinear, mixed integer, optimization problems. An example of such a problem in the nuclear industry is the allocation of redundant parts in the design of a nuclear power plant to minimize plant unavailability.
4. **METHOD OF SOLUTION -** The technique used in ARSTEC is the adaptive random search method. The search is started from an arbitrary point in the search region and every time a point that improves the objective function is found, the search region is centered at that new point.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Presently, the maximum number of independent variables allowed is 10. This can be changed by increasing the dimension of the arrays.
6. **TYPICAL RUNNING TIME -** Running time is problem-dependent. The NESC executed the sample problem in 2 CPU seconds on an IBM370/195.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -**
9. **STATUS -** Abstract first distributed January 1978.
IBM360 version first submitted February 1977, sample problem executed by NESC November 1977 on an IBM370/195.
10. **REFERENCES -** D. M. Rasmuson and N. H. Marshall, ARSTEC: A Program for Solving Nonlinear, Mixed Integer Problems, Using the Adaptive Random Search Technique, EG&G Idaho report, RES-76-180, October 1976.
G. R. Burdick, D. M. Rasmuson, and J. R. Wilson, An Investigation Concerning a Risk-Based Approach to Design of Liquid Metal Fast Breeder Reactor Plants, EG&G Idaho report, RES-76-174, September 1976.
M. W. Heuckroth, L. D. Gaines, J. L. Gaddy, An Examination of the Adaptive Random Search Technique, 79th National American Institute of Chemical Engineers Meeting, Houston, Texas, March 1975.
11. **MACHINE REQUIREMENTS -** Card reader, printer, and 125K bytes of memory
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/MVT.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** The user must specify the objective function via a function subroutine FUNCT and the constraints in a logical function subroutine CNSTRN.
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
D. M. Rasmuson and N. H. Marshall
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401
16. **MATERIAL AVAILABLE -**
Source deck (272 cards)
Sample problem (7 cards)
Reference report, RES-76-180

NESC ABSTRACT 738

04/79

17. CATEGORY - P

KEYWORDS - optimization, adaptive random search method, nonlinear problems

18. SPONSOR - ERDA Division of Reactor Development and Demonstration

1. NAME OR DESIGNATION OF PROGRAM - PRP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - PRP calculates the production cost (product price) when the investments, operating costs, interest rate on debt, rate of return on equity, tax rates, by-product values, and similar related information are supplied. The program can also be used to calculate the rate of return on equity when the selling price of the product is supplied.
4. METHOD OF SOLUTION - PRP uses the discounted cash flow method in a trial-and-error mode, calculating a year-by-year cash flow history of the project. Provisions are made for handling any desired debt-equity ratio and for choosing various options in the calculation of income taxes. The program can be used in a parametric mode where the cost of the feedstock (e.g. coal) and the rate of return are varied over any desired range of values.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 400 years of project life (NYRS)
 - 24 products listed (NPRODS)
 - 24 feedstocks for which the price and rate are given (NFEEDS)
 - 24 depreciation classes (NCLS)
 - 24 years of construction period (NCNSTR)
 - 20 rates of return on equity (NEQMAX)
6. TYPICAL RUNNING TIME - Execution time for a single case is approximately one second. The NESC executed the sample problem in 7 CPU seconds.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed January 1978.
IBM360 version submitted April 1977, sample problem executed by NESC December 1977 on an IBM370/195.
10. REFERENCES - Royes Salmon, PRP: A Discounted Cash Flow Program for Calculating the Production Cost (Product Price) of the Product from a Process Plant, ORNL-5251, March 1977.
11. MACHINE REQUIREMENTS - 92K bytes
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
 - Royes Salmon
 - Oak Ridge National Laboratory
 - P. O. Box X
 - Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE -
 - Source deck (962 cards)
 - Sample problem (26 cards)
 - Sample problem output (25 selected pages)
 - Reference report
17. CATEGORY - D
KEYWORDS - production, capital, charges, processing, economics

NESC ABSTRACT 739

04/79

18. SPONSOR - DOE Division of Fossil Energy

1. NAME OR DESIGNATION OF PROGRAM - PLACRE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - PLACRE is a two-dimensional (plane stress or axisymmetric) elastic-plastic-creep finite element structural analysis program. It has been adapted to analyze one-dimensional pipe-wall problems in which the stress, strain, and temperature depend only on radius. In addition to structural analysis capabilities, PLACRE has facilities for carrying out simultaneous transient thermal analysis for pipe-wall problems.
4. METHOD OF SOLUTION - The finite element method is used for the structural analysis. The basic element for two-dimensional problems is the three-node constant strain triangle; for one-dimensional problems the three-node constant strain rectangle is used. Creep calculations are carried out by an incremental method (reference 1) and plastic calculations by an iterative tangent stiffness method (reference 2). Finite difference techniques are applied in the heat transfer analysis.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
1000 elements and
1000 nodes for general two-dimensional problems
16 elements and
16 nodes for pipe-wall problems
6. TYPICAL RUNNING TIME - Running time is 0.01 second per element for one load increment using two iterations.
7. UNUSUAL FEATURES OF THE PROGRAM - Built-in thermal analysis is included for pipe-walls and special pipe-wall elements. Because the requirements for the analyses of general two-dimensional problems differ from those for pipe-wall problems two models of the PLACRE program are available: a general-purpose model and a pipe-wall model. The only differences are that the general-purpose program has (1) DIMENSION statements to permit more elements, (2) restart capabilities, and (3) facilities for selecting as output only a subset of the elements for use with a postprocessor program.
8. RELATED AND AUXILIARY PROGRAMS - Some earlier editions of PLACRE combined creep/fatigue damage analyses along with the structural analyses. Modifications required for the fatigue damage evaluation resulted in the decision to move the creep/fatigue damage capabilities to a postprocessor.
9. STATUS - Abstract first distributed January 1978.
IBM360,370 version submitted March 1977, sample problem executed by NESC December 1977 on an IBM370/195.
10. REFERENCES - G. A. Greenbaum and M. F. Rubinstein, Creep Analysis of Axisymmetric Bodies Using Finite Elements, Nuclear Engineering Design, Vol. 7, pp. 379-397, 1968.
P. V. Marcal and I. P. King, Elastic-Plastic Analysis of Two-Dimensional Stress Systems by the Finite Element Method, International Journal of Mechanical Sciences, Vol. 9, pp. 143-155, 1967.
W. K. Sartory, PLACRE User's Manual, ORNL/TM-5626, February 1977.
11. MACHINE REQUIREMENTS - About 187,000 double-precision (8 byte) words of storage are required in the general-purpose model for the solution of moderate-sized problems. About 35,000 double precision words of storage are required for pipe-wall problems. 1450K bytes were required for NESC execution of the general-purpose model, 280K bytes for the pipe-wall one.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/MVT (IBM360), OS/370 (IBM370).

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Local proprietary plotting routines and environment routines ERROR, ICLOCK, NUMBER, SYMBOL, PLOT, and PLOTS are not included in the package. Dummy replacement routines are provided. PLACRE uses units 50 and 51 for input and output. In some instances NESC found it necessary to assign unit numbers to READ and WRITE statements. These statements are identified by the character string ACCCTONY in columns 73-80.
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
W. K. Sartory
Engineering Technology Division
Oak Ridge National Laboratory
P. O. Box Y
Oak Ridge, Tennessee 37830
16. **MATERIAL AVAILABLE** - Restricted Distribution
Magnetic Tape Transmittal
Source decks (general-purpose 4369 cards, pipe-wall 4127 cards)
Sample problem (60 cards)
Control information (JCL 72 cards)
Reference report, ORNL/TM-5626
17. **CATEGORY** - I
KEYWORDS - one-dimensional, two-dimensional, deformation, finite element method, heat transfer, pipes, stresses, mechanical structures
18. **SPONSOR** - ERDA Division of Reactor Development and Demonstration

1. **NAME OR DESIGNATION OF PROGRAM - TRIDENT**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC7600, IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** TRIDENT solves the two-dimensional, multigroup transport equations in rectangular (x-y) and cylindrical (r-z) geometries using a regular triangular mesh. Regular and adjoint, inhomogeneous and homogeneous (keff and eigenvalue search) problems subject to vacuum, reflective, white, or source boundary conditions are solved. General anisotropic scattering is allowed and anisotropic distributed sources are permitted.
4. **METHOD OF SOLUTION -** The discrete ordinates approximation is used for the neutron directional variables. An option is included to append a fictitious source to the discrete ordinates equations that is defined such that spherical harmonics solutions (in x-y geometry) or spherical-harmonics-like solutions (in r-z geometry) are obtained. This option is useful for cases in which ray effect distortions are severe. A spatial finite-element method is used in which the angular flux is expressed as a linear polynomial in each triangle that is discontinuous at triangle boundaries. Both inner (within-group) and outer iteration cycles are accelerated by either whole system or fine-mesh rebalance.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Variable dimensioning is used so that any combination of problem parameters leading to a container array less than MAXLEN can be accommodated. On IBM machines TRIDENT executes in double-precision (8 bytes per word) so that MAXLEN can be on the order of 100,000 or more. On CDC machines MAXLEN can be about 40,000 words of small core memory (SCM) and large core memory (LCM) is used for most group-dependent data. Although most problems can be contained in memory, an option exists to automatically overflow the storage of selected large arrays to disk if necessary.
6. **TYPICAL RUNNING TIME -** Running times vary almost linearly with the total number of unknowns. When the ray-effect correction option is used, the running time is increased by a factor of approximately two, depending on the problem. The NESC executed the 10 sample problems in 7.5 CPU minutes on an IBM370/195; in 4 minutes on a CDC7600. A six-group, S2, 1700 triangle, keff calculation of an EBR2 core, modeled in x-y geometry, requires approximately 4.4 minutes of CDC7600 time.
7. **UNUSUAL FEATURES OF THE PROGRAM -** Provision is made for creation of standard CCCC interface output files for SN constants, angle-integrated (scalar) fluxes, and angular fluxes. Standard CCCC interface input files for SN constants, inhomogeneous sources, cross sections, and the scalar flux may be read. Subroutines DRED and DRIT perform information transfer between large core memory and random disk. Data transfers between large and small core memory are performed by CRED and CRIT. Sequential binary operations are performed by SEEK, REED, and RITE. Flexible edit options as well as a dump and restart capability are provided.
8. **RELATED AND AUXILIARY PROGRAMS -** TRIDENT supercedes the TRIPLET program (NESC Abstract 608). With minor modifications, TRIPLET input packages may be used in TRIDENT. LASL now maintains two time-independent, two-dimensional, neutron transport computer codes. TWOTRAN uses a rectangular mesh and is faster than TRIDENT. The latter code should be used only when the triangular option is needed (nonorthogonal material boundaries), when oscillations attributable to the diamond-difference scheme are present, or when the ray effect must be eliminated.
9. **STATUS -** Abstract first distributed January 1978.
IBM360 version submitted February 1977, sample problems executed by NESC December 1977 on an IBM370/195.
CDC7600 version submitted February 1977, sample problems executed by NESC January 1978.
10. **REFERENCES -** J. Seed, W. F. Miller, Jr., and F. W. Brinkley, Jr., TRIDENT: A Two-Dimensional, Multigroup, Triangular Mesh Discrete Ordinates, Explicit Neutron Transport Code, LA-6735-M, March 1977.

B. M. Carmichael, Standard Interface Files and Procedures for Reactor Physics Codes, Version III, LA-5486-MS, February 1974.

T. Pewitt, ANL-AMD System/360 Library Subroutine Description, N251S-1, ABEND, April 1967.

Daniel Carson, ANL-AMD System/360 Library Subroutine Description, K250S-1, Core to Core Conversion, Rev. February 1970.

G. J. Smith and W. J. Cody, ANL-AMD System/360 Library Subroutine Description, Q054S, DATE, February 1968.

K. Hillstrom, ANL-AMD System/360 Library Subroutine Description, Q055S, TIME, February 1970.

11. **MACHINE REQUIREMENTS** - A maximum of three interface file units open at one time and three system input-output units are required. One random disk unit is required if the automatic data overflow option is used. 730K bytes of memory are necessary to execute the sample problems on the IBM system. The amount of memory needed is problem-dependent. A LCM block of 131,064 words was needed to execute the sample problems on the CDC7600.
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV (TRIDENT source and routines) and IBM360 Assembler (subroutines ABEND, DATE, SECOND, TIME, TRACER, CONVO, and CONVI)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360 MVT (IBM360), SCOPE (CDC7600).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Subroutines DOPC, CRED, CRIT, SEEK, REED, and RITE were written according to the Committee on Computer Code Coordination (CCCC) standards (reference 2). The CCCC subroutines included with the package are not the most efficient, but they will suffice to execute the program. Each installation should supply CCCC routines for their particular system.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
T. J. Seed, W. F. Miller, Jr., and
F. W. Brinkley, Jr.
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87545
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (TRIDENT 360-11,326 cards, 7600-11,581 cards, CCCC routines 360-553 cards, 7600-314 cards, Assembler routines 360-644 cards)
Sample problems (571 cards)
Control information (JCL 360-32 cards)
Sample problems output (360-47 selected pages, 2 microfiche, 7600-43 selected pages, 1 microfiche)
Reference report, LA-6735-M, and ANL-AMD System/360 Library Subroutine Descriptions
17. **CATEGORY** - C
KEYWORDS - two-dimensional, multigroup, CCCC, discrete ordinate method, spherical harmonics, transport theory, triangular configuration, TRIPLET codes
18. **SPONSOR** - ERDA Division of Reactor Development and Demonstration

1. NAME OR DESIGNATION OF PROGRAM - CASIM
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM370/360
3. DESCRIPTION OF PROBLEM OR FUNCTION - CASIM is a Monte Carlo program to study the average development of high energy cascades in large targets (shields) of arbitrary geometry and composition. The program is best suited for incident energies in the range 20-1000 GeV.
4. METHOD OF SOLUTION - The simulation makes extensive use of weighting techniques to avoid difficulties encountered in sampling complicated distributions and to allow the user to introduce bias in the sampling. The program uses the particle production model (in the form of a set of inclusive distributions) to compute (a) star densities (i.e. nuclear interaction densities) as a function of location and particle type throughout the target. From these star densities, estimates of a number of quantities of radiobiological interest can be obtained; (b) momentum spectra of particles interacting in the shield also as a function of location and type; (c) energy deposited by the cascade. This quantity is a useful measure of target heating embedded in the target (ionization calorimeter).
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The program does not study transport of low momentum particles (less than or equal to 0.3 GeV/c).
6. TYPICAL RUNNING TIME - Running time is highly problem dependent. The NESC executed the sample problem in 35 CPU minutes and the modification problem (see item 14) in 15 CPU minutes on an IBM370/195.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed March 1978.
IBM370 version submitted May 1975. sample problem executed by NESC February 1978 on an IBM370/195.
10. REFERENCES - A. Van Ginneken, CASIM: Program to Simulate Transport of Hadronic Cascades in Bulk Matter, FN-272, January 1975.
K. Hillstrom, DSIN/DCOS, OS/360-FORTRAN IV Compatible Routine for the Sine and Cosine Function, B158S, October 1969, Revised by J. Wang, July 1975 and August 1977.
J. Wang, EXP, Exponential Function (single precision), B356S, October 1977.
Donald F. Jordan, ARGPOWER, IBM S/360 FORTRAN IV Single-precision Power Function, B457S, January 1968, Revised by W. J. Cody February 1969 and October 1974 and by J. Wang October 1977.
11. MACHINE REQUIREMENTS - 350K of memory, tape drives, line printer
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/370,360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The star (or energy) densities and momentum spectra normally calculated by CASIM are not always the information best suited to the user. As an example of how the program can be modified by the user, the application of CASIM to a highly specific problem is included. Also included in this package are three Assembler routines (DSIN, ESP, FRXPR) from a library at Argonne National Laboratory. If the program is run without these routines, a vast number of underflows may appear, affecting the efficiency of the program. There will also be a slight difference in the answers from those provided by the author.
15. NAME AND ESTABLISHMENT OF AUTHOR -
A. Van Ginneken
Fermi National Accelerator Laboratory

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Batavia, Illinois 60510

- 16. MATERIAL AVAILABLE - Magnetic Tape Transmittal**
Source decks (CASIM FORTRAN 3047 cards, Assembler routines 735 cards, Modified FORTHAN 3207 cards)
Sample problems (CASIM 6 cards, Modified 5 cards)
Sample problem output (CASIM 30 selected pages and 1 microfiche, Modified 11 pages)
Reference report, FN-272, and Subroutine Descriptions
- 17. CATEGORY - W**
KEYWORDS - nuclear cascades, Monte Carlo method, shields
- 18. SPONSOR -** DOE Office of High Energy and Nuclear Physics

1. **NAME OR DESIGNATION OF PROGRAM** - PARK1
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC7600, 6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - PARK1 is a computational tool for the analysis of the interrelated thermal, hydraulic, and nuclear characteristics of a pressurized water nuclear reactor plant under a variety of steady-state and transient conditions. The program will simulate the overall plant dynamic response to changes in plant conditions such as turbine load, motion of control rods, and main coolant pump switching. Specific transients might include plant maneuvers, loss of load, complete or sequential loss of primary coolant flow, cold water accidents, and startup or power range rod withdrawal accidents. Under more general classes of plant transients, PARK1 can simulate reactor protection performance or anticipated transients without scram (ATWS). PARK1 also provides forcing functions for more detailed studies of isolated system components such as hot channels, steam generators, and pressurizers. The features of PARK1 include a steady-state (initial condition) calculation, flexible reactor core configuration to permit 1, 1-1/2, or 2 pass cores with multiple channel regions per pass, separable space-time reactor kinetics including the effects of decay heat, coolant within-core leakage, up to four primary coolant loops, response of reactor plant control systems such as reactor protection and steam generator feedwater control, and graphical display of transient plant variables.
4. **METHOD OF SOLUTION** - The principal computational assumptions are one-dimensionality of the conservation of energy (heat transfer) and conservation of momentum (fluid flow) equations, neglect of effects of fluid expansion, and separable (space-time) neutron kinetics. Solution of the PARK1 system of equations is performed by trapezoidal integration of finite difference equations (central differencing) and is done in sequence, not simultaneously.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Up to 15 channel regions, 8 leakage paths, and four interpass ducts may be used to describe the reactor core. A maximum of four loops and eight steam generator tube bundle regions is permitted. One-dimensional computing grids allow up to 21 axial mesh points in each core channel region, 50 in each primary coolant pipe, and 31 in each steam generator tube bundle region. The reactor kinetics equations consider six delayed neutron groups and up to 11 decay heat groups.
6. **TYPICAL RUNNING TIME** - Typical CDC6600 running time is approximately 20 seconds for a steady-state solution and 3 to 10 minutes for a transient, although actual computer time will vary with the number of time-steps. The time required to execute one time-step is about 0.2 to 0.5 second.
7. **UNUSUAL FEATURES OF THE PROGRAM** - PARK1 provides a plant steady-state computation which optionally includes convergence to a specified average primary coolant temperature. The program will then simulate plant dynamic response to changes in plant conditions such as turbine-generator load, motion of reactor control rods, and main coolant pump switching. Restart capability is available to permit future continuation of transient problems.
8. **RELATED AND AUXILIARY PROGRAMS** - PARK1 provides an optional punched card data link to TOPS (M0543) (NESC Abstract 348) for analyzing pressurizer dynamics. Here the primary system coolant transient surge rate computed by PARK1 is punched in the M0543 format. Alternately, the TOPS pressurizer calculations may be performed within PARK1 as a special option. PARK1 uses routines from the Bettis Programming Environment Library (NESC Abstract 665).
9. **STATUS** - Abstract first distributed December 1977.
CDC7600 Version 39 submitted January 1977.
CDC6600 Version 40 submitted January 1977.
10. **REFERENCES** - W. G. Clarke, J. V. Reihing, Jr., and T. A. Porsching, PARK1: A FORTRAN-IV Computer Program for Nuclear Reactor Power Plant Analysis (LWBR Development Program), WAPD-TM-447(L) Revised, September 1975.

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W. G. Clarke, Transient Analysis of Steam Generators in Nuclear Power Plants Using Digital Computer Techniques, M.S. Thesis, University of Pittsburgh, 1965.

W. R. Cadwell, Editor, Reference Manual - Bettis Programming Environment, WAPD-TM-1181, September 1974.

PARK1, Version 39, ACC No. 743.7600, Argonne Code Center Note 78-16.

11. **MACHINE REQUIREMENTS** - CDC6600 - 140K octal locations of central memory and 300K of extended core storage; CDC7600 - 150K of central memory and 300K of extended core storage; as well as punching and curve plotting capability.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 3.1.5 (CDC6600), SCOPE 1.1 (CDC7600).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Multisegment loading is required; to load the program with a field length of 140K, the HOH and ECS routines must be shifted from the root to the appropriate primary overlay.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
W. G. Clarke and J. V. Reihing, Jr.
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Westinghouse Electric Corporation
Box 79
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16. **MATERIAL AVAILABLE** - Restricted Distribution
Magnetic Tape Transmittal
Source decks (6600-43,890 cards, 7600-43,890 cards)
Sample problems (6600-617 cards, 7600-617 cards)
Sample output (36 selected pages; 3 microfiche)
Reference report, WAPD-TM-447(L), and ACC Note (as appropriate)
17. **CATEGORY** - K
KEYWORDS - PWR reactors, power plants, reactor kinetics, heat transfer, fluid flow, steady-state conditions, finite difference method
18. **SPONSOR** - DOE Division of Naval Reactors

1. **NAME OR DESIGNATION OF PROGRAM - SAGE-WASP**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** SAGE-WASP is designed to find the optimal generation expansion policy for an electrical utility system. New units can be automatically selected from a user-supplied list of expansion candidates which can include hydroelectric and pumped-storage projects. The existing system is modeled. The calculational procedure takes into account user restrictions to limit generation configurations to an area of economic interest. The optimization program reports whether the restrictions acted as a constraint on the solution. All expansion configurations considered are required to pass a user-supplied reliability criterion. The discount rate and escalation rate are treated separately for each expansion candidate and for each fuel type. All expenditures are separated into local and foreign accounts, and a weighting factor can be applied to foreign expenditures.
4. **METHOD OF SOLUTION -** A dynamic programming algorithm is used in the optimization to calculate the best expansion policy. This is defined as the policy which results in a system that satisfies the reliability criterion and which results in the minimum discounted cash flow expenditures over the study period. An objective function is defined to evaluate and compare the effects of the various decisions. A probabilistic simulation model is used to calculate production costs for all allowable configurations.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** SAGE-WASP allows study periods of up to 30 years. The maximum number of configurations in the optimization program for any year is 200. A maximum of 2000 configurations is permitted in any run of the dynamic programming module.
6. **TYPICAL RUNNING TIME -** CASE26, which is the sample provided with the program, took seven minutes on an IBM370/195 computer.
7. **UNUSUAL FEATURES OF THE PROGRAM -** The SAGE-WASP package is designed to run on relatively small computers. The maximum storage required is 43,000 32-bit words or 172K bytes on an IBM370 computer. The code uses magnetic disk files to preserve information from iteration to iteration, thus avoiding repetition of calculations.
8. **RELATED AND AUXILIARY PROGRAMS -** The WASP program evolved from the Tennessee Valley Authority's Systems Analysis Generation Expansion (SAGE) program. This release includes the modifications and enhancements defined by the IAEA Newsletters (references 3, 4, and 5) and includes any changes up to but not including those described at the Columbus, Ohio, August 1977 WASP User's Meeting.
9. **STATUS -** Abstract first distributed December 1977.
IBM370 version submitted September 1977, sample problem executed by NESC November 1977 on an IBM370/195.
10. **REFERENCES -** R. T. Jenkins and D. S. Joy, WIEN Automatic System Planning Package (WASP) - An Electric Utility Optimal Generation Expansion Planning Computer Code, ORNL-4945, July 1974.
International Atomic Energy Agency (IAEA) report, WASP-II User's Manual - 2nd Draft, September 1976.
Peter Heinrich, IAEA WASP Newsletter No. 1, November 17, 1976.
Peter Heinrich, IAEA WASP Newsletter No. 2, March 10, 1977.
Alvaro J. Covarrubias, IAEA WASP Newsletter No. 3, September 30, 1977.
R. Taber Jenkins and Timothy C. Vorce, Supplementary WASP Documentation, WASP Conference Paper, Columbus, Ohio, August 18-19, 1977.
Bruce A. Anderson, Modifications to Augment Private Utility Use of the Wien Automatic System Planning Package, Duke Power Company report.
11. **MACHINE REQUIREMENTS -** 170K bytes of storage are required.

12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV. Subroutines FUNINT, ADD, REMOVE, PAK, and UNPAK are available in Assembler language and can be substituted for the FORTRAN subroutines of the same name in CONGEN, MERSIM, and DYNPRO to shorten execution time.
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - The program was developed on the IAEA's IBM370/145 operating under OS/VS1. It was tested at the Energy Software Center on an IBM370/195 operating under OS/MVT.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Eleven disk files are created by the program and up to six of these are used by an individual program.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
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113 Chattanooga Bank Building
Chattanooga, Tennessee 37401
D. S. Joy
Chemical Technology Division
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37830
16. **MATERIAL AVAILABLE** - Special Distribution
Magnetic Tape Transmittal
Source decks (FORTRAN 8049 cards, Assembler 823 cards)
Sample problem (743 cards)
Control information (JCL 58 cards)
Sample problem output (FT06 65 selected pages, FT08 11 selected pages; complete output 3 microfiche)
Reference reports, Manual, and Newsletters
17. **CATEGORY** - D
KEYWORDS - power plants, economics, planning, electric utilities, expansion
18. **SPONSOR** - Tennessee Valley Authority
ERDA Division of Nuclear Research and Application

1. **NAME OR DESIGNATION OF PROGRAM** - CORRAL2
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC6400, CYBER73
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - CORRAL2 describes fission product behavior in multicompartiment LWR containments taking into account natural transport and deposition as well as the effects of engineered safety features. This program is specifically designed to handle fission product behavior in LWR accidents involving core meltdown, though less severe accidents can also be treated.
4. **METHOD OF SOLUTION** - CORRAL2 input requirements include a description of the containment system, engineered safeguards parameters, timing of events, thermodynamic conditions as a function of time, and fission product release component fractions. The code uses this input to continuously compute changing properties and fission product removal rates as a function of time. These values are used in incremental solutions to the coupled set of differential equations to obtain the time-dependent fission-product concentrations and accumulations in each compartment of the containment. The principal output consists of cumulative fractional releases from containment with time for each of the fission product groups.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The containment system can be described by up to 15 individual compartments; the accident sequence is described by up to 20 sequential event times. Radionuclide release by any of four release mechanisms for each of 8 groups of fission products can be specified.
6. **TYPICAL RUNNING TIME** - The running time is problem dependent particularly with respect to the number of compartments used. For two-compartment cases with 80 computational cycles representative central processor times on the CYBER73 are 70-120 seconds. Four-compartment problems with 100 computational cycles require approximately 600 seconds of central processors on the CYBER73. The NESC executed the first sample problem in 1.2 seconds on a CDC7600. The second sample problem was allowed to run for 41.5 seconds before it ran out of time. It is not known how long the second problem would take to run to completion.
7. **UNUSUAL FEATURES OF THE PROGRAM** - NAMELIST is used for data entry. CORRAL2 is programmed for stacked case capability.
8. **RELATED AND AUXILIARY PROGRAMS** - CORRAL2 is a generalized version of the CORRAL PWR and CORRAL BWR codes developed during the course of the Reactor Safety Study (WASH-1400).
9. **STATUS** - Abstract first distributed February 1978.
CDC CYBER73 version submitted May 1977, sample problem executed, without plotting, by NESC December 1977 on a CDC7600.
10. **REFERENCES** - R. J. Burian and P. Cybulskis, CORRAL II User's Manual, January 1977.
Dave Kasik, Battelle Computer Center Programming Bulletin No. 88, INITGRF Package for 4060 Graph Drawing, August 30, 1972.
A. K. Postma, P. C. Owzarski, and D. L. Lessor, Transport and Deposition of Airborne Fission Products in Containment Systems of Water Cooled Reactors Following Postulated Accidents, WASH-1400, Appendix VII J, October 1975.
11. **MACHINE REQUIREMENTS** - 137,700 (octal) 60-bit words of central memory and 52,000 (octal) 60-bit words extended core are used. The program output prints 136-character records.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - NOS/BE.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The system assumes the memory has been set to zero before execution. If the stacked case capability is used, memory must be zeroed before execution of each case.

The plotting package has been written for Datagraphix 4060 hardware and may not be compatible with other systems. To perform plotting, the user must supply subroutines SUBJEG, SETSMG, LEGEND, INITGRF, EXITG, PWRXY, UNSCZZ, SCALZZ, and QIKGRF. If one does not desire the plotting option, the entire overlay (2.0) (i.e., program PLTFP and subroutine MINMAX) may be removed along with the statement IF (NPLT) CALL OVERLAY(3HCOR,2,0,SHRECALL) in the (0.0) overlay.

15. NAME AND ESTABLISHMENT OF AUTHOR -

P. Cybulskis
Columbus Laboratories
Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (2608 cards)
Sample problems (179 cards)
Reference user's manual and Bulletin

17. CATEGORY - G

KEYWORDS - fission products, reactor safety, accidents, aerosols, containment, radioactivity

18. SPONSOR - NRC Office of Nuclear Regulatory Research

1. **NAME OR DESIGNATION OF PROGRAM** - EURCYL1
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - EURCYL1 produces a finite-element model of a cylinder-cylinder intersection for any of a number of general-purpose, thermal-structural computer programs including ANSYS, MARC, MATUS (NESC Abstract 597), and WECAN. The mesh is created using three-dimensional solid elements. Node and element descriptions are generated in punched card or data file format.
4. **METHOD OF SOLUTION** - EURCYL1 produces a model of one-quarter of a cylinder-cylinder intersection. Half or whole models are created by replication. The user supplies the basic dimensions. The axis of the smaller cylinder (nozzle) is always perpendicular to the axis of the larger cylinder (vessel). EURCYL1 will create the model using 8, 20, or 32 node three-dimensional elements. Elements are generated angularly around the nozzle, then through the thickness, and finally down the nozzle and along the vessel. The nodes are generated first in the angular, then in the thickness, and finally in the length dimension.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The number of nodes and elements is limited by storage. For a CDC7600 with 65K word fast memory the maximum number of nodal points is 2000, the maximum number of elements is $(5400/(M+1))$ where M is the number of nodes per element. A minimum of six (8 node) elements in each 90 degree arc of nozzle or cylinder is required to adequately model the structure. An equal number of elements is required along the length of the vessel ($y=0$) as along the arc of the cylinder ($x=0$). The number of elements around the nozzle must equal the sum of the number along the bottom of the cylinder and the $x=\max$ end.
6. **TYPICAL RUNNING TIME** - Typical CDC7600 running times are less than 1 second per case.
7. **UNUSUAL FEATURES OF THE PROGRAM** -
8. **RELATED AND AUXILIARY PROGRAMS** - EURCYL1 is an extension of the earlier EURCYL program (NEA Abstract E408) which has been expanded to output node and element descriptions in a format compatible with several general-purpose analysis programs.
9. **STATUS** - Abstract first distributed April 1978.
CDC7600 version submitted October 1977, sample problem executed by NESC December 1977.
10. **REFERENCES** - A. L. Snow and P. Bell, A User's Guide to EURCYL-1: A Cylinder-Cylinder Intersection Mesh Generator, WARD-SD-3045-6, September 1977.
P. DeWindt and J. Reynen, EURCYL: A Computer Program to Generate Finite Element Meshes for Cylinder-Cylinder Intersections, EUR 5030e, 1973.
11. **MACHINE REQUIREMENTS** - Less than 100K words of storage are required. EURCYL1 expects to read input from TAPE5, to write print output on TAPE6, punch output to TAPE7, and to store data on TAPE8 and TAPE9, except with the MAM (MATUS-APACHE-MESH3D) option when all the data is stored on THREEED.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 2.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The PKIO subroutine is not included in the EURCYL1 package. This subroutine is required only when the MAM option is used and is a part of the MATUS package (NESC Abstract 597).
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
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Advanced Reactors Division
Westinghouse Electric Corporation

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16. MATERIAL AVAILABLE - Restricted Distribution

Magnetic Tape Transmittal

Source deck (1637 cards)

Sample problem (8 cards)

Reference reports

17. CATEGORY - L

KEYWORDS - finite element method, mesh generation, three-dimensional, MATUS codes, ANSYS codes, MARC codes, WECAN codes, EURCYL codes

18. SPONSOR - DOE Division of Reactor Research and Technology

1. **NAME OR DESIGNATION OF PROGRAM** - LINEAR, SIGMA1
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC7600, 6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - LINEAR and SIGMA1 are FORTRAN programs designed to convert ENDF/B File 3 cross section data to linear-linear interpolatable form, to thin these data, and to Doppler-broaden linear-linear data to one final temperature. The output is written in ENDF/B format.
LINEAR converts evaluated cross sections in the ENDF/B format to linear-linear interpolatable form and thins those sections already in that form. This eliminates any subsequent code's need to do this task.
SIGMA1 will Doppler-broaden the converted sections of ENDF/B File 3 cross-section data to the final temperature. The energy grid is selected to ensure that the broadened data is linear-linear interpolatable. If the original data is not at zero Kelvin the data are broadened by the effective temperature difference to the final temperature.
4. **METHOD OF SOLUTION** - Within the ENDF/B format each section of tabulated data (File 3) is represented by a table of energy versus cross section and any one of five possible interpolation laws. LINEAR will replace each section with a new table of energy versus cross section data in which the interpolation law is always linear-linear. The first of the five specified ENDF/B interpolation laws, histogram, constant cross section between two energies, is converted to linear-linear by substituting two points for each initial point. The second law, linear-linear, is linear in energy and linear in cross section already and the section is not altered. The final three laws, log-linear, linear-log and log-log, have logarithmic values and the section data are converted to linear by an interval-halving algorithm. The interval is divided in half until the value at the middle of the interval can be approximated by linear-linear interpolation. The LINEAR program uses a multipoint, fractional error thinning algorithm to minimize the size of each cross section table.
SIGMA1 starts from the free-atom Doppler broadening equations and adds the assumptions of linear data within the table and constant data outside the range of the table.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The programs use only the ENDF/B BCD format tape, and copy all sections except File 3 as read. Since File 3 data are in identical format for ENDF/B Versions I through V these programs can be used with all of these versions.
The input to SIGMA1 must be data which vary linearly in energy and cross section between tabulated points. The LINEAR program provides such data.
6. **TYPICAL RUNNING TIME** - LINEAR uses 0.7 minute on a CDC7600 to linearize ENDF/B Version IV tape 409 to 0.1% accuracy. SIGMA1 uses 0.9 minute on a CDC7600 to Doppler-broaden ENDF-76 tape 6 from 0 to 300K.
7. **UNUSUAL FEATURES OF THE PROGRAM** -
8. **RELATED AND AUXILIARY PROGRAMS** -
9. **STATUS** - Abstract first distributed March 1978.
CDC7600 version submitted August 1977, sample problem executed by NESC December 1977 on a CDC7600.
10. **REFERENCES** - D. E. Cullen, Program LINEAR (Version 77-1): Linearize Data in the Evaluated Nuclear Data File/Version B (ENDF/B) Format, UCRL-50400, Vol. 17, Part A, January 12, 1977.
D. E. Cullen, Program SIGMA1 (Version 77-1): Doppler Broaden Evaluated Cross Sections in the Evaluated Nuclear Data File/Version B (ENDF/B) Format, UCRL-50400 Vol. 17, Part B, January 12, 1977.
D. Garber, Data Format and Procedures for the Evaluated Nuclear Data File, ENDF, BNL-NCS-50496, (ENDF-102), October 1975.
11. **MACHINE REQUIREMENTS** - Approximately 25K words of memory are required
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 2.1.

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - SIGMA1 as received produced many error messages of type 115 (argument too small) when run by NESC. Eighteen FORTRAN statements, testing for arguments smaller than EXP can handle and branching around the EXP calculation, have been added to SIGMA1 to eliminate this. They are identified by the character string ACCCPAUL, in columns 73-80.

In checking sample problem output with that in the reference report, note that the Q-value for section 42000 1287 4 in the sample problem was changed from $-9.198E+5$ in ENDF/B-IV tape 406, dated 29-Aug-74, used by author, to $-2.470E+5$ in tape 409, revision 2, 25-Jun-75.

15. NAME AND ESTABLISHMENT OF AUTHOR -

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16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (LINEAR 664 cards, SIGMA1 1129 cards)
Sample problem (LINEAR 1 card, SIGMA1 1 card)
Reference reports, UCRL-50400 Vol. 17, Part A and B

17. CATEGORY - B

KEYWORDS - cross sections, Doppler broadening, ENDF/B

18. SPONSOR - DOE Division of Military Application

1. NAME OR DESIGNATION OF PROGRAM - DRAFTMAN
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - DRAFTMAN is a FORTRAN DISSPLA-based program that allows the user to obtain drawings of simple graphs. Figures are developed interactively on a graphics terminal, with the terminal user prompted for responses describing the figure being developed. When user/terminal interaction is completed the figure is drawn on the screen for review. The user can then submit a batch job directing the output to a plotting device for a high-quality drawing of the figure. The program can be utilized completely in a batch mode, if desired.
4. METHOD OF SOLUTION - DRAFTMAN utilizes the ISSCO DISSPLA graphics package. The program generates the drawing according to the user's input data. There is complete freedom in specifying most of the figures' parameters. The DISSPLA graphics package character set used is the duplex style, which is quite similar to the Leroy font. The aspect ratio is fixed at 8.5 x 11 inches and the symbol size at 3/16 of an inch.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The maximum number of curves that can be drawn on one plot is six. The maximum number of data points that can define any curve is thirty. However, if more than thirty points are needed, two or more curves can be joined together.
The type of curve fit can be point-to-point cubic spline, parametric cubic spline, third-order parametric polynomial interpolation, or fifth-order parametric polynomial interpolation.
6. TYPICAL RUNNING TIME - Less than one minute was required to compile and produce the sample output.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - SLIDES (NESC Abstract 728) takes text and commands and produces DISSPLA-lettered slides and posters.
9. STATUS - Abstract first distributed February 1978.
IBM360 version submitted June 1977, sample problem executed by NESC January 1978 on an IBM370/195.
10. REFERENCES - M. D. Gawlik, DRAFTMAN - A Routine for Drawing Publishable Quality Figures, Argonne National Laboratory, Applied Mathematics Division, TM-295, July 1978.
11. MACHINE REQUIREMENTS - 200K bytes of storage, appropriate graphics terminal, and plotting devices
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 and TSO (IBM360), OS/370 (IBM370).
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The proprietary ISSCO DISSPLA plotting package is required.
Three dummy subroutines ANMODE, ERASE, and TSEND are supplied to permit batch-mode execution of the GRAPH program. The NESC-supplied file of sample job control cards is intended to be more generally applicable than the job control language information given in the reference report.
15. NAME AND ESTABLISHMENT OF AUTHOR -
M. D. Gawlik
Applied Mathematics Division
Argonne National Laboratory

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9700 South Cass Avenue
Argonne, Illinois 60439

- 16. MATERIAL AVAILABLE - Magnetic Tape Transmittal**
Source decks (GRAPH 544 cards, DRAW 306 cards, dummy subroutines 9 cards)
Sample problem (20 cards)
Control information (JCL 163 cards)
Reference report
- 17. CATEGORY - F**
KEYWORDS - diagrams, computer graphics, interactive computing, DISSPLA codes
- 18. SPONSOR -** Argonne National Laboratory

1. NAME OR DESIGNATION OF PROGRAM - STEEP4
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600,7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - STEEP4 calculates fusion reaction rates in terms of the specific reactivity ($\sigma-v$) which is the product of cross section and relative velocity averaged over the actual ion distributions of the interacting particles in the plasma. Maxwellian ion distributions are modified to include slowing-down contributions which are characterized in terms of plasma parameters. Rapid and accurate algorithms are used for integrating the specific reactivity from spectra and input cross sections. Options are also provided for rapid calculation of screening effects on specific reaction rates.
4. METHOD OF SOLUTION - The main program uses the method of steepest descent. However, options are provided to use Gauss-Hermite and dense trapezoidal quadrature integration techniques. Gamow penetration form, log-log interpolation, and cubic interpolation routines are used to provide interpolated values of cross sections for the integration routines. Slowing-down contributions are included by joining a $1/E$ ion slowing-down distribution smoothly to a background Maxwellian distribution for the total ion distribution. Multiplicative screening factors are calculated from plasma parameters using weak-, intermediate-, and strong-screening formulations.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The form of the slowing-down distribution neglects absorption and leakage of plasma particles during the slowing-down process and is based on the assumption that the slowing-down ion is faster than the background ions but slower than the plasma electrons. Spatial and angular dependences of the ion distributions are not treated in this version of the code.
6. TYPICAL RUNNING TIME - The program requires about 0.1 second for specific reactivity evaluation without slowing-down or screening corrections for each set of plasma parameters when run on the CDC7600. The additional time for screening factor calculation is negligible; however, each slowing-down evaluation requires 10 to 20 seconds.
7. UNUSUAL FEATURES OF THE PROGRAM - STEEP4 is modularly structured so that selected sections may be removed for incorporation in thermonuclear burn codes to provide rapid and yet relatively accurate in-line specific reactivity computation. The options to include slowing-down and screening effects provide a great deal of flexibility and increase the range of applicability of the code. Also a subroutine is provided to read input cross-section data from an assumed library of charged-particle cross sections.
8. RELATED AND AUXILIARY PROGRAMS - STEEP4 uses the LASL program library subroutine PLOTM (reference 2) to generate SC4020 film plot output.
9. STATUS - Abstract first distributed February 1978.
CDC7600 version submitted December 1976, sample problems executed by NESC January 1978 on a CDC7600.
10. REFERENCES - D. R. Harris, D. E. Dei, A. A. Hussein, Z. A. Sabri, and G. M. Hale, The STEEP4 Code for Computation of Specific Thermonuclear Reaction Rates from Pointwise Cross Sections, LA-6344-MS, June 1976.
R. Frank, PLOTM - Standardized Plot on Film with Tic Marks, Los Alamos Scientific Laboratory Programmer's Information Manual, LA-5525-M, Vol. 2, 1974.
11. MACHINE REQUIREMENTS - A SC4020 Film Unit is used to provide film plotting capability.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 2.1.3.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

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15. NAME AND ESTABLISHMENT OF AUTHORS -

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16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (2191 cards)
Sample problem (134 cards)
Reference report, LA-6344-MS

17. CATEGORY - X

KEYWORDS - reaction kinetics, thermonuclear reactions, cross sections, ENDF/B, PLOTM codes

18. SPONSOR - DOE Division of Military Application

1. NAME OR DESIGNATION OF PROGRAM - CURT2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360/370
3. DESCRIPTION OF PROBLEM OR FUNCTION - CURT2 is a computer code that calculates stresses and displacements in a shell structure made up of curved or straight cylindrical segments such as those in a piping system. Loadings considered are internal pressure and/or arbitrary end loadings that may be distributed symmetrically or nonsymmetrically around the circumference.
4. METHOD OF SOLUTION - The governing shell theory equations can be formulated in terms of a system of eight first-order partial differential equations. The multisegment method for two-point boundary-value problems governed by a system of ordinary partial differential equations is applied to obtain the solution.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - CURT2 will compute the stress distributions and displacements of generic points in a structure that consists of up to 5 arbitrarily arranged straight and curved cylindrical shells. The thickness of each part, the modulus of elasticity and Poisson's ratio for each part must be constant. The maximum number of pivotal points is 19 and the maximum number of segments over all parts 200.
6. TYPICAL RUNNING TIME - The sample problem took 6 minutes to run on an IBM370/195.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - CURT2 is a revision of CURVED TUBES developed at United Technology Center.
9. STATUS - Abstract first distributed February 1978.
IBM360 version submitted November 1977, sample problems executed by NESC December 1977 on an IBM370/195.
10. REFERENCES - R. C. Gwaltney, CURT-II - A Computer Program for Analyzing Curved Tubes or Elbows and Attached Pipes with Symmetric and Unsymmetric Loadings, ORNL-TM-4646, October 1974.
A. Kalnins, Analysis of Curved Thin-Walled Shells of Revolution, American Institute of Aeronautics and Astronautics Journal, Vol. 6, No. 4, pp. 584-588, April 1968.
11. MACHINE REQUIREMENTS - 450K bytes of storage are required.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The vector scaling routine, DSCALE, is written in IBM360 Assembly language. It can be removed, with only a marginal loss in accuracy, to allow implementation of CURT2 on other machines. An alternative ADJSTP routine has been included with the package.
15. NAME AND ESTABLISHMENT OF AUTHOR -
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Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source decks (FORTRAN 1369 cards, BAL 125 cards)
Sample problem (112 cards)
Auxiliary information (ADJSTP 71 cards)

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Control information (JCL 56 cards)

Sample problem output (921 cards, 50 selected pages, 3947 records of maximum length 133 characters)

Reference report, ORNL-TM-4646

17. CATEGORY - 1

KEYWORDS - stress analysis, pipes, pipe fittings, cylinders, shells

18. SPONSOR - AEC Division of Reactor Research and Development

1. NAME OR DESIGNATION OF PROGRAM - SOMIX1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM370
3. DESCRIPTION OF PROBLEM OR FUNCTION - SOMIX1 analyzes transient free convection motion in low-oxygen gas environments of a cylindrical enclosure, representing a LMFBF heat transfer cell, following a sodium pipe rupture which releases a spray of sodium droplets. Calculated are the combustion and heat transfer from the falling spray to the gas atmosphere, droplet motion, gas temperature and pressure rise and internal gas circulation.
4. METHOD OF SOLUTION - A finite-difference numerical scheme is used for the two-dimensional, incompressible, fluid-flow analysis in cylindrical geometry. The stream function-vorticity concept is used to simplify the momentum equations. The successive-over-relaxation or fast Fourier transform with Gaussian elimination technique is used to solve the elliptic stream function equation.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maximum of -
5 different drop sizes
For fast Fourier transform problems -
(NMAX*(JMAX-1)*ND).LE.18000
(IMAX*JMAX).LE.297
where
NMAX = number of drop release time-steps,
JMAX = number of radial mesh points,
IMAX = number of axial mesh points, and
ND = number of different drop sizes.
Dimensions in the COMMON statement in the MAIN program may be modified to accommodate problems requiring additional mesh points.
6. TYPICAL RUNNING TIME - Typical problem execution time is 5 to 15 minutes. The NESC executed the sample problem in less than 9 minutes on an IBM370/165.
7. UNUSUAL FEATURES OF THE PROGRAM - The sodium spray may consist of different drop sizes. A semi-empirical sodium drop burning model is based on recent sodium drop burning data.
8. RELATED AND AUXILIARY PROGRAMS - SOCOOL2 (NESC Abstract 521) and SOFIRE2 (NESC Abstract 559).
9. STATUS - Abstract first distributed July 1978.
IBM370 version submitted October 1977, replaced by revised version June 1978, sample problem executed by NESC without the plotting option, June 1978 on an IBM370/165.
10. REFERENCES - M. P. Heisler and K. K. Mori, SOMIX-1 User's Manual, N707T130045, Rev. B, Atomic International Division, Rockwell International, June 1978.
ERDA-RRD Safety Analysis Branch, A Compendium of Computer Codes for the Safety Analysis of LMFBF's, ERDA-31, June 1975.
North American Rockwell Corporation, Engineer's Computing Manual S-C 4020 Excerpt, 18 pages, 11-11-68 and 2-2-72.
SOMIX-1 NESC No. R751.370, National Energy Software Center Note 78-32, June 30, 1978.
11. MACHINE REQUIREMENTS - The sample problem uses 556K bytes of memory, card reader and line printer (I/O devices 5 and 6), and the SC4020 for film plotting.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV H Extended
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/370.

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** The NESC provided dummy routines for the Stromberg-Carlson plotter routines: CAMRAV, DXDYV, FRAMEV, SETMIV, XSCALV, YSCALV, LABLV, LINEV, APRNTV, BRITEV, CHSIZV, GRID1V, PRINTV, RITE2V, SETMOV, NXV, NYV, and PLOTV. These routines should be replaced with alternatives for the environment in which the program is being executed to obtain graphical output.
The sample problem input has been packaged as two files. Use of the first permits execution without plotting; all plotting input information is in the second.
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
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Atoms International Division
Rockwell International
8900 DeSoto Avenue
Canoga Park, California 91304
16. **MATERIAL AVAILABLE - Restricted Distribution**
Magnetic Tape Transmittal
Source deck (2897 cards)
Sample problem (51 cards)
Sample problem output (1 microfiche)
Reference report, N707T1130045, Computing Manual S-C 4020 Excerpt, and NESC Note
17. **CATEGORY - G**
KEYWORDS - sodium, fires, convection, LMFBR reactors, SOFIRE2 codes, SOCOOL2 codes
18. **SPONSOR -** DOE Division of Reactor Research and Technology

1. NAME OR DESIGNATION OF PROGRAM - COROPT
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - Honeywell 6000
3. DESCRIPTION OF PROBLEM OR FUNCTION - COROPT was designed as a flexible system design tool. It is intended to address the question, "How should a core be designed to yield optimum performance given certain design constraints and limits." Simple models are used to describe the reactor nuclear, thermal-hydraulic, and mechanical performance as functions of independent design variables and operating conditions. The user specifies design constraints on the fuel, blanket, or control subassemblies which must be satisfied. An optimization algorithm is used to determine the set of independent core design and operating condition variables that yield the optimum user-specified performance index which can be cost, doubling time, or other parameters. The reactor core can be described by a set of mass, momentum, and energy conservation equations which determine the relation between independent core design variables and dependent operating and performance parameters.
4. METHOD OF SOLUTION - The program consists of five basic sections. The first section controls the program flow. The second section models the reactor nuclear, thermal-hydraulic, and mechanical characteristics. The third section determines various performance indices. The fourth section defines and compares parameter constraint limits. The fifth section is an optimization algorithm (modified SIMPLEX) that finds the set of independent variable values which yield the optimum reactor performance subject to user-imposed constraints.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - COROPT considers the core as composed of hexagonal rings of assemblies. Surrounding the core are radial blanket assemblies. Control assemblies are assumed to be placed symmetrically within the core. All assemblies are assumed to have identical pitch and outside flat-to-flat dimensions.
6. TYPICAL RUNNING TIME - Generally, convergence can be achieved in fewer than 30 to 40 SIMPLEX iterations.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - CANDOPT shows good agreement with detailed core design analysis programs such as FUMBLE (NESC Abstract 480), FULMIX, and PEFT over a broad range of core design and operating parameters.
9. STATUS - Abstract first distributed February 1978.
H6000 version submitted February 1977, revised May 1978.
10. REFERENCES - G. V. Neill and D. P. Johnson, COROPT: A Computer Program for Finding Optimum LMFBR Mixed-Oxide Fuel Cores, General Electric Company, GEFR-00006, January 1977.
11. MACHINE REQUIREMENTS - 35K words of memory are required.
12. PROGRAMMING LANGUAGE USED - FORTRAN
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Data are input to the COROPT program in NAMELIST format. Two system routines ERRSYS and LINRTN are not included in the COROPT package. ERRSYS is used to monitor system errors and LIMRTN to detect when a set time limit is exceeded. These will have to be dummied or replaced with alternative routines appropriate to the environment.
15. NAME AND ESTABLISHMENT OF AUTHORS -
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Fast Breeder Reactor Department

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- 16. MATERIAL AVAILABLE - Special Distribution**
 Magnetic Tape Transmittal
 Source decks (COROPT 3893 cards, CORCOM 52 cards)
 Sample problem (CORDAT 43 cards)
 Reference report
- 17. CATEGORY - D**
 KEYWORDS - LMFBR reactors, economics, nuclear fuels, reactor cores, optimization
- 18. SPONSOR - DOE Division of Reactor Research and Technology**

1. NAME OR DESIGNATION OF PROGRAM - OCOPTR, DRVOCR
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - OCOPTR and DRVOCR are computer programs designed to find minima of non-linear differentiable functions $f: R^n \rightarrow R$ with n dimensional domains. OCOPTR requires that the user only provide function values (i.e. it is a derivative-free routine). DRVOCR requires the user to supply both function and gradient information.
4. METHOD OF SOLUTION - OCOPTR and DRVOCR use the variable metric (or quasi-Newton) method of Davidon (1975). For OCOPTR, the derivatives are estimated by finite differences along a suitable set of linearly independent directions. For DRVOCR, the derivatives are user-supplied. Some features of the codes are the storage of the approximation to the inverse Hessian matrix in lower trapezoidal factored form and the use of an optimally-conditioned updating method. Linear equality constraints are permitted subject to the initial Hessian factor being chosen correctly.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The functions to which the routine is applied are assumed to be differentiable. The routine also requires $(n+2/2) + 0(n)$ storage locations where n is the problem dimension.
6. TYPICAL RUNNING TIME - Running time is problem-dependent. The NESC executed the sample problems in 6 CPU seconds for both programs on an IBM370/195.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed March 1978.
IBM370 version submitted November 1977, sample problems executed by NESC February 1978 on an IBM370/195.
10. REFERENCES - W. C. Davidon and L. Nazareth, OCOPTR - A Derivative Free Fortran Implementation of Davidon's Optimally Conditioned Method, Argonne National Laboratory, Applied Mathematics Division, TM-303, August 1977.
W. C. Davidon and L. Nazareth, DRVOCR - A Fortran Implementation of Davidon's Optimally Conditioned Method, Argonne National Laboratory, Applied Mathematics Division, TM-306, August 1977.
W. C. Davidon, Optimally Conditioned Optimization Algorithms without Line Searches, Mathematical Programming, Vol. 9, pp. 1-30, 1975.
11. MACHINE REQUIREMENTS - 50K of memory is required
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/MVT.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
J. L. Nazareth
Applied Mathematics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (OCOPTR 1274 cards, DRVOCR 1236 cards)
Sample problems (OCOPTR 130 cards, DRVOCR 134 cards)
Reference reports, TM-303 and TM-306

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17. CATEGORY - P

KEYWORDS - optimization, nonlinear problems, finite difference method

18. SPONSOR - DOE Division of Basic Energy Sciences

753.2

1. **NAME OR DESIGNATION OF PROGRAM** - DEMONR
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360/65
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - DEMONR treats the behavior of neutrons in a slab shield. It is frequently used as a teaching tool.
4. **METHOD OF SOLUTION** - An unbiased Monte Carlo code calculates the number, energy, and direction of neutrons that penetrate or are reflected from a shield.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Only one shield may be used in each problem. The shield material may be a single element or a homogeneous mixture of elements with a single effective atomic weight. Only elastic scattering and neutron capture processes are allowed. The source is a point located on one face of the slab. It provides a cosine distribution of current. Monoenergetic or fission spectrum neutrons may be selected.
6. **TYPICAL RUNNING TIME** - For 10,000 neutrons incident on a five centimeter slab of sodium, the CPU time is about 35 seconds. The NESC executed the sample problems in 100 CPU seconds on an IBM370/195.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The user may choose the number of energy groups and angular intervals for problem output. The cross-section detail is also selected by the user to be appropriate for the shield material.
8. **RELATED AND AUXILIARY PROGRAMS** - DEMONR is based on the DEMON demonstration Monte Carlo code described in reference 1.
9. **STATUS** - Abstract first distributed April 1978.
IBM360 version submitted October 1976, sample problems executed by NESC March 1978 on an IBM370/195.
10. **REFERENCES** - N. M. Schaeffer, Reactor Shielding for Nuclear Engineers, TID-25951, 1973.
W. E. Selph, J. D. Marshall, and N. M. Schaeffer, Demonstration Monte Carlo Program, RRA-N7122 A, Revised June 15, 1972.
J. C. Courtney and D. S. Ambuehl, Fission Spectrum Calculations in Slab Geometries, Transactions of the American Nuclear Society, Vol. 21, p. 76, 1975.
Appendix B, MIRAN: A Machine Independent Package for Generating Uniform Random Numbers, SAI-72-590-LJ, Vol. II, 1972.
DEMONR, ACC No. 754.360, Argonne Code Center Note 78-20, DEMONR Input Data Requirements, May 10, 1978.
11. **MACHINE REQUIREMENTS** - A card reader, tape drives, line printer, and 60K of memory are required.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - HASP 3.1.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Because of the random number generator (RNG), the output will vary from installation to installation. For each problem the number of neutrons transmitted, reflected, and absorbed are given. To assure a correct running, the sum of the row (column) totals of the current per source neutron of all three of the above must equal the number of neutrons going into the shield. For the sample problem the number of neutrons going in was 1. The RNG routines RANDU, URAND, and RANSET may be replaced by more efficient routines designed for the particular system being used.
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
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Nuclear Science Center

Louisiana State University
Baton Rouge, Louisiana 70803

16. MATERIAL AVAILABLE -

- Source deck (558 cards)
- Sample problem (75 cards)
- Sample problem output (12 pages)
- Reference material, ANS Transactions abstract, Appendix B of SAI-72-590-LJ Vol. II, and
ACC Note

17. CATEGORY - J

KEYWORDS - Monte Carlo method, neutrons, point sources, slabs, shielding, slowing-down,
DEMON codes

18. SPONSOR - Louisiana State University

1. NAME OR DESIGNATION OF PROGRAM - VARR2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - VARR2 is a two-dimensional transient slightly-compressible fluid dynamics program. It solves the complete unsteady Navier-Stokes equation, the energy equation, and the continuity equation in either Cartesian or axisymmetric cylindrical geometry. Slight density variations are accounted for by use of the Boussinesq approximation, which couples the energy and momentum equations. At a cell face, the normal velocity component may be inward, outward, or zero; the tangential velocity component may specify free slip, no slip, or no slip with a turbulent velocity profile. For heat transfer problems, adiabatic or constant heat flux boundary conditions can be specified. By specifying the totality of cell-face boundary conditions in a self-consistent manner, the user can specify a wide spectrum of overall boundary conditions; for example, those called rigid, continuative, periodic, inflow/outflow, or derived.
4. METHOD OF SOLUTION - The governing differential equations are replaced by finite difference equations of explicit type and solved over a region of fixed rectangular cells by using the simplified marker and cell technique (SMAC) of Amsden and Harlow. The continuity equation is solved through a successive over-relaxation (SOR) iterative process on a Poisson equation for pressure.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - With current dimensioning, the maximum number of cells is about 1600; roughly a 40 x 40 mesh. The problem geometry must be reasonably approximated by a two-dimensional net of rectangular cells, either in Cartesian geometry or transformed from axisymmetric cylindrical geometry. Interior obstacles are allowed. The working fluid may be specified as either sodium or water if the built-in material property coefficients are used. Otherwise, the properties of the working fluid may be entered as part of the problem input.
6. TYPICAL RUNNING TIME - Generally, if the mass balance convergence criterion is modest, approximately one-tenth of one percent or greater, running time is less than 1 millisecond per mesh point per time step. The sample problem was executed in about 38 CP seconds.
7. UNUSUAL FEATURES OF THE PROGRAM - VARR2 is especially suited to the study of turbulent flows. The program solves the transport equations for the turbulence kinetic energy and the turbulence kinematic viscosity. These quantities are then coupled into the momentum and energy transport equations. The very high velocity gradients encountered in turbulent flows at rigid walls are represented by analytic functions to ensure that the correct wall shear stress will be predicted.
8. RELATED AND AUXILIARY PROGRAMS - SOLA, SOLA-SURF (NESC Abstract 651), and SOLA-ICE (NESC Abstract 723)
9. STATUS - Abstract first distributed June 1978.
CDC7600 version submitted August 1975, revised March 1977, sample problem executed by NESC March 1978.
10. REFERENCES - James L. Cook and Paul I. Nakayama, VARR II - A Computer Program for Calculating Turbulent Fluid Flows with Slight Density Variation, CRBRP-ARD-0106, Vols. 1, 2, and 3, November 1976. (WARD-D-0106 has identical contents.)
WARD Addendum, August 1975.
SD 4060 Stored Program Recording System, Programmer's Reference Manual for the Integrated Graphics Software System (I.G.S.), Vol. 2, October 1976.
Argonne Code Center Note 78-24, May 24, 1978.
11. MACHINE REQUIREMENTS - 147,000 (octal) words of SCM and 14,400 (octal) words of LCM storage are used. Plotting is done using SD-4060 Stored Program Recording System.
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and COMPASS

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 2.0, SCOPE 2.1.3.

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - It is assumed that the operating system will zero the memory before overlay generation and before each execution. To achieve a significant increase in the number of mesh points available, it probably will be necessary to place more arrays in LCM. Reference to LCM is by Level 2 declarations. The Integrated Graphics System plotting software is included with the program. The plotting software probably will not be useful unless a SD-4060 system is available.

15. NAME AND ESTABLISHMENT OF AUTHORS -

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Madison, Pennsylvania 15663

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (VARR2 FORTRAN-3150 cards, COMPASS-168 cards, IGS Plotting Package
FORTRAN-8791 cards, COMPASS-1479 cards)
Sample problem (50 cards)
Auxiliary programs (IGS test programs 2579 cards, W-ARD system routines 61 cards)
Control information (JCL 63 cards)
Sample problem output (43 selected pages, 1 microfiche)
Reference report, Addendum, Manual, and Note

17. CATEGORY - H

KEYWORDS - hydrodynamics, fluid flow, transients, turbulence, fuel assemblies, heat transfer, Navier-Stokes equation, turbulent flow, CRBR reactors, Boussinesq approximation, finite difference method, two-dimensional, cylinders

18. SPONSOR - DOE Office of Nuclear Energy Programs

1. **NAME OR DESIGNATION OF PROGRAM - TIMEX**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360,370, CDC7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** TIMEX solves the time-dependent, one-dimensional multigroup transport equation with delayed neutrons in plane, cylindrical, spherical, and two-angle plane geometries. Both regular and adjoint, inhomogeneous and homogeneous problems subject to vacuum, reflective, periodic, white, albedo or inhomogeneous boundary flux conditions are solved. General anisotropic scattering is allowed and anisotropic inhomogeneous sources are permitted.
4. **METHOD OF SOLUTION -** The discrete ordinates approximation for the angular variable is used with the diamond (central) difference approximation for the angular extrapolation in curved geometries. A linear discontinuous finite element representation for the angular flux in each spatial mesh cell is used. Negative fluxes are eliminated by a local set-to-zero and correct algorithm. The time variable is differenced by an explicit technique that is unconditionally stable so that arbitrarily large time-steps can be taken. Two acceleration methods, exponential extrapolation and rebalance, are utilized to improve the accuracy of the time differencing scheme.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Variable dimensioning is used so that any combination of problem parameters leading to a container array less than MAXCOR can be accommodated. In addition, the CDC version permits the use of extended core storage less than MAXECS.
6. **TYPICAL RUNNING TIME -** The running time for TIMEX is highly problem-dependent, but varies almost linearly with the total number of unknowns and time-steps. A 16-group, 30-interval mesh, S2, 6 delayed neutron group calculation of the decay of a point burst in a Pu-Be sphere requires about 14 minutes on the IBM370/195 or 4 minutes on the CDC7600 for 200 time-steps.
7. **UNUSUAL FEATURES OF THE PROGRAM -** Provision is made for creation of standard interface output files for angular fluxes and angle-integrated fluxes. Standard interface input files for SN constants, inhomogeneous sources, cross sections, and initial angular fluxes may be read. A special angular flux file is available to provide exact initial conditions.
8. **RELATED AND AUXILIARY PROGRAMS -** The ONETRAN program may be utilized to provide compatible initial conditions to TIMEX. The ANISN FIDO format may be utilized to provide compatible input cross section data.
9. **STATUS -** Abstract first distributed July 1978.
IBM360 version submitted January 1976, sample problems executed by NESC June 1978 on an IBM370/165 and IBM370/195.
CDC7600 version submitted January 1976, sample problem executed by NESC July 1978 on a CDC7600.
10. **REFERENCES -** T. R. Hill and Wm. H. Reed, TIMEX: A Time-Dependent Explicit Discrete Ordinates Program for the Solution of Multigroup Transport Equations with Delayed Neutrons, LA-6201-MS, February 1976.
T. R. Hill, ONETRAN: A Discrete Ordinates Finite Element Code for the Solution of the One-dimensional Multigroup Transport Equation, LA-5990-MS, June 1975.
B. M. Carmichael, Standard Interface Files and Procedures for Reactor Physics Codes, Version III, LA-5486-MS, February 1974.
W. W. Engle, Jr., A User's Guide Manual for ANISN, A One-dimensional Discrete Ordinates Transport Code with Anisotropic Scattering, K-1693, March 1967.
R. M. Frank, J506A Basic SC4020 Film Display Subroutines, LASL Program Library Description, 1967.
A. Solem, J506B Utility Film Subroutines, LASL Program Library Description, November 19, 1976.
T. R. Hill, TIMEX Test Problem Set, LASL TIMEX Memorandum, January 1976.

11. **MACHINE REQUIREMENTS** - Use of a container array of 50,000 requires 500K bytes of IBM storage for execution. Five interface units may be required (use is optional), 2 system input/output units and 5 output units are required for the IBM version. Use of a container array of 16,000 and 16,000 words of ECS requires 164K total words of CDC storage for execution. Two system input/output units and 11 additional input/output files are defined in the CDC version.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360,370 (IBM360,370), SCOPE 2.1.3 (CDC7600).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The frequency factors calculated in the exponential extrapolation are extremely sensitive to the machine precision and LOGF subroutine. When the frequencies are small, this may result in significant differences from the results given in the test problem execution of the TIMEX transmittal package. In addition, two LASL specific subroutines DATE1 and SECOND have been supplied as dummy routines. DATE1 must be provided by the user to return the current date as an A8 word. SECOND provides the floating-point value of the current time in seconds and an alternate local routine is required in order for the periodic and time limit options to work.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
T. R. Hill* and W. H. Reed
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P. O. Box 1663
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Contact
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (360-6114 cards, 7600-5788 cards)
Sample problems (TIMEX 616 cards, ONETRAN 71 cards)
Sample problems output (360-TIMEX 95 selected pages, ONETRAN 17 pages, 7600-TIMEX 87 selected pages, ONETRAN 19 pages)
Reference report, LA-6201-MS, LASL Program Library Descriptions, and TIMEX Memorandum
17. **CATEGORY** - F
KEYWORDS - time dependence, discrete ordinate method, one-dimensional, CCCQ, delayed neutrons, multigroup, anisotropic scattering, ONETRAN codes, ANISN codes
18. **SPONSOR** - ERDA Division of Reactor Research and Development

1. **NAME OR DESIGNATION OF PROGRAM** - GNASH
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - The preequilibrium, statistical nuclear model code GNASH calculates reaction and level cross sections, isomer ratios, and spectra (neutron, gamma-ray, and charged-particle) resulting from particle-induced reactions using the Hauser-Feshbach formalism along with simple preequilibrium corrections. Gamma-ray competition is considered in detail for every decaying compound nucleus.
4. **METHOD OF SOLUTION** - Multistep particle-induced reactions are computed through a series of populations and depopulations of compound nuclei involved in a specified decay chain.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The program can handle the decay of up to 10 compound nuclei, each emitting 6 types of radiation. For each nucleus, up to 200 energy bins and 50 discrete levels can be used. A maximum spin of 20 is allowed.
6. **TYPICAL RUNNING TIME** - Running times are strongly dependent on the number of decays allowed and especially the size of the integration step. For 14 MeV neutrons on Co59, allowing the decay of 4 compound nuclei involving a total of 12 decay reactions with a step-size of 0.5 MeV, running time is 20 seconds of CPU time. The NESC executed the sample problem in 13 CPU seconds on a CDC7600.
7. **UNUSUAL FEATURES OF THE PROGRAM** - GNASH computes spectra (particle and gamma-ray), reaction and activation cross sections, and cross sections for production of discrete gamma-rays. The program can handle decay sequences involving up to 60 nuclei in one computation.
8. **RELATED AND AUXILIARY PROGRAMS** - For production of transmission coefficients, the COMNUC program (NESC Abstract 482) can be used.
9. **STATUS** - Abstract first distributed April 1978.
CDC7600 version submitted August 1977, replaced February 1979 by revised Edition B submitted January 1979, sample problem executed by NESC February 1979 on a CDC7600.
10. **REFERENCES** - P. G. Young and E. D. Arthur, GNASH: A Preequilibrium Statistical Nuclear Model Code for Calculation of Cross Sections and Emission Spectra, LA-6974, November 1977.
11. **MACHINE REQUIREMENTS** - 49K words of small core memory (SCM) and at least 80K words of large core memory (LCM) for problems of reasonable size. The sample problem uses 134K of SCM and 140K of LCM.
12. **PROGRAMMING LANGUAGES USED** - FORTRAN and COMPASS
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The values of NJDIM, NEEDIM, NLDIM, NLEVDIM should be left fixed at values of 40, 25, 30, and 50, respectively. The variable NKDIM can be changed, and probably is the most useful method of reducing LCM usage.
COMPASS routines, ECRD and ECWR, are included to transfer variables between SCM and LCM. These routines take the place of LASL's system routines ECRD and ECWR.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
P. G. Young and E. D. Arthur
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87545
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (GNASH 2733 cards, COMPASS routines 62 cards)

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Sample problem (877 cards)
Library (GROUND2 609 cards)
Reference report

- 17. CATEGORY - A**
KEYWORDS - Hauser-Feshbach theory, cross sections, emission spectra, compound nuclei, statistical models
- 18. SPONSOR -** DOE Division of Physical Research

1. **NAME OR DESIGNATION OF PROGRAM** - COREL/RASE4/DAMG2
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC6600,7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - COREL calculates the final average projected range, standard deviation in projected range, standard deviation in locations transverse to projected range, and average range along path for energetic atomic projectiles incident on amorphous targets or crystalline targets oriented such that the projectiles are not incident along low index crystallographic axes or planes.
RASE4 calculates the instantaneous average projected range, standard deviation in projected range, standard deviation in locations transverse to projected range, and average range along path for energetic atomic projectiles incident on amorphous targets or crystalline targets oriented such that the projectiles are not incident along low index crystallographic axes or planes. RASE4 also calculates the instantaneous rate at which the projectile is depositing energy into atomic processes (damage) and into electronic processes (electronic excitation), the average range of target atom recoils projected onto the direction of motion of the projectiles, and the standard deviation in the recoil projected range.
DAMG2 calculates the distribution in depth of the energy deposited into atomic processes (damage), electronic processes (electronic excitation), or other energy-dependent quality produced by energetic atomic projectiles incident on amorphous targets or crystalline targets oriented such that the projectiles are not incident along low index crystallographic axes or planes.
4. **METHOD OF SOLUTION** - COREL: The truncated differential equation which governs the several variables being sought is solved through second-order by trapezoidal integration. The energy-dependent coefficients in the equation are obtained by rectangular integration over the Thomas-Fermi elastic scattering cross section.
RASE4: The truncated differential equation which governs the range and straggling variables is solved through second-order by trapezoidal integration. The energy-dependent coefficients in the equation, the energy deposition rates, and the recoil range and straggling variables are obtained by rectangular integration over the Thomas-Fermi elastic scattering cross section.
DAMG2: The integral which governs the depth distribution of interest is evaluated by rectangular integration. Energy redistribution by the recoiling target atoms is included in a Gaussian approximation.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - COREL and RASE4: Compound targets with up to four different atomic constituents may be considered. The maximum incident energy which may be used is 800 times the Lindhard characteristic energy, a quantity which depends on the mass and atomic number of the incident projectile and the target atoms. Maximum incident energy can be increased by increasing storage area available for the program, and increasing the dimensions of the energy-dependent arrays.
6. **TYPICAL RUNNING TIME** - For a given incident energy the programs run longer for lighter projectiles. Average running time for COREL is 30 seconds for 200 equally-spaced incident energies. Average running time for RASE4 for 10 equally-spaced incident energies and 10 equally-spaced instantaneous energies is 180 seconds. Average running time for DAMG2 for 10 equally-spaced incident energies is 120 seconds. The NESC executed the sample problems for COREL, RASE4, and DAMG2 in 2, 6, and 4 CPU seconds respectively.
7. **UNUSUAL FEATURES OF THE PROGRAM** -
8. **RELATED AND AUXILIARY PROGRAMS** -
9. **STATUS** - Abstract first distributed May 1978.
CDC6600 version submitted February 1978, sample problems executed by NESC April 1978 on a CDC7600.

NESC ABSTRACT 758

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10. **REFERENCES** - D. K. Brice, Ion Implantation Range and Energy Deposition Codes COREL, RASE4, and DAMG2, SAND75-0622, July 1977.
11. **MACHINE REQUIREMENTS** - 134K words of memory are needed for COREL, 130K words are needed for RASE4, and 143K words of memory are needed for DAMG2. These regions may be reduced by decreasing the dimensions of certain arrays.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV. The programs, originally written for the FUN compiler, were translated by the NESC for compilation under FTN.
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Output from COREL is used as input to RASE4 (TAPE10), and output from RASE4 is used for input to DAMG2 (TAPE20). TAPE10 and TAPE20 must be rewound before running RASE4 and DAMG2, respectively.
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
D. K. Brice
Division 5112
Sandia Laboratories
Albuquerque, New Mexico 87115
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (COREL 681 cards, RASE4 1067 cards, DAMG2 694 cards)
Sample problems (COREL 10 cards, RASE4 16 cards, DAMG2 8 cards)
Reference report
17. **CATEGORY** - Q
KEYWORDS - ion implantation, radiation effects, scattering, slowing-down
18. **SPONSOR** - DOE Division of Military Application

1. NAME OR DESIGNATION OF PROGRAM - CORTES

2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
IBM360,370

3. DESCRIPTION OF PROBLEM OR FUNCTION - CORTES is a package consisting of five finite element programs developed for the stress analysis of ANSI B16.9 tee joints. The five programs are:

SA, the stress analysis program which analyzes pipe joints for the effects of internal pressure and arbitrary combinations of bending moment, torsional moment, axial force, and shear force on the ends of the branch and run pipes. A limited temperature stress analysis capability is provided.

EP, the elasto-plastic stress analysis program which analyzes pipe joints for the effects of internal pressure and arbitrary combinations of forces (including moments) and/or displacements (including rotations) imposed on the ends of the run and branch pipes.

THFA, the transient heat flow analysis program which determines the time history of temperature variations in the pipe joints. The joint is assumed initially to be at a uniform temperature. Temperature changes are then specified at the inner surface, and a heat flow analysis is performed assuming a perfectly insulated outer surface.

SHFA, the steady-state heat flow analysis program which determines the steady-state temperature distribution in pipe joints. Temperatures are specified on given cross-sections of the branch and run portions of the tee joint, and the temperature distribution throughout the remainder of the joint is calculated assuming the inner and outer surfaces are perfectly insulated.

TSA, accepts as input, the output data from THFA or SHFA and performs the thermal stress analysis on the pipe joints.

4. METHOD OF SOLUTION - The joint is idealized as a system of 8-node hexahedral finite elements. A modified Zienkiewicz-Irons isoparametric element which has superior bending properties compared with the unmodified isoparametric element is used. The transient heat flow (THFA) problem is solved by a step-by-step integration procedure assuming linear variation of temperature with time within a step.

5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -

EP - Displacements and strains are assumed to be small and no geometric (initial stress) stiffness effects are considered. The materials are assumed to yield according to the von Mises criterion, and tangent stress-strain relationships after yield are determined according to conventional flow rule procedures for strain hardening materials.

THFA - The specified temperature variations at the inner surface are assumed to be symmetrical about the x-y plane.

SHFA - The temperature distribution is assumed to be symmetric about the x-y plane.

SA and TSA - Any nodes introduced within the wall thickness are assumed to be uniformly spaced through the thickness.

6. TYPICAL RUNNING TIME - Execution time varies according to the data used. Excluding wait time, it took approximately 140, 190, 40, 30, and 120 seconds to compile and execute each of the five test problems on an IBM370/195. A large amount of wait time is attributable to numerous I/O operations and is inversely proportional to the size of the container array "A".

7. UNUSUAL FEATURES OF THE PROGRAM -

8. RELATED AND AUXILIARY PROGRAMS - The program GRFPAK (NESC Abstract 760) provides plotting support for the CORTES programs.

9. STATUS - Abstract first distributed June 1978.

IBM360 version submitted September 1975, revised edition submitted November 1977, replaced by revised Edition B November 1978, sample problems executed by NESC April 1978 on an IBM370/195.

10. **REFERENCES** - A. N. Gantayat and G. H. Powell, Stress Analysis of Tee Joints by the Finite Element Method, UC SESM 73-6 (ORNL-3193-1), February 1973.
 Graham H. Powell, Finite Element Analysis of Elasto-Plastic Tee Joints, UC SESM 74-14 (ORNL-SUB-3193-2), September 1974.
 R. E. Textor, User's Guide for SHFA: Steady-State Heat Flow Analysis of Tee Joints by the Finite Element Method, UCCND/CSD/INF-60, January 1976.
 B. R. Bass, J. W. Bryson, and S. E. Moore, Validation of the Finite Element Computer Program CORTES-SA for Analyzing Piping Tees and Pressure Vessel Nozzles, reprint from Joint Energy Technology Conference and Exhibition, Houston, Texas, September 18-22, 1977.
 NESC Note 78-28, CORTES NESC No. 759.360, July 11, 1978.
11. **MACHINE REQUIREMENTS** - All five programs use card input and a line printer. Execution of the SA test problem required 960K memory and 12 scratch disk units. The EP test problem required 920K memory and 11 scratch disk units. The THFA sample problem required 460K memory and 6 scratch disk units. The SHFA sample problem required 350K memory and 6 scratch disk units. The TSA test case used 880K memory and 11 scratch disk units.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Four environmental system routines, ITIME, DATE, ICTICK, and PLOT, used by CORTES were not supplied. Dummy routines have been included. ITIME and ICTICK return the elapsed wall time and elapsed CPU time, respectively, in hundredths of a second since the previous call to these routines. The first call initializes the routines. PLOT refers to proprietary CalComp software and DATE returns the date in the form MM/DD/YY.
 Since comment blocks exceeding 30 consecutive lines are truncated during a FORTRAN G compilation, the FORTRAN H compiler should be used to insure that all comments are listed for the EP, THFA, and SHFA programs.
 The output written to unit 10 by SHFA during execution of the sample problem is read as input from unit 10 for the TSA sample problem.
 It should be noted that some variables in common blocks /GASS/ and /NQUAD/ may not always be stored identically in all routines of a CORTES program.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
 A. N. Gantayat and G. H. Powell
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 R. E. Textor and B. R. Bass
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 Union Carbide Corporation, Nuclear Division
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 Oak Ridge, Tennessee 37830
 J. W. Bryson and S. E. Moore
 Engineering Technology Division
 Oak Ridge National Laboratory
 Oak Ridge, Tennessee 37830
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
 Source decks (SA 4298 cards, EP 6250 cards, THFA 3126 cards, SHFA 2967 cards, TSA 3599 cards)
 Sample problems (SA 10 cards, EP 38 cards, THFA 64 cards, SHFA 15 cards, TSA 6 cards)
 Control information (JCL SA 122 cards, EP 70 cards, THFA 41 cards, SHFA 42 cards, TSA 55 cards)
 Sample problems output (SA 12 selected pages, EP 25 selected pages, 2 microfiche, THFA 15 selected pages, 1 microfiche, SHFA 11 selected pages, TSA 17 selected pages, 1 microfiche)
 Reference report, Reprint, and NESC Note

NESC ABSTRACT 759

04/79

- 17. CATEGORY - I**
KEYWORDS - stress analysis, heat flow, thermal stresses, pipe joints, finite element method, GRFPAK codes
- 18. SPONSOR -** NRC Division of Reactor Safety Research

1. **NAME OR DESIGNATION OF PROGRAM - GRFPAK**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** GRFPAK is a graphics package written for the CORTES finite-element programs. It includes three plotting routines to assist in analyzing, interpreting, and presenting CORTES results. One plotting routine displays stresses or stress indices by means of contour curves drawn within either the outside or inside surface outline of a quarter section of the tee-joint. Using this routine, one can also obtain plots of the finite-element mesh as viewed from any point in space. A second plotting routine gives a stress versus distance plot along any specified line of nodes. A third routine displays cross-sectional views of the finite-element mesh for both the undeformed (original) and deformed configuration. The deformed configurations are drawn using an exaggerated scale specified by the user.
4. **METHOD OF SOLUTION -** All of the plotter software calls are channeled through one of the several multiple entries in subroutine PLTINT. The segment of GRFPAK designed for contour, mesh, and displacement plotting can produce the finite-element mesh for the original geometry and for each load case of the displaced geometry, and contour plots for any surface in any quadrant for any stress (or temperature). These contours may be displayed on the mesh or on the outline of the tee. The node line plot segment produces the plots of the longitudinal (along the node line) stresses and transverse (normal to the node line) stresses along the 0 degree node line (x-y plane) and 90 degree node line (y-z plane) for a given surface. The global (x, y, z) coordinates for the nodes along the 0 degree node line are given a -45 degree rotation to a new x'-y' coordinate system. The abscissa values in the plots represent x' along this line. For the 90 degree node line the abscissa values for the plots represent the y global coordinate values. For THFA, the temperature values along these node lines are plotted. If more than one time-step is being plotted for THFA or TSA, all of the time-steps will appear on one graph. The cross-section segment of GRFPAK produces plots of the x=0 and z=0 planes of the tee for SA and EP. The entire cross section or only a specified number of nodes along the axes from the control node may be represented.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Requests for plots relating to displacements are invalid for the CORTES programs TSA, THFA, and SHFA. The maximum value for the variable MTOT in the MAIN program is 22,000.
6. **TYPICAL RUNNING TIME -** Execution time is approximately 12 seconds for sample data which produces nine plots. The NESC executed the sample problem in 35 seconds on an IBM370/195.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -** GRFPAK reads and processes data from the CORTES finite-element programs (NESC Abstract 759).
9. **STATUS -** Abstract first distributed July 1978.
IBM360 version submitted August 1977, sample problem executed by NESC June 1978 on an IBM370/195.
10. **REFERENCES -** P. G. Fowler and J. W. Bryson, User's Manual for the CORTES Graphics Package GRFPAK, ORNL/NUREG/TM-127, August 1977.
11. **MACHINE REQUIREMENTS -** Card reader, tape unit, line printer, and CalComp plotting equipment are required. The amount of memory needed depends on the number of nodes and elements in the finite element idealization. The sample problem which consists of 675 elements required 290K bytes of memory.
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/360.

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The program was developed to produce plots on a 925/1036 CalComp plotter. The amount of memory used can be increased or decreased by changing the value of the variable MTOT and dimensioning the A array by MTOT in the MAIN program. GRFPAK requires as input two data sets generated by CORTES. The logical unit 12 data set contains the connectivity of the nodes, coordinates of the nodes, and the stress quantities (temperature quantities for THFA). Logical unit 16 contains the displacements at the nodes for each load case produced by SA and EP. Logical unit 13 is a temporary unit employed when cross section plots are requested. A dummy subroutine IDAY was provided by the NESC. The routine IDAY, which is an ORNL system routine, returns the current date in the form MM/DD/YY.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
P. G. Fowler and J. W. Bryson
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P. O. Box X
Oak Ridge, Tennessee 37830
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (3516 cards)
Sample problems (unit 5 data set-30 cards, unit 12 data set-131 blocks*, unit 16 data set-16 blocks*)
Control information (JCL 100 cards)
Sample problems output (12 pages and 8 plots)
Reference report
*RECFM=VBS,BLKSIZE=3156
17. **CATEGORY** - N
KEYWORDS - finite element method, pipes, stresses, computer graphics, CORTES codes
18. **SPONSOR** - NRC Office of Nuclear Regulatory Research

1. **NAME OR DESIGNATION OF PROGRAM** - PTA1
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM370/195
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - PTA1 (Pressure Transient Analysis) performs pressure-transient analysis of large piping networks. The program is particularly oriented toward the analysis of the effects of a sodium/water reaction on the intermediate heat-transport system of a liquid-metal-cooled fast breeder reactor, but may be applied to other pulse sources and piping systems. A variety of junction types are included, and complex piping networks can be treated. The effect of elastic-plastic deformation of piping on pulse propagation, pipe friction and nonlinear velocity terms are included in the formulation.
4. **METHOD OF SOLUTION** - PTA1 uses the one-dimensional method of characteristics applied to non-linear fluid-hammer analysis of pressure transients in large piping systems. Non-linear convective terms, pipe friction, fluid compressibility, and wave-speed dependence on pipe deformation are included in the formulation of the governing equations. Various types of junctions and fittings may be specified including closed ends, multibranching tees, surge tanks, sudden expansions and contractions, dummy junctions, acoustic-impedance discontinuities, nonreflecting far-end boundaries, and simple models for pumps and rupture disks.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Maxima of -
 - 100 pipes
 - 100 junctions
 - 100 nodes per pipe
 - 50 pressure-time input points
 - 10 surge tanks
 - 10 pumps
 - 10 rupture disks
 - 6 pipes connected at a tee

The standard assumptions underlying one-dimensional fluid-hammer analysis of pressure transients in piping systems include: a) the axial velocity is the only nonzero velocity component, b) the pressure and axial velocity are functions of axial position and time only, c) changes in fluid density are negligible compared to the density itself, and d) viscous losses in the fluid are neglected. In addition, assumptions in the pipe response model include: e) the pipe response is quasi-static, f) bending moments in the pipe wall are neglected, g) axial stresses and strains in the pipe are neglected, h) the pipe material is incompressible, and i) circumferential strains are small.
6. **TYPICAL RUNNING TIME** - PTA1 requires approximately 30 seconds to complete the sample problem on an IBM370/195.
7. **UNUSUAL FEATURES OF THE PROGRAM** - Some important features of PTA1 are: a) the effect of plastic deformation of a pipe is incorporated through a modified fluid wave speed, which varies with deformation history at each computational node in a plastically deforming pipe; b) different fluid and pipe materials can be used by changing selected subroutines; and c) pipe junctions, pipe-friction loss term and source pressure-time term can be readily substituted or modified by the user.
8. **RELATED AND AUXILIARY PROGRAMS** - Related codes include: WHAM6 (NESC Abstract 278), COMPARE (NESC Abstract 702), NAHAMMER (NESC Abstract 717), NATRAN2 (NESC Abstract 719), NATRANSIENT (NESC Abstract 718), and HAMOC (NESC Abstract 710).
9. **STATUS** - Abstract first distributed April 1978.
IBM370 version submitted January 1978, modified October 1978, sample problem executed by NESC October 1978 on an IBM370/195.
10. **REFERENCES** - C. K. Youngdahl and C. A. Kot, PTA-1: A Computer Program for Analysis of Pressure Transients in Hydraulic Networks, Including the Effect of Pipe Plasticity, ANL-76-64, November 1976.

C. K. Youngdahl, C. A. Kot, and R. A. Valentin, Experimental Validation of PTA-1 Computer Code for Pressure Transient Analysis Including the Effect of Pipe Plasticity, ANL-78-38, April 1978.

G. L. Fox, Jr. and D. D. Stepniewski, Pressure Wave Transmission in a Fluid Contained in a Plastically Deforming Pipe, Transactions of the American Society of Mechanical Engineers, Vol. 96, No. 4, pp. 258-262, November 1974.

Y. W. Shin and W. L. Chen, Numerical Fluid-Hammer Analysis by the Method of Characteristics in Complex Piping Networks, Nuclear Engineering Design, Vol. 33, pp. 357-369, 1975.

C. K. Youngdahl and C. A. Kot, Effect of Plastic Deformation of Piping on Fluid-Transient Propagation, Nuclear Engineering Design, Vol. 35, pp. 315-325, 1975.

11. **MACHINE REQUIREMENTS** - The program requires 300K bytes of memory for execution.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/370.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** -
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
C. K. Youngdahl and C. A. Kot
Components Technology Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. **MATERIAL AVAILABLE** - Restricted Distribution
Magnetic Tape Transmittal
Source deck (1548 cards)
Sample problem (13 cards)
Sample problem output (42 pages)
Reference report, ANL-76-64
17. **CATEGORY** - G
KEYWORDS - pressure gradients, hydraulics, LMFBR reactors, deformation, pipes, plasticity, molten metal-water reactions, elasticity
18. **SPONSOR** - DOE Division of Reactor Research and Technology

1. **NAME OR DESIGNATION OF PROGRAM** - CACECO
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC CYBER74,7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - The CACECO program predicts the thermodynamic responses of primary and secondary containment to a variety of accidents in a Liquid Metal Fast Breeder Reactor (LMFBR) facility. The user defines these accidents in terms of the following: (a) sodium leakage as spray and spill, (b) air injection, (c) decay heat release, and (d) space cooler operation. CACECO is capable of providing pressure-temperature histories of four cells. Each cell may have connected to it any number of one-dimensional structures which can be used to model walls, floors, or equipment. The structures are linked to the cells or other structures by convective and/or radiative boundary conditions. The structures may be planar, cylindrical, or spherical and can be composed of a number of regions with different properties.
4. **METHOD OF SOLUTION** - The Euler method is used to integrate the differential equations for mass and energy in each analysis cell.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Maxima of -
25 temperature nodes in each heat structure
24 heat structures to represent equipment, roofs, walls, and
floors of the analysis cells
4 analysis cells
6. **TYPICAL RUNNING TIME** - Running time is proportional to the number of analysis cells and total number of temperature nodes in the heat structures. User Guide Example 2 had 4 analysis cells and 15 heat structures with a total of 247 temperature nodes. This case took 11,900 time steps at the rate of 2950 steps per CDC7600 computer minute to complete a 173.6 hour scenario in approximately 4 minutes. Seven restarts were used.
7. **UNUSUAL FEATURES OF THE PROGRAM** - CACECO includes chemical reactions, carbon dioxide and water vapor releases upon heating of concrete, decay heat, atmosphere leakages, sodium transfers between cells, sodium and water boiling and condensation, accommodating the complex phenomena of LMFBR accident scenarios. Almost all input data can be revised upon restart and the usual case should be run as a sequence of restarts to provide user interaction with the program.
8. **RELATED AND AUXILIARY PROGRAMS** - CACECO is an offspring of the CONTEMPT code (NESC Abstract 433). Program CCLST produces a one-page summary of CACECO results.
9. **STATUS** - Abstract first distributed June 1978.
CDC CYBER74 version submitted June 1977, sample problem executed by NESC May 1978 on a CDC7600.
10. **REFERENCES** - R. D. Peak, Users Guide to CACECO Containment Analysis Code, HEDL-TC-859, June 1977.
R. D. Peak, D. E. Simpson, and D. D. Stepnewski, Response of Liquid Metal Fast Breeder Reactor Containment to a Hypothetical Core Meltdown Accident, Nuclear Engineering and Design, Vol. 42, pp. 169-180, 1977.
L. C. Richardson, L. J. Finnegan, R. J. Wagner, and J. M. Waage, CONTEMPT, A Computer Program for Predicting the Containment Pressure-Temperature Response to a Loss-of-Coolant Accident, IDO-17220, June 1967.
11. **MACHINE REQUIREMENTS** - 120K words (octal) of memory, a tape drive, card reader and line printer are used.
12. **PROGRAMMING LANGUAGE USED** - CDC FORTRAN Extended with only a few statements that do not comply with the American National Standards Institute (ANSI) FORTRAN.
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 3.4.4 Level 414.

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** Eleven subroutines and functions are machine or system-dependent and must be checked during conversion of the code to another installation. Of these, only CVIRDP and FPICK are so important that they must be converted. The others can be eliminated. Both programs, CACECO and CCLST, assume that the system has preset the memory to zero. When program CCLST is used to produce a summary, file PTape must be rewound before execution.
15. **NAME AND ESTABLISHMENT OF AUTHOR -**
R. D. Peak
Hanford Engineering Development Laboratory
Westinghouse Hanford Company
P. O. Box 1970
Richland, Washington 99352
16. **MATERIAL AVAILABLE - Restricted Distribution**
Magnetic Tape Transmittal
Source decks (FORTRAN-CACECO 9384 cards, CCLST 563 cards, UPDATE-CACECO 7895 cards, CCLST 586 cards)
Sample problems (CACECO 556 cards, CCLST 6 cards)
Sample problems output (CACECO 57 selected pages and 1 microfiche, CCLST 2 pages)
Reference report, HEDL-TC-859, and Reprint
17. **CATEGORY - G**
KEYWORDS - containment, heat transfer, sodium, chemical reactions, thermodynamics, LMFBR reactors, leaks, accidents
18. **SPONSOR - DOE Division of Reactor Research and Technology**

1. NAME OR DESIGNATION OF PROGRAM - REFLUX
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - REFLUX calculates the temperature-time history of a representative fuel rod during the reflood stage of a hypothetical loss-of-coolant accident (LOCA). The logic used for selection of the appropriate flow regime for analysis of the cladding temperature transient is based on the axial position with regard to the continuous liquid level (based on a mass balance), a liquid carry-over criterion (derived from a force balance on a drop suspended in a vapor stream), and the local cladding surface temperature. A generalized boiling curve is constructed, and the local flow and clad conditions determine the applicable heat transfer coefficient.
4. METHOD OF SOLUTION - The coolant thermal-hydraulic calculation of REFLUX is based on a single subchannel, one-dimensional, separated two-phase flow formulation solution of the conservation equations of mass, energy, and momentum. The equations to be solved are written in backward finite-difference form, in space and time. A marching solution from subchannel inlet to exit is performed at each time-step. The code uses the fuel-clad temperature field from the preceding time-step to advance the coolant thermal-hydraulic solution to the present time-step. The void fraction in the flow boiling regimes is defined by the drift flux model. Provision is made for analyzing non-equilibrium situations encountered under reflood conditions, and a complete two-step dispersed flow film boiling model is included. The coupled fuel-clad temperature field is solved by an implicit finite difference technique for radial conduction, including decay heat generation and temperature-dependent material properties.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - REFLUX is expected to provide reasonable results for flooding rates of 0.4 to 10 in/sec, pressures of 15 to 60 psia, peak powers of 0.5 to 1.5 kw/ft, inlet coolant temperatures of 50 degrees F to saturation, and initial temperatures of 250 to 2000 degrees F. Flow reversals cannot be analyzed with the present version.
6. TYPICAL RUNNING TIME - The NESC executed the sample problem in 62 seconds on an IBM370/165.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed July 1978.
IBM360 version submitted February 1978, sample problem executed by NESC June 1978 on an IBM370/165.
10. REFERENCES - Walter Lee Kirchner, Reflood Heat Transfer in a Light Water Reactor, NUREG-0106, Vols. I and II, August 1976.
11. MACHINE REQUIREMENTS - Tape unit, line printer, and 100K bytes of memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The REFLUX program should be compiled with the H-extended or the G1 compiler to duplicate the author's results. Compiling under the H or G compiler leads to differences in conversion of the input data which produces variations in the output.
15. NAME AND ESTABLISHMENT OF AUTHOR -
W. L. Kirchner, MS-603
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87545

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- 16. MATERIAL AVAILABLE -** Magnetic Tape Transmittal
Source deck (1621 cards)
Sample problem (47 cards)
Sample problem output (30 selected pages)
Reference report

- 17. CATEGORY -** H
KEYWORDS - coolants, cladding, LOCA, heat transfer, core flooding systems, fuel rods, LWR reactors

- 18. SPONSOR -** NRC Division of Reactor Safety Research

1. NAME OR DESIGNATION OF PROGRAM - SOERP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370, CDC7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - SOERP computes second-order error propagation equations for the first four moments of a function of independently distributed random variables. SOERP was written for a rigorous second-order error propagation of any function which may be expanded in a multivariable Taylor series, the input variables being independently distributed. The required input consists of numbers directly related to the partial derivatives of the function, evaluated at the nominal values of the input variables and the central moments of the input variables from the second through the eighth.
4. METHOD OF SOLUTION - The development of equations for computing the propagation of errors begins by expressing the function of random variables in a multivariable Taylor series expansion. The Taylor series expansion is then truncated, and statistical operations are applied to the series in order to obtain equations for the moments (about the origin) of the distribution of the computed value. If the Taylor series is truncated after powers of two, the procedure produces second-order error propagation equations.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The maximum number of component variables allowed is 30. The IBM version will only process one set of input data per run.
6. TYPICAL RUNNING TIME - NESC executed the sample problems of the IBM version in 15 CPU seconds on an IBM370/165. The sample problems of the CDC version were executed in 3 CP seconds on a CDC7600.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed July 1978.
CDC7600 version submitted April 1978, sample problem executed by NESC June 1978 on a CDC7600.
IBM360 version submitted April 1978, replaced by revised version submitted May 1978, sample problem executed by NESC June 1978 on an IBM370/165.
10. REFERENCES - N. D. Cox and C. F. Miller, User's Description of Second-Order Error Propagation (SOERP) Computer Code for Statistically Independent Variables, TREE-1216, February 1978.
NESC Note 78-27, SOERP NESC No. 764.7600, June 5, 1978.
11. MACHINE REQUIREMENTS - A card reader, tape unit, line printer, and 80K bytes of storage are required for the IBM version; 14,000 (octal) words of SCM are required for the CDC version.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360,370 (IBM360,370) and SCOPE (CDC7600).
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - 300K bytes were required for NESC compilation and execution of the IBM version on the Model 165.
15. NAME AND ESTABLISHMENT OF AUTHORS -
N. D. Cox and C. F. Miller
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401
16. MATERIAL AVAILABLE -
Source decks (360-496 cards, 7600-553 cards)
Sample problems (360-54 cards, 7600-66 cards)

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Sample problems output (360-8 pages, 7600-14 pages)
Reference report and NESC Note, when applicable

17. **CATEGORY** - P
KEYWORDS - errors, series expansion, statistics
18. **SPONSOR** - EG&G Idaho, Inc.

1. NAME OR DESIGNATION OF PROGRAM - ZONE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - The ZONE program is a finite element mesh generator which produces the nodes and element description of any two-dimensional geometry. The geometry is divided into a mesh of quadrilateral and triangular zones defined by node points taken in a counter-clockwise sequence. The zones are arranged sequentially in an ordered march through the geometry. The order can be chosen so that the minimum bandwidth is obtained. The mesh that is generated can be used as input to any two-dimensional as well as any axisymmetrical structure program.
4. METHOD OF SOLUTION - The basic concept used is the definition of a two-dimensional structure by the intersection of two sets of lines which describe the geometric and material boundaries. A set of lines called meridians define the geometric and material boundaries and generally run in the same direction. Another set of linear line segments called rays which intersect the meridians are also defined at the material and geometric boundaries. The section of the structure between successive rays is called a region. The ray segment between any two consecutive ray-meridian intersections or void area in the structure is called a layer and is described as passing through, or bounding a material. The boundaries can be directly defined as a sequence of straight line segments or can be computed in terms of elliptic segments or circular arcs. A meridian or ray can also be made to follow a previously-defined meridian or ray at a fixed distance by invoking an offset option.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The following are limited only by a DIMENSION statement. The code currently has a maxima of -
100 coordinate points defining a meridian or ray
40 meridians
40 layers
There are no limits on the number of zones or nodes for any problems.
6. TYPICAL RUNNING TIME - The sample problems took less than one minute to execute.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The output from ZONE serves as the input file to NAOS, HONDO (NESC Abstract 672), and other axisymmetric finite element programs. The PLOT program is a postprocessor for ZONE used to generate the graphical display of the geometry for LLL TV Monitor Display System viewing on hard copy.
9. STATUS - Abstract first distributed June 1978.
CDC7600 version submitted June 1976, replaced by revised edition January 1978,
sample problem executed by NESC May 1978.
10. REFERENCES - Michael J. Burger, ZONE - A Finite Element Mesh Generator, UCID-17139, May 1976.
11. MACHINE REQUIREMENTS - 8 output and scratch files are used.
12. PROGRAMMING LANGUAGE USED - FORTRAN
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The program assumes that the system clears the memory to zero prior to problem execution. Dummy routines are included in the package in place of LLL system environment routines.
15. NAME AND ESTABLISHMENT OF AUTHOR -
M. J. Burger
Lawrence Livermore Laboratory

P. O. Box 808
Livermore, California 94550

16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (2692 cards)
Sample problems (173 cards)
Reference report
17. **CATEGORY** - N
KEYWORDS - finite element method, mesh generation, HONDO codes, NAOS codes
18. **SPONSOR** - Lawrence Livermore Laboratory

1. NAME OR DESIGNATION OF PROGRAM - FRANTIC-NRC
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM370
3. DESCRIPTION OF PROBLEM OR FUNCTION - FRANTIC-NRC was developed to investigate periodic testing schemes and operational and design modifications as they affect system unavailabilities and accident probabilities. The program calculates both the instantaneous and the average unavailability for any general system model and gives a breakdown of the unavailability contributions from failures, testing, and repair. Non-repairable components, monitored components, and periodically-tested components are considered. Accident sequences, such as those constructed from event trees, can also be evaluated for their instantaneous and average probability behavior. The name FRANTIC is an acronym for Formal Reliability Analysis including Normal Testing, Inspection and Checking. The code represents one extension of the probabilistic methodology described in WASH-1400. Testing characteristics which can be input include the test interval, test duration time, repair time or allowed downtime, the test override capability, test efficiency, and associated human-caused failure probabilities. The output provides tables and plots of the system unavailability along with a breakdown of the unavailability contributions. Sensitivity studies can be performed.
4. METHOD OF SOLUTION - The exponential failure distribution is used to describe hardware failures. The constant component failure rates can be changed to investigate the effects of different hardware reliabilities. Periodic equations determine the testing and repair contributions. Human errors and common mode failures can be included by assigning an appropriate constant probability for the contributors.

Using the input component failure rates and test and repair characteristics, FRANTIC computes the component unavailabilities at a series of time points. At each time point, the corresponding system unavailability is computed by calling a user-supplied subroutine, SYSCOM, which defines the system unavailability in terms of the component values. The resulting time-dependent system unavailability function is output in the form of a table or graph.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - The sample problem was executed by the NESC in 10 CPU seconds on an IBM370/195.
7. UNUSUAL FEATURES OF THE PROGRAM - A unique feature of FRANTIC-NRC is the detailed, time-dependent modeling of periodic testing which includes the effects of test downtimes, test overrides, detection inefficiencies, and test-caused failures.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed July 1978.

IBM370 version submitted December 1977, sample problems executed by NESC May 1978 on an IBM370/195.
10. REFERENCES - W. E. Vesely and F. F. Goldberg, FRANTIC - A Computer Code for Time Dependent Unavailability Analysis, NUREG-0193, October 1977.

W. E. Vesely and F. F. Goldberg, Time Dependent Unavailability Analysis of Nuclear Safety Systems, Institute of Electrical and Electronic Engineers Transactions on Reliability, Vol. R-26, pp. 257-260, October 1977.

Reactor Safety Study - An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants, WASH-1400 (NUREG-75/014), October 1975.
11. MACHINE REQUIREMENTS - 140K bytes of memory are required for execution.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/370.

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - FRANTIC-NRC uses proprietary CalComp software and system-dependent routines to produce graphical output. Subroutines PLOTS, PLOT, SYMBOL, SCALE, AXIS, LINE, NUMBER, NEWPEN, MESSAG, GRID, and LOGRID were not included in the FRANTIC-NRC package as submitted. In testing the package at NESC an alternate GRID subroutine was supplied and use of MESSAG and LOGRID deleted by "commenting out". In FRANTIC, MESSAG is used to provide instructions to the CalComp operator on pen and paper usage. LOGRID provides grid markings for the logarithmic scale graphs. The package contains an alternative GRAPH subroutine to provide printer plots rather than CalComp plots. This GRAPH subroutine requires the NIH IPP plot package.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
W. E. Vesely and F. F. Goldberg
Office of Nuclear Regulatory Research
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (FRANTIC 1313 cards, GRID 32 cards)
Sample problems (215 cards)
Auxiliary routines (GRAPH 100 cards)
Control information (JCL 94 cards)
Sample problems output (49 selected pages)
Reference report, NUREG-0193
17. **CATEGORY** - G
KEYWORDS - reliability, availability, systems analysis, time dependence, engineered safety systems, testing
18. **SPONSOR** - NRC Office of Nuclear Regulatory Research

1. **NAME OR DESIGNATION OF PROGRAM** - BEACON/MOD2A
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - The BEACON series of programs is designed to perform a best estimate analysis of the flow of a mixture of air, water, and steam in a nuclear reactor containment system under loss-of-coolant accident conditions. The code can simulate two-component, two-phase fluid flow in complex geometries using a combination of two-dimensional, one-dimensional, and lumped-parameter representations for the various parts of the system. BEACON/MOD2A contains mass and heat transfer models for wall film and for wall conduction, and is suitable for the evaluation of short-term transients in PWR dry containment systems. The two-component (air and water), two-phase (vapor and liquid) capability permits simulation of complex nonequilibrium problems such as flashing, two-phase jets, and liquid deentrainment.
4. **METHOD OF SOLUTION** - Each phase is described by its own density, velocity, and temperature as determined by separate sets of mass, momentum, and energy equations. The two phases are coupled by exchange parameters which model the exchange of mass, momentum, and energy between the two phases. The two sets of field equations are solved with an Eulerian finite difference technique that implicitly treats the phase transitions and interphasic heat transfer in the pressure iteration. The implicit solution is accomplished iteratively without linearization and allows both phases to be compressible. The coupling between the two phases can be very loose as occurs with separated flow or very tight as with finely dispersed flow. Computations for single phase flow are also obtainable without special treatment.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The Eulerian computational equations have been modified for the variable nodalization of a mesh with the spatial dimensions of each cell stored in row-wide and column-wide arrays. Neither dimension should vary between adjacent cells by more than a factor of 2. The centers of adjacent cells must align either in the radial (abscissa) or vertical (ordinate) direction, and no mesh may have more than 50 interior cells in either direction. The coupling of the Eulerian regions must be on a cell-to-cell basis. Due to the array sizes in the code, a maximum of 20 Eulerian regions and 20 lumped-parameter regions are allowed per problem setup. The total number of cells (nodes) in all Eulerian regions is limited to 2184.
6. **TYPICAL RUNNING TIME** - Running time is highly-variable depending on problem complexity. NESC executed the 7 sample problems in 5 minutes on a CDC7600.
7. **UNUSUAL FEATURES OF THE PROGRAM** -
8. **RELATED AND AUXILIARY PROGRAMS** - The BEACON solution procedure is based on the solution scheme of K-FIX (NESC Abstract 727) developed at Los Alamos Scientific Laboratory. The program uses the INEL Environmental Library and INEL-IGS graphics software system for film plotting.
9. **STATUS** - Abstract first distributed August 1978.
CDC7600 version of BEACON/MOD2 submitted January 1978, replaced by BEACON/MOD2A submitted January 1979, revised March 1979, sample problems executed by NESC, without the plotting option, April 1979 on a CDC7600.
10. **REFERENCES** - Roy A. Wells, BEACON/MOD2A A Computer Program for Sub-compartment Analysis of Nuclear Reactor Containment--A User's Manual, CDAP-TR-051, March 1979.
INEL-IGS, Idaho National Engineering Laboratory, Integrated Graphics System Programming Guide, Aerojet Nuclear Company Computer Science Center, March 1976.
National Energy Software Center Note 79-48, BEACON/MOD2A Tape Description, NESC No. 767.7600, May 26, 1979.
W. C. Rivard and M. D. Torrey, K-FIX: A Computer Program for Transient Two-Dimensional, Two-Fluid Flow, LA-NUREG-6623, NRC-4, April 1977.

F. H. Harlow and A. A. Amsden, Numerical Calculation of Multiphase Fluid Flow, Journal of Computational Physics, Vol. 17, No. 19, (1975).

11. **MACHINE REQUIREMENTS** - 110,000 (octal) words of SCM and 46,100 (octal) words of LCM for the largest of the seven sample problems. LCM required is a function of the problem size (i.e., the number of nodes or computational cells) and is dynamically allocated by the BEACON code.
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV (98%) and COMPASS (2%)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 2.1.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - A few of the INEL environmental library and the IGS graphics routines are written in COMPASS; the remainder of the package is in FORTRAN.
NESC replaced subroutine JOBID, which at INEL reads the name from the job card, to allow users to bypass a fatal error. Subroutine JOBLOC in the IGS graphics library contains the same statement (MJ 740B) that caused the JOBID error but has not been changed because NESC did not test the plotting package.
The segmenting loader gives the message of unsatisfied externals where none apparently occur. This warning message does not affect the execution of the program.
One can choose the plotting option in all the sample problems except number 4 by changing NOPLOTS to PLOTS on card number 00150 in each problem set.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
C. R. Broadus, R. J. Doyle, S. W. James,
J. F. Lime, and M. Sahota
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (BEACON 35,151 cards, BEACON UPDATE 23,054 cards, INEL environmental library 19,013 cards, INEL environmental library UPDATE 12,990 cards, INEL-IGS graphics 9005 cards, INEL-IGS graphics UPDATE 9098 cards)
Sample problems (354 cards)
Control information (103 cards)
Sample problems output (75 selected pages, 3 microfiche)
Reference report, CDAP-TR-051, INEL Programming Guide, and Note
17. **CATEGORY** - G
KEYWORDS - fluid flow, two-dimensional, one-dimensional, transients, thermodynamics, containment systems, LOCA, CONTEMPT-LT codes, CONTEMPT4 codes, KFIX codes
18. **SPONSOR** - NRC Division of Reactor Safety Research

1. **NAME OR DESIGNATION OF PROGRAM** - BEHAVE-SST
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - BEHAVE-SST calculates the steady-state and overpower transient behavior of cladding, fuel, and voidage in oxide LMFBR fuel rods prior to cladding failure. Cylindrical symmetry is assumed throughout the program. The BEHAVE-SST program calculates the stress, strain, displacement, and temperature fields in the fuel and cladding. Processes simulated include: cracking of fuel, dilation of fuel and cladding due to irradiation effects and thermal expansion, fuel densification by both stress and diffusion-controlled processes, axial slippage or locking at the fuel-cladding interface, axial flow of fuel, and gas pressurization of the central molten fuel region. Cladding failure is predicted utilizing a life-fraction cumulative damage technique.
4. **METHOD OF SOLUTION** - The finite-element method is used in the cladding and outer fuel zones. Displacement compatibility is maintained axially as well as radially between adjacent elements in the same axial section, but radial displacement compatibility is not maintained between adjacent axial sections. Circular cylindrical ring elements with three degrees of freedom are used in the fuel and cladding. No relative shear deformation is permitted between ring elements, but a special shear element at the fuel-cladding interface permits relative slippage or produces friction-induced fuel pellet locking. An interior inviscid fuel zone interacts with the outer, structural fuel zone as a constant-displacement-rate boundary condition, or as a constant-pressure boundary condition, depending on problem conditions. Within the inviscid fuel region, axial relocation of fuel occurs under certain conditions. Swelling of fuel and cladding, and fission gas release, are represented by empirical models.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The program is dimensioned for a maximum grid structure as defined below:
 - (a) cladding divided radially into 10 rings,
 - (b) outer (structural) fuel zone divided radially into 10 rings,
 - (c) middle (nontransport) fuel region divided radially into 10 rings,
 - (d) inner (transport) fuel region divided radially into 10 rings (absent during transients),
 - (e) fuel and cladding divided axially into 5 sections.

The internal steady-state and transient temperature routines are limited to single-phase sodium flow.
6. **TYPICAL RUNNING TIME** - A steady-state problem employing the maximum grid structure in the fuel and cladding and 24 time-steps required 47 seconds of CDC7600 processor time, or approximately 2.0 seconds per time-step. A transient problem employing the same grid structure and 43 time-steps required 208 seconds of processor time, or approximately 4.8 seconds per time-step.
7. **UNUSUAL FEATURES OF THE PROGRAM** -
 - (a) Axially interactive effects are calculated.
 - (b) Cracks are represented as a continuum, producing zero stress normal to the crack plane. Cracking occurs under any tensile stress normal to two possible directions of cracking ((r, theta) and (r,z)) planes.
 - (c) Rapid closure of the fuel-cladding gap is assumed, permitted by immediate cracking of the fuel at the first application of power.
 - (d) Fuel is divided into two phenomenological zones, the inner zone being made up of two regions. Boundaries between the zones and regions are defined by time-temperature relations and move in space as a function of time. Crack closure is assumed in the inner zone.
 - (e) The nodal grid is redefined in the radial direction every

time-step by averaging conditions from the old grid. A fine grid is imposed in regions of rapidly-changing properties.

8. **RELATED AND AUXILIARY PROGRAMS** - Transient Heat Transfer program, version D and E (THTD, THTE). BEHAVE-SST is the fourth in the BEHAVE series of programs--BEHAVE1, BEHAVE2, BEHAVE3--modeling fuel rod performance. BEHAVE-SST is intended for use in confirming cladding loading and failure predictions made by the simpler models included in whole core accident analysis programs, such as SAS and MELT.
9. **STATUS** - Abstract first distributed July 1978.
CDC7600 version submitted August 1977, sample problems executed by NESC June 1978 on a CDC7600.
10. **REFERENCES** - R. R. Sherry and D. B. Atcheson, User's Manual for the BEHAVE-SST (Steady State and Transient) Fuel Rod Mechanics Program, GEFR-00001, February 1977.
D. B. Atcheson, R. R. Sherry, and K. J. Shimane, Cladding Failure in TREAT Overpower Experiments: A Mechanistic Interpretation and Its Implications for LMFBR Safety Analysis, Proceedings of the International Meeting on Fast Reactor Safety and Related Physics, CONF-761001, Vol. III, pp. 1679-1688, October 1976.
11. **MACHINE REQUIREMENTS** - 150K of small-core memory (SCM) is required. The program is overlaid extensively.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 2.1.3.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - An H6000 version used at GE-FBRD provides for temperature coupling to the THTD or THTE programs. The program produces slightly different results depending on the compiler used. MNF versions 4.3, 5.1, 5.12, and 5.20 and FTN 4.5 each produced slightly different output for the steady-state (SS) sample problem. The output included in the package is from the FTN run.
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
D. B. Atcheson
Advanced Reactor Systems Department
General Electric Company
310 Deguigne Drive
Sunnyvale, California 94086
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (FORTRAN-10,113 cards, UPDATE-7612 cards)
Sample problems (SS-28 cards, TRANSIENT-184 cards)
Sample problems output (SS-34 selected pages, 1 microfiche, TRANSIENT-22 selected pages, 4 microfiche)
Reference report, GEFR-00001
17. **CATEGORY** - H
KEYWORDS - finite element method, two-dimensional, fuel-cladding interaction, stresses, temperature distribution, fuel cans, swelling, thermal expansion, strains, fuel rods, heat transfer, reactor safety, LMFBR reactors, THTD codes, THTE codes
18. **SPONSOR** - ERDA Division of Reactor Development and Technology

1. **NAME OR DESIGNATION OF PROGRAM** - PCTEST
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - PCTEST performs principal component analysis on multivariate data with emphasis on methods which can be used to detect outlier data.
4. **METHOD OF SOLUTION** - Standard principal component analyses techniques are enhanced by using statistics to test the hypothesis that the error associated with each observation is zero.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Programming is done in single-precision; conversion to double-precision would not be difficult. Dynamic dimensioning is used to accommodate a large variety of data sets.
6. **TYPICAL RUNNING TIME** - Execution of most problems requires less than 30 seconds.
7. **UNUSUAL FEATURES OF THE PROGRAM** - PCTEST is especially useful for detecting outliers in multivariate data.
8. **RELATED AND AUXILIARY PROGRAMS** - The program is an extension of one routine of RECOG (reference 2) which performs principal component analysis.
9. **STATUS** - Abstract first distributed July 1978.
IBM360 version submitted April 1978, sample problem executed by NESC June 1978 on an IBM370/195.
10. **REFERENCES** - V. E. Kane, T. Baer, and C. L. Begovich, Principal Component Testing for Outliers, K/UR-7, July 1977.
L. A. Cox, Jr., R. H. Prichard, and C. F. Bender, RECOG: A Polyalgorithm for the Analysis of Generalized Data Sets. An Operator's Manual, UCID-16443 Rev. 1, April 9, 1975.
11. **MACHINE REQUIREMENTS** - 260K bytes plus array storage (total of approximately 265K bytes for 100 samples, 10 variables).
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360,370.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The proprietary International Mathematical and Statistical Libraries (IMSL) routines MDCH and MDFD and the Integrated Software Systems Corporation DISSPLA graphics system are used. MDCH and MDFD calculate the probability that a chi-squared or F random variable, respectively, is less than or equal to a given value.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
V. E. Kane
Uranium Resource Evaluation Project
Oak Ridge Gaseous Diffusion Plant
P. O. Box P
Oak Ridge, Tennessee 37830
C. L. Begovich
Nuclear Division
Union Carbide Corporation
P. O. Box X
Oak Ridge, Tennessee 37830
16. **MATERIAL AVAILABLE** -
Source deck (1092 cards)
Sample problem (272 cards)
Reference report, K/UR-7

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17. CATEGORY - P

KEYWORDS - multivariate analysis, data processing, statistics, pattern recognition, RECOG codes

**18. SPONSOR - DOE Office of Uranium Resources and Enrichment,
Raw Materials**

1. **NAME OR DESIGNATION OF PROGRAM** - GAPCON-THERMAL3
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC CYBER74, 6600, 7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - GAPCON-THERMAL3 calculates the thermal and mechanical behavior of the fuel and cladding in a nuclear fuel rod during normal operation for both steady-state and operational transients.
4. **METHOD OF SOLUTION** - The radial temperature profile is obtained by orthogonal collocation. Stresses and strains are determined by using chained iterative radial and axial finite element models. Fission gas release and gap conductance are calculated from empirical models. The solution iterates to convergence on the gap conductance for each axial node and subsequently on gas release rate for the fuel rod. Additional iterative loops handle plasticity, creep, and nonlinear structural effects due to gap closure.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Modeling is axisymmetric for the thermal and mechanical calculations. The current model does not compute the strain at pellet-pellet interfaces. As many as 17 variable-length axial regions can be modeled with no limitation on the number of fuel and cladding radial nodes. No more than 49 time-steps greater than or equal to 1- day duration are allowed.
6. **TYPICAL RUNNING TIME** - Three to 30 seconds per time-step are required on the CDC6600.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The finite element chained radial-axial-radial mechanics modeling yields a good approximation to total two-dimensional finite element calculation results without commensurate large computer storage and long running time. The program includes variable dimensions to limit storage to individual problem requirements. A restart tape and plot tape are produced by the main code as optional output.
8. **RELATED AND AUXILIARY PROGRAMS** - PLOT3 produces high quality off-line plots of GAPCON-THERMAL3 output. GAPCON-THERMAL3 incorporates the thermal calculations of GAPCON-THERMAL2 (NESC Abstract 618) with a more detailed nonlinear mechanical analysis to evaluate the interactive effects. Available output includes fuel and cladding stresses and strains in radial, hoop, and axial directions and fuel and cladding axial and radial displacements.
9. **STATUS** - Abstract first distributed December 1978.
CDC CYBER74 version submitted January 1978, sample problem executed by NESC June 1978 on a CDC7600.
10. **REFERENCES** - D. D. Lanning, C. L. Mohr, F. E. Panisko, and K. B. Stewart, Gapcon-Thermal-3 Code Description, PNL-2434, January 1978.
D. D. Lanning, F. E. Panisko, and C. L. Mohr, Verification of the GAPCON-THERMAL-3 Computer Code, PNL-2435, September 1978.
11. **MACHINE REQUIREMENTS** - About 220K of addressable storage is needed for execution of a typical problem.
12. **PROGRAMMING LANGUAGE USED** - CDC Extended FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 3.4 (CDC6600), NOS/BE and SCOPE 2.1 (CDC7600).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** -
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
D. D. Lanning, C. L. Mohr, F. E. Panisko,
and K. B. Stewart
Pacific Northwest Laboratories
Battelle
P. O. Box 999
Richland, Washington 99352

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (7631 cards)

Sample problem (94 cards)

Auxiliary routines (PLOT3 571 cards)

Reference report, PNL-2434

17. CATEGORY - 1

KEYWORDS - cladding, fuel rods, steady-state conditions, deformation, transients, stresses, finite element method, plasticity, creep, GAPCON-THERMAL2 codes, PLOT3 codes

18. SPONSOR - NRC Division of Systems Safety

1. **NAME OR DESIGNATION OF PROGRAM - TRUMP**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** TRUMP solves a general nonlinear parabolic partial differential equation describing flow in various kinds of potential fields, such as fields of temperature, pressure, or electricity and magnetism; simultaneously, it will solve two additional equations representing, in thermal problems, heat production by decomposition of two reactants having rate constants with a general Arrhenius temperature dependence. Steady-state and transient flow in one, two, or three dimensions are considered in geometrical configurations having simple or complex shapes and structures. Problem parameters may vary with spatial positions, time, or primary dependent variables—temperature, pressure, or field strength. Initial conditions may vary with spatial position; and among the criteria that may be specified for ending a problem are upper and lower limits on the size of the primary dependent variable, upper limits on the problem time or on the number of time-steps or on the computer time, and attainment of steady state.
4. **METHOD OF SOLUTION -** Solutions may be obtained by use of explicit- or implicit-difference equations, or by an optimized combination of both.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** The program currently provides for maxima of -
 - 40 materials
 - 5 reactants
 - 150 surface conditions
 - 20 boundary nodes
 - 16 entries per tabulated function (table-length)
6. **TYPICAL RUNNING TIME -** Running time is strongly dependent on the complexity of the problem. Calculation of all 16 sample problems required approximately 4 minutes on an IBM370/195. Execution time averages from 0.3 to 2 milliseconds per time-step for each nodal point and connection between nodal points.
7. **UNUSUAL FEATURES OF THE PROGRAM -** The package includes three materials property libraries, each of which contains the properties of approximately 1000 materials in the standard TRUMP input format. System units for the libraries are, respectively: centimeter-gram-second-calorie-degree C, meter-kilogram-second-joule-degree C, and meter-kilogram-second-joule-degree K.
8. **RELATED AND AUXILIARY PROGRAMS -** The FED mesh generation program may be used to generate finite difference zoning for TRUMP. The TRUMP/XB2 program processes the TRUMP thermal property data compilation. The original CDC LRLTRAN version of TRUMP was prepared by A. L. Edwards of Lawrence Livermore Laboratory, Livermore, California.
9. **STATUS -** Abstract first distributed August 1978.
CDC LRLTRAN version submitted 1973.
IBM360 version submitted August 1977, sample problems executed by NESC July 1978 on an IBM370/195.
10. **REFERENCES -** Arthur L. Edwards, TRUMP: A Computer Program for Transient and Steady-State Temperature Distributions in Multidimensional Systems, UCRL-14754 Rev. 3, September 1, 1972.
D. C. Elrod and W. D. Turner, Implementation of the TRUMP Computer Code on the IBM360 Operating System, UCCND Letter to R. H. Odegaard, NRC, with attachments, May 12, 1977.
A. L. Edwards, A Compilation of Thermal Property Data for Computer Heat-Conduction Calculations, UCRL-50589, February 24, 1969.
Dale A. Schauer, FED: A Computer Program to Generate Geometric Input for the Heat-Transfer Code TRUMP, UCRL-50816 Rev. 1, January 12, 1973.

11. MACHINE REQUIREMENTS - 400K bytes of storage
12. PROGRAMMING LANGUAGES USED - FORTRAN IV (95%) and BAL (5%)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 (IBM360), OS/370 (IBM370).
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The core restart feature, the time-sharing option, and the graphics capabilities were not implemented in the ORNL IBM360 version of TRUMP. During execution of the sample problems, several hundred "harmless" underflows occur in subroutines TALLY and FINK.
15. NAME AND ESTABLISHMENT OF AUTHORS -
360 D. C. Elrod and W. D. Turner
Nuclear Division
Union Carbide Corporation
P. O. Box P
Oak Ridge, Tennessee 37830

6600 A. L. Edwards
Lawrence Livermore Laboratory
P. O. Box 808
Livermore, California 94550
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (FORTRAN-4536 cards, BAL-288 cards)
Sample problem (574 cards)
Materials properties libraries (9015 cards)
Auxiliary information (materials index-1294 cards)
Control information (JCL-90 cards)
Sample problem output (printer-64 selected pages, 1 microfiche punch-1 page listing)
Reference reports, UCRL-14754 Rev. 3, UCRL-50589, and UCCND letter with attachments
17. CATEGORY - H
KEYWORDS - temperature distribution, three-dimensional, transients, steady-state conditions, heat transfer, partial differential equations, nonlinear problems, potential flow
18. SPONSOR - AEC
NRC Division of Safeguards, Fuel Cycle and Environmental Research

1. NAME OR DESIGNATION OF PROGRAM - FORTIO
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - FORTIO is a set of Assembly language subroutines which allow FORTRAN IV programs to use several OS/360-370 data management and supervisor macro instructions. In particular, the FORTRAN programmer has available BSAM, QSAM, and BPAM access methods; can open, close and position files; position at or point to a block within a file; create and modify DCB's; dynamically LOAD, LINK, CALL, or DELETE other modules; and dynamically obtain and free storage (GETMAIN, FREEMAIN, GETPOOL, FREEPOL, etc.).
4. METHOD OF SOLUTION - The FORTIO Assembly language subroutines provide an interface between FORTRAN programs and selected IBM360-370 Operating System (OS) Supervisor and Data Management input-output macros.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed August 1978.
IBM360 version submitted May 1977, sample problem executed by NESC May 1978 on an IBM370/195.
10. REFERENCES - L. Shalla, FORTIO--A FORTRAN I/O Interface, ANL-76-56, April 1976.
IBM Corporation, OS Data Management Macro Instructions, GC26-3794-1, June 1973.
IBM Corporation, IBM System/360 Operating System Supervisor Services and Macro Instructions, GC28-6646-7, September 1974.
11. MACHINE REQUIREMENTS - Less than 10K bytes of storage is required to load all of the FORTIO subroutines.
12. PROGRAMMING LANGUAGE USED - Basic Assembly Language
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 (IBM360) and OS/370, OS/VS1, OS/VS2 Release 1 (IBM370).
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - To use FORTIO effectively, the IBM360,370 programmer must be familiar with the OS Supervisor and Data Management macros. The FORTIO source files are in IEBUPDAT format.
15. NAME AND ESTABLISHMENT OF AUTHOR -
L. Shalla
Applied Mathematics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (Macros-261 cards, FORTIO-1984 cards)
3330 load module (24 blocks)
Sample problems (51 cards)
Control information (JCL 268 cards)
Sample problems output (2 pages)
Reference report, ANL-76-56

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- 17. CATEGORY - P**
KEYWORDS - data processing, operating systems, utility routines
- 18. SPONSOR -** Argonne National Laboratory

1. **NAME OR DESIGNATION OF PROGRAM** - PRPLOT
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM370/360
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - PRPLOT is a line printer graphics subroutine package that maintains compatibility with the CalComp incremental pen plotter software. Calls to PLOT, PLOTS, FACTOR, WHERE, SYMBOL, NUMBER, SCALE, LINE, and AXIS are supported and a dummy NEWPEN subroutine is included. When a large plot size is selected, the plot is generated in page-wide strips to be separated and assembled as the complete plot.
4. **METHOD OF SOLUTION** - PRPLOT is a set of FORTRAN subroutines that are implemented using efficient data structures to minimize memory requirements. The software converts the user-supplied data to a form suitable for printing as a graphical representation. The coordinate axes of the plot are defined such that the y-axis parallels the paper movement direction and the x-axis the print mechanism.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The allowable complexity of the plot is controlled by the size of a work array passed from the calling program. Symbols are generated using only vectors of 0, 90, 180, or 270 degrees, and axes are generated only at 0 or 90 degrees.
6. **TYPICAL RUNNING TIME** - The execution time required for generation of a plot varies with the plot complexity. On an IBM370/155 with a FORTRAN G level compilation sample problem 1 required approximately 4 seconds for execution, the hidden line plot executed in 14 seconds.
7. **UNUSUAL FEATURES OF THE PROGRAM** - Subroutine SYMBOL plots alpha symbols, numbers, and certain special symbols with either line printer characters or constructed symbols at any of the four angles of 0, 90, 180, or 270 degrees. Sample problem 2 is an example of hidden-line three-dimensional plotting.
8. **RELATED AND AUXILIARY PROGRAMS** -
9. **STATUS** - Abstract first distributed August 1978.
IBM370 version submitted September 1977, sample problems executed by NESC June 1978 on an IBM370/195.
10. **REFERENCES** - John R. Rumsey and Roger S. Walker, Line Printer Plotting, TX-11-0001, University of Texas at Arlington, August 1975.
Hugh Williamson, Hidden Line Plotting, Communications of the Association for Computing Machinery, Vol. 15, No. 2, pp. 100-103, February 1972.
11. **MACHINE REQUIREMENTS** - The PRPLOT subroutines require approximately 50K bytes of storage.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360 (IBM360), OS/370 (IBM370).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The user must provide the storage area required to maintain the graphical representation of the plot. This area requires approximately--(number of plot calls + 13) * (number of pages in plot)--integer*4 locations. If insufficient storage is provided the PLOT subroutine will calculate the required amount and provide this information to the user via an error message.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
R. S. Walker and J. Rumsey
Public Transportation Center
University of Texas at Arlington
Arlington, Texas 76019

- 16. MATERIAL AVAILABLE - Magnetic Tape Transmittal**
Source decks (5435 cards)
Sample problems (problem 1 driver-32 cards, problem 2 driver-602 cards, data-1 card)
Control information (JCL 114 cards)
Sample problems output (14 pages)
Reference report, TX-11-0001
- 17. CATEGORY - N**
KEYWORDS - computer graphics, utility routines, computer output devices
- 18. SPONSOR -** DOT Urban Mass Transportation Administration

1. NAME OR DESIGNATION OF PROGRAM - POLUTE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - POLUTE is a computer model designed to estimate the uptake of air pollutants by forests. The model utilizes submodels to describe atmospheric diffusion immediately above and within the canopy, and into the sink areas within or on the trees. The program implementing the model is general and can be used, with only minor changes, for any gaseous pollutant. The model provides an estimate describing the response of the vegetation-atmosphere system to the environment as related to three types of processes: atmospheric diffusion, diffusion near and inside the absorbing plant, and the physical and chemical processes at the sink on or within the plant.
4. METHOD OF SOLUTION - The Continuous System Modeling Program (CSMP) is used to obtain the solution of transport equations describing exchange of pollutant between the atmosphere and vegetation.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The limitations are the same as those of the CSMP software.
6. TYPICAL RUNNING TIME - Execution time ranges from 0.5 to 3.0 minutes.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed September 1978.
IBM360,370 version submitted June 1978, sample problem executed by NESC July 1978 on an IBM370/195.
10. REFERENCES - C. E. Murphy, Jr., J. R. Sinclair, and K. R. Knoerr, An Assessment of the Use of Forests as Sinks for Removal of Atmospheric Sulfur Dioxide, Journal of Environmental Quality, Vol. 6, No. 4, pp. 388-396, 1977.
T. R. Sinclair, K. R. Knoerr, and C. E. Murphy, Jr., Model for Estimating Air Pollutant Uptake by Forests: Calculations of Forest Absorption of Sulfur Dioxide from Disposed Sources, DP-MS-75-72, 1975.
T. R. Sinclair, K. R. Knoerr, and C. E. Murphy, Jr., Absorption of Airborne Pollutants by a Forest Canopy, I. Computer Modeling, DP-MS-76-17, 1976.
T. R. Sinclair, K. R. Knoerr, and C. E. Murphy, Jr., Absorption of Airborne Pollutants by a Forest Canopy, II. Sulfur Dioxide, DP-MS-76-28, 1976.
Continuous System Modeling Program III (CSMP III) Program Reference Manual, International Business Machines Corporation, White Plains, New York, 1975.
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - CSMP
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/370.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - POLUTE requires use of the CSMP III, IBM proprietary software, Program Product Number 5734-X50.
15. NAME AND ESTABLISHMENT OF AUTHORS -
C. E. Murphy, Jr.
Savannah River Laboratory
E. I. duPont de Nemours and Company
Aiken, South Carolina 29801
T. R. Sinclair
Agricultural Research Service, USDA NER
Cornell University
Ithaca, New York 14850

K. R. Knoerr
School of Forestry
Duke University
Durham, North Carolina 27701

16. MATERIAL AVAILABLE -

Source deck and sample input parameters (368 cards)
Sample problem output (34 pages)
Reference reports, DP-MS-76-17, DP-MS-76-28, and DP-MS-76-72

17. CATEGORY - R

KEYWORDS - air cleaning, air pollution, decontamination, diffusion, environment, foliar uptake, forests, gaseous wastes, plants, root absorption, surface air, sulfur dioxide

18. SPONSOR - DOE Division of Biomedical and Environmental Research

1. **NAME OR DESIGNATION OF PROGRAM** - HEMP
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - The HEMP code solves the conservation equations of two-dimensional elastic-plastic flow, in plane x-y coordinates or in cylindrical symmetry around the x-axis. Provisions for calculation of fixed boundaries, free surfaces, pistons, and boundary slide planes have been included, along with other special conditions.
4. **METHOD OF SOLUTION** - The solution is by the method of finite differences and uses the Lagrangian formulation. The materials within a physical system are divided into quadrilaterals bounded by J and K grid lines. A decoupling of grid lines is allowed along K-lines, and voids may open and close between K-lines.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The maximum number of J's in any K-line is 101. A problem of up to about 10,000 zones may be run.
6. **TYPICAL RUNNING TIME** - Basic HEMP calculation speed is about 5 points (or zones) per millisecond. The number of problem cycles necessary depends on the problem termination time and the time-step size. Typical problems run from a few minutes to several hours with time a function of zone size, material composition and activity in the zones.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The input system, described in the HEMP User's Manual is designed so that the least amount of data to describe a particular physical system need be supplied. However, provision is made for describing initial conditions (zonal or nodal) in great detail, if required.
8. **RELATED AND AUXILIARY PROGRAMS** -
9. **STATUS** - Abstract first distributed August 1978.
CDC7600 version submitted October 1976, sample problem executed by NESC July 1978 on a CDC7600.
10. **REFERENCES** - Mark L. Wilkins, Calculation of Elastic Plastic Flow, UCRL-7322, Rev. 1, January 24, 1969.
E. D. Giroux, HEMP User's Manual, UCRL-51079, Rev. 1, December 17, 1973.
11. **MACHINE REQUIREMENTS** - The HEMP main code fills the small core memory (SCM) with the code, working storage, library, and system routines. The large core memory (LCM) utilized is a function of problem size, the amount required is 527,270 (octal) words.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV, LLL CHAT compiler
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 2.1.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Memory must be precleared to zero. The program treats LCM as an input-output storage device. Data is accessed to and from LCM in K-line groups. The dimensions of variables in LCM numbered COMMON blocks must be adjusted for each problem.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
M. L. Wilkins and J. A. Levatin
Lawrence Livermore Laboratory
P. O. Box 808
Livermore, California 94550
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (14,240 cards)
Sample problem (29 cards)
Reference reports

17. CATEGORY - F

KEYWORDS - hydrodynamics, Navier-Stokes equation, two-dimensional, equations of state, finite difference method, Lagrange equations, elasticity, plasticity, fluid mechanics

18. SPONSOR - ERDA Division of Military Application

1. NAME OR DESIGNATION OF PROGRAM - COMPARE-MOD1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - COMPARE-MOD1 performs transient calculation of the thermodynamic conditions in zero velocity or stagnant volumes connected by flowing junctions with provision for mass and energy addition. Volume thermodynamics and junction flows are for homogeneous mixtures of: steam, two-phase water to its triple point, any three perfect gases, or combinations of the above. Critical vent flow can be arbitrarily based on either the Moody, homogeneous equilibrium model (HEM) or polytropic orifice relationship. Subcritical flow can be arbitrarily based on either the polytropic orifice or the one-dimensional, constant area, constant density momentum equation with inertia. A compressible density accounting is used in the one-dimensional momentum equation. The program was written to perform transient subcompartment analysis of nuclear power plants, including those with ice condensers.
4. METHOD OF SOLUTION - Volume thermodynamics and junction flows are determined independently in a quasi-static explicit manner. Mass and energy inflow or outflow accounting for each volume is done first for each time increment, assuming vent flows are constant. Thermodynamic equilibrium is assumed and state points determined. The resulting thermodynamic conditions are assumed constant and used to calculate the new vent flows between volumes for the next time interval.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The program currently provides for maxima of:
 - 100 volumes
 - 200 junctions
 - 5 mass and energy addition tables (blowdown sets)
 - 10 variable area doors
 - 500 heat sink nodal pointsWater temperature is restricted to the range 273.16-620 degrees K (32.018-656 degrees F).
6. TYPICAL RUNNING TIME - A two-volume, one-junction problem requires 0.002 second per time-step on the CDC7600. A representative problem is completed in 2 seconds.
7. UNUSUAL FEATURES OF THE PROGRAM - Ideal-like gas polytropic equations are used to calculate orifice flow, including losses. Two-phase water with air flow is calculated. Inertial effects, compressibility in the one-dimensional momentum equation, variable area doors, and heat sinks can be modeled.
8. RELATED AND AUXILIARY PROGRAMS - COMPARE-MOD1 is a later version of COMPARE (NESC Abstract 702), containing additional features.
9. STATUS - Abstract first distributed December 1978.
CDC7600 version submitted January 1978, sample problem executed by NESC June 1978 on a CDC7600.
10. REFERENCES - R. G. Gido, J. S. Gilbert, R. G. Lawton, and W. L. Jensen, COMPARE-MOD-1: A Code for the Transient Analysis of Volumes with Heat Sinks, Flowing Vents, and Doors, LA-7199-MS, March 1978.
R. G. Gido, R. G. Lawton, C. I. Grimes, and J. A. Kudrick, COMPARE: A Computer Program for the Transient Calculation of a System of Volumes Connected by Flowing Vents, LA-NUREG-6488-MS, September 1976.
11. MACHINE REQUIREMENTS - 61,000 (octal) words
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - LASL CROS operating system.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

16. NAME AND ESTABLISHMENT OF AUTHORS -

R. G. Gido, J. S. Gilbert, and R. G. Lawton
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87544
W. L. Jensen
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

18. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (2865 cards)
Sample problem (28 cards)
Reference report, LA-7199-MS

17. CATEGORY - H

KEYWORDS - reactor safety, containment systems, pressure gradients, transients, fluid flow, moment of inertia, thermodynamics, heat transfer, pressure, temperature, PWR reactors, COMPARE codes

18. SPONSOR - NRC Division of Systems Safety

1. **NAME OR DESIGNATION OF PROGRAM - PDEONE**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC7600,6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** PDEONE was developed as an interface to allow the software developed in the field of ordinary differential equations (ODEs) to be applied directly to the solution of partial differential equation problems. The original intent was to use PDEONE for solving coupled systems of nonlinear parabolic PDEs and this is reflected in the equations and conditions. However, the solution of other problems such as hyperbolic and elliptic PDEs may also be attempted. The equations are sufficiently general to include PDEs for which solutions may neither exist nor be unique. It is the user's responsibility to define a meaningful problem.
4. **METHOD OF SOLUTION -** Given a user-defined spatial mesh, PDEONE uses consistent centered difference approximations to form and evaluate at time t the right-hand side of a semidiscrete approximating system of ODEs which is compatible with, and can be readily solved by, most ODE integrators.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Currently only one PDE is allowed to be defined on a given interval (a,b) . This may be increased to n PDEs by increasing the dimensions of the arrays in PDEONE.
6. **TYPICAL RUNNING TIME -** Running time is dependent upon the number of PDEs and the spatial mesh given. NESC compiled and executed the four sample problems in 10, 25, 15, and 35 CP seconds, respectively, on a CDC7600.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -** PDEONE was originally incorporated into and tested with the ODE integrator GEARB (NESC Abstract 661).
9. **STATUS -** Abstract first distributed August 1978.
CDC7600 version submitted February 1976, sample problems executed by NESC July 1978 on a CDC7600.
10. **REFERENCES -** Richard F. Sincovec and Niel K. Madsen, Software for Nonlinear Partial Differential Equations, Association for Computing Machinery Transactions on Mathematical Software, Vol. 1, No. 3, pp. 232-260, September 1975.
11. **MACHINE REQUIREMENTS -** 27,000 (octal) words of small core memory are needed to execute the sample problems.
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** SCOPE.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** The user must supply a main driver and an ODE integrator and construct subroutines D, F, and BNDRY for PDEONE implementation.
By inserting the statement IMPLICIT REAL*8 (A-H,O-Z) into subroutine PDEONE, the program may be used with the IBM360 versions of GEARB (NESC Abstract 661) and EPISODEB (NESC Abstract 705).
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
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R. F. Sincovec
Energy Technology Applications
Boeing Computer Services, Inc.

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Mail Stop 9C-01
P. O. Box 24346
Seattle, Washington 98124

- 16. MATERIAL AVAILABLE -**
Source deck (203 cards)
Sample problem drivers (315 cards)
Reference reprint
- 17. CATEGORY - P**
KEYWORDS - ordinary differential equations, partial differential equations, nonlinear problems, finite difference method, numerical solution, time dependence, GEARB codes, EPISODEB codes
- 18. SPONSOR -** AEC Division of Military Application
American Chemical Society Petroleum Research Fund

1. NAME OR DESIGNATION OF PROGRAM - PROSA1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM370
3. DESCRIPTION OF PROBLEM OR FUNCTION - PROSA1 is an implementation of the probabilistic response surface technique developed for use with accident analysis programs to conduct probability studies of hypothetical accidents. PROSA1 determines the distribution of a random variable that is a function of many other random variables when this functionality is not known analytically and can be obtained only through parametric studies with a deterministic computer code. The program first systematically provides input parameter combinations for evaluation by a deterministic code. Then, with the output from the deterministic code for each of these parameter combinations, multivariate quadratic response surfaces are generated approximating the functionality between the input and output of the deterministic code. Using these response surfaces PROSA1 calculates probability histograms and joint histograms for the output variables. Special features of the code generate or treat sensitivities, statistical moments of the input and output variables, regionwise response surfaces, correlated input parameters, and conditional distributions.
4. METHOD OF SOLUTION - As input data the program needs the probability distributions of the variable parameters (e.g., reactivity and heat transfer coefficients considered as sources of uncertainties in an accident analysis). Uniform, normal, truncated normal, exponential, beta, and log-normal probability distributions are available. The first part of the program determines knot-point coordinates of the parameters, using a user-specified probability range (confidence interval). These serve as input to deterministic codes (such as accident analysis codes SACO or SAS) which calculate consequence values in the specified knot points.

The consequence values are used by the second part of PROSA1 to solve 1) the approximating functions (response surfaces); 2) the sensitivity/importance of each parameter with respect to the consequence variables; 3) the statistical moments of the input parameters; 4) the mean values and standard deviations of the consequences; and 5) the correlation coefficients for all pairs of the consequences. In the simplest case a single multivariate second-degree surface is matched to the knot-point consequences. It is possible to use regionwise response surfaces, distinct second-degree surfaces for every "quadrant" of the multivariate parameter space.

By use of random-number sampling of the parameter distributions and simulation with the as-calculated response surface the program also calculates 6) the probability distributions and the first four moments of the consequences; 7) the joint distributions; and 8) the statistical-error estimates for the distributions.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The maximum number of variable input parameters and consequence variables that can be analyzed simultaneously are 12 and 6, respectively. Eight different probability distributions are available for the input parameters. The correlations (if any) between the input parameters are limited to linear correlations. Up to four simultaneous criteria or conditions can be specified for the consequences.

The individual and joint distributions are obtained in forms of histograms with 12 and 144 categories, respectively. The width of the categories is a user-specified fraction of the standard deviations of the consequences.
6. TYPICAL RUNNING TIME - Typical running time in the case of six input parameters and six consequence variables is 60 seconds for 40,000 simulations on an IBM370/195.
7. UNUSUAL FEATURES OF THE PROGRAM - By defining one or more input parameters to be consequences as well, it is possible to use the code for calculating optimal importance distributions for the input parameters.
8. RELATED AND AUXILIARY PROGRAMS - The PROSA1 code is designed for use in conjunction with a deterministic/mechanistic accident analysis code (such as SACO, SAS, or RELAP). The first part of PROSA1 provides input to the accident analysis code, which in turn provides input to the second part of PROSA1.

9. **STATUS** - Abstract first distributed August 1978.
IBM370 version submitted April 1978, sample problem executed by NESC July 1978 on an IBM370/195.
10. **REFERENCES** - J. K. Vaurio and C. Mueller, Probabilistic Analysis of Liquid-Metal Fast Breeder Reactor Accident Consequences with Response Surface Techniques, Nuclear Science and Engineering, Vol. 65, pp. 401-413, 1978.
J. K. Vaurio and C. Mueller, PROSA-1: A Probabilistic Response Surface Analysis Code, ANL/RAS 77-35, September 1977.
11. **MACHINE REQUIREMENTS** - 350K bytes of storage, system input, output and punch units are required.
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV (97%) and Assembly language (3%)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/370.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The program contains a few FORMAT statements using T format (an IBM extension to ANSI FORTRAN).
PROSA1 obtains random numbers U (uniformly distributed between 0 and 1) using the FLTRNF function subprogram supplied as an Assembly language routine. Other random variates are calculated from U.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
J. K. Vaurio* and C. Mueller
Reactor Analysis and Safety Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
* Contact
16. **MATERIAL AVAILABLE** - Restricted Distribution
Magnetic Tape Transmittal
Source deck (FORTRAN-2384 cards, Assembly language-69 cards)
Sample problem (48 cards)
Reference report, ANL/RAS 77-35, and NS&E reprint
17. **CATEGORY** - G
KEYWORDS - accidents, Monte Carlo method, fast reactors, reactor safety, sensitivity, HCDA, probability, SACO codes, LMFBR reactors
18. **SPONSOR** - DOE Division of Reactor Research and Technology

1. NAME OR DESIGNATION OF PROGRAM - IMPORTANCE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM370
3. DESCRIPTION OF PROBLEM OR FUNCTION - IMPORTANCE computes various measures of probabilistic importance of basic events and minimal cut sets to a fault tree or reliability network diagram. The minimal cut sets, the failure rates and the fault duration times (i.e., the repair times) of all basic events contained in the minimal cut sets are supplied as input data. The failure and repair distributions are assumed to be exponential. IMPORTANCE, a quantitative evaluation code, then determines the probability of the top event and computes the importance of minimal cut sets and basic events by a numerical ranking. Two measures are computed. The first describes system behavior at one point in time; the second describes sequences of failures that cause the system to fail in time. All measures are computed assuming statistical independence of basic events. In addition, system unavailability and expected number of system failures are computed by the code.
4. METHOD OF SOLUTION - Seven measures of basic event importance and two measures of cut set importance can be computed. Birnbaum's measure of importance (i.e., the partial derivative) and the probability of the top event are computed using the min cut upper bound. If there are no replicated events in the minimal cut sets, then the min cut upper bound is exact. If basic events are replicated in the minimal cut sets, then based on experience the min cut upper bound is accurate if the probability of the top event is less than 0.1.
Simpson's rule is used in computing the time-integrated measures of importance. Newton's method for approximating the roots of an equation is employed in the options where the importance measures are computed as a function of the probability of the top event, and a shell sort puts the output in descending order of importance.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - The test cases executed in about 1 second on the IBM370/195.
7. UNUSUAL FEATURES OF THE PROGRAM - For systems where repair is not allowed, the code accepts proportional hazards as input data. In another option, where repair is permitted, failure rate data can also be expressed in relative terms by representing the failure rate and repair rate data for the basic events in terms of a reference time unit.
8. RELATED AND AUXILIARY PROGRAMS - Other qualitative evaluation programs for system safety and reliability analysis are MOCUS (NESC Abstract 653), PREP (NESC Abstract 528), COMCAN (NESC Abstract 704), SETS (NESC Abstract 623), FTA (NESC Abstract 666), and FTAP, Department of Operations Research, Berkeley. A discussion of these and others is contained in reference 2.
The IMPORTANCE program was originally developed on the CDC7600 by Howard E. Lambert at Lawrence Livermore Laboratory, and was later converted to the IBM370 by T. Chawla and G. Hauser of the Reactor Analysis and Safety Division at Argonne National Laboratory.
9. STATUS - Abstract first distributed August 1978.
IBM370 version submitted April 1977, sample problem executed by NESC July 1978 on an IBM370/195.
10. REFERENCES - H. E. Lambert, Fault Trees for Decision Making in Systems Analysis, UCRL-51829, October 9, 1975 (Ph.D. thesis).
Howard E. Lambert and Frank M. Gilman, The IMPORTANCE Computer Code, UCRL-79269 (Preprint), March 14, 1977.
11. MACHINE REQUIREMENTS - Execution of the sample problem required 140K bytes of storage.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/370.

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The program uses logical unit 8 as a storage device.
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
H. W. Lambert*
Lawrence Livermore Laboratory
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2150 Shattuck Avenue
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16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (1586 cards)
Sample problem (123 cards)
Reference reports
17. **CATEGORY** - G
KEYWORDS - fault tree analysis, reliability, system failure analysis, probability, MOCUS codes, FTA codes, PREP codes, COMCAN codes, SETS codes
18. **SPONSOR** - Lawrence Livermore Laboratory
NRC Division of Nuclear Regulatory Research

1. NAME OR DESIGNATION OF PROGRAM - NALAP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC7600, CYBER76
3. DESCRIPTION OF PROBLEM OR FUNCTION - NALAP is an LMFBR system transient code. This code, adapted from the light water reactor transient code RELAP3B, simulates thermalhydraulic response of sodium-cooled fast breeder reactors when subjected to postulated accidents such as a massive pipe break as well as a variety of other upset conditions that do not disrupt the system geometry.
4. METHOD OF SOLUTION - Various components of the plant are represented by control volumes. These control volumes are connected by junctions, some of which may be leak or fill junctions. The fluid flow equations are modeled as compressible, single-stream flow with momentum flux in one dimension. The transient response is computed by integrating the thermal-hydraulic conservation equations from user-initialized operating conditions by an implicit numerical scheme. The point-kinetics approximation is used to represent the time-dependent heat generation in the reactor core.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 40 control volumes
 - 50 connecting junctions
 - 6 thermal properties
 - 25 pressures
 - 13 liquid temperatures per pressure
 - 6 gas temperatures per pressurePressure table values must be greater than zero and less than or equal to 7000 psia. The pressure table restrictions may be altered by modifying DIMENSION statements.
6. TYPICAL RUNNING TIME - A 27-volume, 32-junction problem took approximately 32 milliseconds per time-step on a CDC7600. Typically, the time-step for a double-ended pipe break case was 0.05 millisecond near the break time. Beyond 0.3 millisecond after the break, the time-step was increased to 0.5 millisecond. The four sample problems were executed in 6 CP minutes on a CDC7600.
7. UNUSUAL FEATURES OF THE PROGRAM - NALAP allows some volumes (typically in a secondary and/or tertiary loop) to contain water or steam. In fact, all volumes may contain water, in which case NALAP can be used as RELAP3B.
8. RELATED AND AUXILIARY PROGRAMS - Predecessors to this program are the INEL RELAP editions, RELAP2 and RELAP3 (NESC Abstract 369), and RELAP3B (NEC Abstract 733).
9. STATUS - Abstract first distributed September 1978.
CDC7600 version submitted December 1975, sample problem executed by NESC August 1978 on a CDC7600.
10. REFERENCES - B. A. Martin, A. K. Agrawal, D. C. Albright, L. G. Epel, and G. Maise, NALAP An LMFBR System Transient Code, BNL 50457, July 1975.
K. V. Moore and W. H. Rettig, A Digital Program for Reactor Blowdown and Power Excursion Analysis, IDO-17263, March 1968.
W. H. Rettig, G. A. Jayne, K. V. Moore, C. E. Slater, and M. L. Uptmor, RELAP3--A Computer Program for Reactor Blowdown Analysis, IN-1321, June 1970.
11. MACHINE REQUIREMENTS - CDC7600 (or CYBER76) with 142,000 (octal) words of memory. In addition to card input and printer output, a FORTRAN logical unit 1 may be used for the automatic time-step option, and units 2, 3, and 4 may be used under the restart option. These units may be assigned to disk or tape.
12. PROGRAMMING LANGUAGES USED - FORTRAN IV (99%) and COMPASS (1%)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 2.1.

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- 14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** The following non-ANSI language extensions were used:
OVERLAY statements and calls.
ENCODE and DECODE statements to prepare output page headings.
PROGRAM statements to specify file assignments.
Non-ANSI system routines called:
EOF--returns nonzero value when end-of-file reached.
REMARK--places message on DAYFILE.
DATE--returns calendar date in the form mm/dd/yy.
TIME--returns time of day in the form hh.mm.ss.
SECOND--returns CP time used.
SHIFT--performs a left or right binary shift.
If all of these are replaced by dummy routines, only the page headings are affected. A COMPASS routine named WHEN is included which may be removed for non-7600 environments. For restart problems, the data is read from TAPE3 and is written to TAPE4.
- 15. NAME AND ESTABLISHMENT OF AUTHORS -**
B. A. Martin, A. K. Agrawal, D. C. Albright,
L. G. Epel, and G. Maisie
Department of Applied Sciences
Brookhaven National Laboratory
Upton, New York 11973
• Contact
- 16. MATERIAL AVAILABLE - Magnetic Tape Transmittal**
Source deck (23,504 cards)
Sample problem (438 cards)
Sample problem output (2 microfiche)
Reference report, BNL 50457
- 17. CATEGORY - G**
KEYWORDS - transients, accidents, pipes, kinetics, fluid flow, design basis accidents, heat transfer, hydraulics, reactor cooling systems, ruptures, LMFBR reactors, RELAP codes
- 18. SPONSOR -** NRC Division of Reactor Safety Research

1. NAME OR DESIGNATION OF PROGRAM - SPEKEN
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - SPEKEN computes Pearson, Spearman, and Kendall correlation coefficients and associated significance levels for multivariate data. Special features of the program include exclusion of pairs of data values where one value is missing, and adjustment for tied rankings. The hypothesis of independence between each pair of variables can be tested using the obtained significance level for each correlation.
4. METHOD OF SOLUTION - Standard statistical formulae for the three correlations are evaluated. A large sample approximation is used for the nonparametric correlations and the tables are used for fewer than 15 pairs of samples.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - Usually less than 30 seconds is required on the IBM360/91. The two sample problems executed in less than 5 seconds on the IBM370/195.
7. UNUSUAL FEATURES OF THE PROGRAM - A variety of input formats are available, and any or all of the three correlations can be generated.
8. RELATED AND AUXILIARY PROGRAMS - Input for SPEKEN was designed to be compatible with the pattern recognition codes, RECOG-ORNL, and DENDRO.
9. STATUS - Abstract first distributed September 1978.
IBM360 version submitted April 1978, sample problems executed by NESC June 1978 on an IBM370/195.
10. REFERENCES - V. E. Kane, N. M. Larson, and V. C. Nall, A Computer Program to Generate Pearson, Spearman, and Kendall Correlations, K/UR-8, November 1977.
N. M. Larson, C. L. Begovich, and V. C. Nall, A User's Manual for the Hierarchical Cluster Analysis Code DENDRO, ORNL/CSD/TM-20, September 1977.
C. L. Begovich and N. M. Larson, A User's Manual for the Pattern Recognition Code RECOG-ORNL, ORNL/CSD/TM-21, May 1977.
11. MACHINE REQUIREMENTS - Standard system input and printer and punch output units are required.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360,370.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The International Mathematical and Statistical Libraries (IMSL) routine MDTD is called to calculate the significance level associated with the statistic, t.
15. NAME AND ESTABLISHMENT OF AUTHOR -
N. M. Larson
Nuclear Division
Union Carbide Corporation
P. O. Box X
Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (1045 cards)
Sample problems (502 cards)
Reference report, K/UR-8
17. CATEGORY - P

KEYWORDS - multivariate analysis, correlation functions, statistics, RECOG-ORNL codes, DENDRO codes

18. **SPONSOR** - DOE Office of Uranium Resources and Enrichment,
Raw Materials

1. NAME OR DESIGNATION OF PROGRAM - DOE2.0
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC7600,6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - DOE2.0 is a set of computer programs for the analysis of energy consumption in buildings. Programs are included to calculate the heating and cooling loads for each space (zone) in the building for each hour of a year (LOADS), to simulate the operation and response of the equipment and systems that control temperature and humidity and distribute heating and cooling to the space (SYSTEMS), to model primary energy conversion equipment that uses fuel (e.g. oil, gas, or sun) to provide the required heating, cooling, and electricity (PLANT), and to compute the life-cycle cost for building operation based on economic parameters (ECONOMICS). A problem-oriented building design language (BDL) facilitates the description of the building geometry, its central plant equipment, its HVAC systems, occupancy, equipment, and lighting schedules, and the selection of other problem parameters. In addition to the LSPE programs (LOADS, SYSTEMS, PLANT, and ECONOMICS), the system includes the BDL processor, two report generators, a weather data processor, and a stand-alone response factor generating program. Standard output reports are produced by the RPTGEN program. A weather data tape included with the system contains weather station data for 61 U.S. cities and 15 California climate zones.
4. METHOD OF SOLUTION - The LOADS program computes hourly space loads resulting from transmission gains and losses through walls, roofs, floors, and windows; solar gains through windows; internal gains from occupants, lighting, and equipment; and infiltration gains and losses caused by pressure differences across openings. The LOADS calculations are based on ASHRAE algorithms (reference 1), including the response factor technique for calculating transient heat flow through walls and roofs and the weighting factor technique for calculating heating and cooling loads. The SYSTEMS program takes the hourly space loads calculated by LOADS along with characteristics of the secondary HVAC equipment selected by the user from a list of available system types and component and control features and thermal characteristics of the zone, and determines the actual room temperature and heat extraction or addition rates using ASHRAE algorithms (reference 2). The PLANT program uses the building thermal energy load data determined by SYSTEMS and data specifying the type, size, control conditions, and operating parameters of the plant equipment provided by the user, to allocate available equipment and simulate their operation. The PLANT program simulates conventional central plant configurations as well as total energy plants and systems using solar collectors, rock beds and other active solar components. The life-cycle costing methodology used in the ECONOMICS program is derived from DOE guidelines (reference 3). Life-cycle costing method investment statistics (i.e. cost savings, savings-to-investment ratio, energy savings, energy savings-to-investment ratio, and discounted payback period) are calculated to provide a measure for comparing the cost effectiveness of each case against a reference case.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The LOADS program allows the user to configure an arbitrary structure composed of walls, roofs, windows, floors, ceilings, and thermal spaces. The user can specify scheduled occupancy, lighting, electric, and equipment loads in each space. Simulations available in SYSTEMS are a single-zone fan system, multizone fan system, double-duct fan system, plenum induction systems, unit heater, unit ventilator, floor-panel heating system, two-pipe fan-coil system, four-pipe fan-coil system, two-pipe induction unit fan system, constant-volume reheat fan system, unitary hydronic heat pump, return and ventilating system, and ceiling bypass variable volume system. Equipment types simulated by the PLANT program are gas turbine, diesel engine, steam or electric boilers, one-stage absorption chiller, two-stage absorption chiller with or without economizer, hermetic compression chiller with or without economizer, hermetic compression chiller, open centrifugal compression chiller, reciprocating compression chiller, double-bundle chiller, cooling tower, ceramic cooling tower, steam or gas turbines, air or liquid flat-plate solar collector, rock bed, and hot and cold storage water tank. The program allows only one type of absorption chiller, one type of compression chiller (other than double-bundle chillers), and one type of cooling tower. Any loads not met because of insufficient capacity are reported.

The number of the different types of BDL instructions allowed in a single run are limited to maxima of -

- 128 walls and roofs
- 128 windows
- 128 interior walls or ceilings
- 64 underground walls or floors
- 64 spaces
- 40 air distribution systems
- 40 schedules
- 6 different sizes of each type of primary plant equipment

6. **TYPICAL RUNNING TIME** - 3 to 5 CP seconds are required for each thermal zone for a one-year analysis. The sample problems took 204 seconds of CP time on a CDC7600.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The Building Design Language (BDL) is designed to assist the user in the effective application of the system. This command-word-structured, free-format language can greatly simplify the definition of a model for a given building and manipulation of the model components to produce an energy-conservative design.
8. **RELATED AND AUXILIARY PROGRAMS** - SOLSYS (NESC Abstract 692), the NASA-NECAP program (NASA CR-2590), the NBS NBSLD program (NBSIR 74-574), the DOD BLAST program (CERL-TR-E-119 and CEEDO-TR-77-35), and the University of Wisconsin TRNYSYS program.
9. **STATUS** - Abstract first distributed September 1978.
CDC7600 version of DOE1 submitted June 1978, replaced April 1979 by DOE2.0 submitted February 1979, sample problems executed by NESC April 1979 on a CDC7600.
10. **REFERENCES** - M. Lokmanhekim, ASHRAE Task Group on Energy Requirements for Heating and Cooling of Buildings, Procedure for Determining Heating and Cooling Loads for Computerizing Energy Calculations, Algorithms for Building Heat Transfer Subroutines, American Society of Heating, Refrigerating, and Air Conditioning Engineers, 1971.
W. F. Stoecker, ASHRAE Task Group on Energy Requirements for Heating and Cooling of Buildings, Procedures for Simulating the Performance of Components and Systems for Energy Calculations, American Society of Heating, Refrigerating, and Air Conditioning Engineers, 1975.
Life Cycle Costing, Emphasizing Energy Conservation, ERDA 76/130, September 1976, Revised May 1977.
1977 ASHRAE Handbook of Fundamentals, American Society of Heating, Refrigerating, and Air Conditioning Engineers.
J. Duffie and W. Beckman, Solar Energy Thermal Processes, John Wiley and Sons, New York, 1974.
NESC Note 79-28, Description of DOE2.0 Package Transmittal Tapes, April 23, 1979.
S. C. Diamond, H. L. Horak, B. D. Hunn, J. L. Peterson, M. L. Roschke, and E. F. Tucker, DOE-2 PROGRAM MANUAL, LA-7688, February 15, 1979.
H. L. Horak, B. D. Hunn, J. L. Peterson, M. L. Roschke, E. F. Tucker, and D. A. York, DOE-2 REFERENCE MANUAL, LA-7688, February 15, 1979.
Building Energy Analysis Group, DOE-2 USERS GUIDE, LBL-8689, February 15, 1979.
Building Energy Analysis Group, DOE-2 BDL SUMMARY, LBL-8688, February 15, 1979.
Building Energy Analysis Group, DOE-2 SAMPLE RUN BOOK, LBL-8678, February 15, 1979.
11. **MACHINE REQUIREMENTS** - DOE2.0 requires 61,000 (octal) words of program storage for execution of the sample problem.
12. **PROGRAMMING LANGUAGES USED** - FORTRAN (99%) and COMPASS (1%)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 2.1.

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The memory size is increased as needed by the COMPASS subroutine SETFLS. Minor changes may be required to this subroutine at other installations.
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
Contact F. C. Winkelmann
Building Energy Analysis Group
Energy and Environment Division
Lawrence Berkeley Laboratory
Berkeley, California 94720
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal (2 tapes)
Source decks (FORTRAN BDL-13,623 cards, SIMCOM-688 cards, LDSCOM-5195 cards, SYSCOM-6101 cards, PLTCOM-5213 cards, CBSCOM-3882 cards, ECOCOM-654 cards, REPCOM-777 cards, HRP COM-921 cards, UPDATE BDL SRC-12,268 cards, SIMSRC-701 cards, LDSSRC-4997 cards, SYSSRC-5161 cards, PLTSRC-5109 cards, CBSSRC-3577 cards, ECOSRC-631 cards, REPCRDS-759 cards, HRDSRC-886 cards)
Sample problems (3253 cards)
Weather file library (77 36-record* files of binary data)
Auxiliary routines and information (FORTRAN KEYCOM-548 cards, CLCCOM-1091 cards, EDTCOM-279 cards, PRGCOM-285 cards, RLCCOM-136 cards, REFACT-632 cards, PACKER-932 cards, LISTER-465 cards, EDIT-833 cards, KEYCRDS-969 cards, CLCCRDS-1613 cards, EDTCRDS-518 cards, REPCRDS-1085 cards, MATLIB-201 cards, UPDATE KEYSRC-543 cards, CLCSRC-887 cards, EDTSRC-285 cards, PRGSRC-290 cards, RLCSRC-139 cards, KEYCRD-970 cards, CLCCRD-1614 cards, EDTCRD-519 cards, REPCRD-1086 cards)
Control information (479 cards)
Sample problems output (tape-complete output of sample problems)
Reference reports, LA-7688, LA-7689, LBL-8678, LBL-8688, LBL-8689, and NESC Note 79-28
*Maximum size (512 words)
17. **CATEGORY** - T
KEYWORDS - air conditioning, boilers, buildings, construction, control systems, economics, energy analysis, energy consumption, life-cycle cost, lighting systems, operation, roofs, site selection, space heating, systems analysis, ventilation, walls, weather
18. **SPONSOR** - DOE Office of Conservation and Solar Applications,
Division of Buildings and Community Systems,
Architectural and Engineering Systems Branch

1. **NAME OR DESIGNATION OF PROGRAM -** SLGTR
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** The program simulates the condition of a partly liquid slag film flowing on a cooled vertical or horizontal wall of a large duct, through which pass slag-laden combustion gases. It computes the axial variations of gas temperature, radiative and convective heat fluxes from the hot combustion gas to the cooled wall, and thickness, temperature, and velocity distributions of the slag film. The program is useful in performing design calculations for a radiant-heater concept in the downstream system of an MHD power plant.
4. **METHOD OF SOLUTION -** The axial length of the duct is divided into fine increments within which gas and slag conditions are assumed constant. The gas temperature within the axial increment is taken as the inlet temperature of the increment. The outlet temperature of the increment is calculated from an energy balance on an elementary volume of the combustion gas. The heat fluxes from the combustion gas to the cooled wall consist of radiative and convective contributions. The equation of conservation of mass and the momentum equation for the slag flow and the energy equation across the slag film are combined to form a double-integral equation. Within each axial increment, the slag surface temperature is the only unknown quantity in the double-integral equation, and the calculations of slag film thickness, heat transfer to, and conducted away from, the slag surface are iterated by the half-interval method until the correct slag surface temperature is computed.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** The inlet conditions and physical properties of the combustion gas and the slag film are supplied as input data by the user. The model is not valid for a solid slag film.
6. **TYPICAL RUNNING TIME -** The CPU time for the sample problem is less than 5 seconds on an IBM370/195.
7. **UNUSUAL FEATURES OF THE PROGRAM -** The analytical model can be solved by employing a finite-difference scheme which requires 50% more computing time.
8. **RELATED AND AUXILIARY PROGRAMS -**
9. **STATUS -** Abstract first distributed September 1978.
IBM370 version submitted May 1978, sample problems executed by NESC August 1978 on an IBM370/195.
10. **REFERENCES -** L. S. H. Chow and T. R. Johnson, Slag Transport Models for Vertical and Horizontal Surfaces, ANL/MHD-78-1, January 1978.
11. **MACHINE REQUIREMENTS -** The program requires approximately 190K bytes of memory and standard input and output units for execution.
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/370.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -**
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
L. S. H. Chow
Engineering Division
T. R. Johnson
Chemical Engineering Division
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9700 South Cass Avenue
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16. MATERIAL AVAILABLE -

Source deck (584 cards)
Sample problem (19 cards)
Sample problem output (5 pages)
Reference report

17. CATEGORY - H

KEYWORDS - coal-fired MHD generators, power plants, ducts, combustion products, films, flow rate, MHD channels, siags, plasma seeding, thermal conductivity, viscosity

**18. SPONSOR - DOE Office of Fossil Energy,
Division of Magnetohydrodynamics**

1. NAME OR DESIGNATION OF PROGRAM - DSNP

2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM370

3. DESCRIPTION OF PROBLEM OR FUNCTION - DSNP (Dynamic Simulator for Nuclear Power-Plants) is a system of programs and data files by which a nuclear power plant, or part thereof, can be simulated. The acronym DSNP is used interchangeably for the DSNP language, the DSNP libraries, the DSNP precompiler, and the DSNP document generator.

The DSNP language is a special-purpose, block-oriented digital-simulation language developed to facilitate the preparation of dynamic simulations of a large variety of nuclear power plants. It is a user-oriented language that permits the user to prepare simulation programs directly from power plant block diagrams and flow charts by recognizing the symbolic DSNP statements for the appropriate physical components and listing these statements in a logical sequence according to the flow of physical properties in the simulated power plant.

Physical components of nuclear power plants are represented by functional blocks, or modules. Many of the more complex components are represented by several modules. The nuclear reactor, for example, has a kinetic module, a power distribution module, a feedback module, a thermodynamic module, a hydraulic module, and a radioactive heat decay module. These modules are stored in DSNP libraries in the form of a DSNP subroutine or function, a block of statements, a macro, or a combination of the above. Basic functional blocks such as integrators, pipes, function generators, connectors, and many auxiliary functions representing properties of materials used in nuclear power plants are also available.

The DSNP precompiler analyzes the DSNP simulation program, performs the appropriate translations, inserts the requested modules from the library, links these modules together, searches necessary data files, and produces a simulation program in FORTRAN. FORTRAN is considered to be a subset of DSNP and can be inserted anywhere in the simulation program without restriction. I/O statements can be located anywhere in the program in arbitrary sequence. No formatting is required and the listed variables are printed at user-defined intervals in an easy-to-read tabular form.

4. METHOD OF SOLUTION - The mathematical models used vary from one component module to another. Mostly, however, lumped parameter models were used. The differential equations produced by each component module are solved by a centralized integration scheme. The various loops of the power plant can be solved with different integration schemes using different time-step sizes. Any of eight integration schemes including Adams' 2nd-order, Euler, Milne's 5th-order predictor-corrector, Runge-Kutta 4th-order, Simpson 3rd-order, trapezoidal, and the method used in CSMP III can be selected. DSNP is written in double-precision, and all units are SI metric.

5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Only overall plant transients can be studied since most models are based on the lumped parameter approximation. For detailed transients inside the core, heat exchanger, or any other component, more sophisticated Level-2 or Level-3 libraries will be developed in the future.

6. TYPICAL RUNNING TIME - Running time is a function of the size of the simulation. The precompilation time is approximately 50 seconds per 1000 FORTRAN statements.

7. UNUSUAL FEATURES OF THE PROGRAM -

8. RELATED AND AUXILIARY PROGRAMS - The auxiliary program, MINIEDITOR, included in the DSNP package is used to change precompiler translation tables.

9. STATUS - Abstract first distributed January 1979.

IBM370 version submitted September 1978, sample problems executed by NESC December 1978 on an IBM370/195.

10. REFERENCES - D. Saphier, The Simulation Language of DSNP, ANL-CT-77-20 Rev. 02, September 1978.

D. Saphier, The Level One Modules Library for DSNP, ANL-CT-77-21 Rev. 02, September 1978.

D. Saphier, The Precompiler for DSNP, ANL-CT-77-22 Rev. 02, September 1978.

D. Saphier, MINIEDITOR, ANL-CT-77-18 Rev. 02, August 1978.

D. Saphier, A Simulation Language for Nuclear Power Plants, Proceedings of the 1977 Summer Computer Simulation Conference, July 18-20, 1977, pp. 353-358, AFIPS Press, Montvale, New Jersey, 1977.

Waterloo SCRIPT Reference Guide, University of Waterloo, Waterloo, Ontario, 1976.

DSNP NESC No. 784.370, Description of Transmittal Tape, NESC Note 79-19, January 30, 1979.

11. **MACHINE REQUIREMENTS** - 240K bytes of storage are required to compile and translate a typical power plant simulation program. Six scratch files require disk or fast magnetic tape storage and a permanent library file unit is used. All sample problems were executed in a 250K byte or smaller region.

12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV and DSNP

13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/370.

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The documentation was prepared and is maintained using the proprietary University of Waterloo SCRIPT text-processing system. Files 7-10 of the transmittal tape are SCRIPT data files.

15. **NAME AND ESTABLISHMENT OF AUTHORS** -

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Components Technology Division

16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (Precompiler-2644 cards, Library-3313 cards)
Sample problems (1318 cards, Default data-32 cards, PDS DSNP.CNTL)
Auxiliary routine (MINIEDITOR-113 cards)
Auxiliary information (4 SCRIPT text files-PDS LIB.TEXT, PDS TEXT.TEXT, DSNP.TEXT*, and COMP.TEXT* of DSNP manuals, 1 printer file+ of DSNP manuals)
Sample problems output (75 selected pages, complete-9 microfiche)
+RECFM=VB,LRECL=255,BLKSIZE=1680
+RECFM=VBA,LRECL=125,BLKSIZE=1654

17. **CATEGORY** - K
KEYWORDS - simulation, nuclear power plants, programming languages

18. **SPONSOR** - DOE Division of Reactor Research and Technology

1. **NAME OR DESIGNATION OF PROGRAM** - AXICRP
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC CYBER74,6600,7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - AXICRP is a finite-element computer code for creep analysis of plane stress, plane strain, and axisymmetric bodies of revolution. Principal application has been to obtain the creep solution for a Fast Flux Test Facility (FFTF) hexagonal flow duct. Other applications to a thick-walled cylinder and a rectangular beam demonstrate the variety of structural geometries which can be analyzed.
4. **METHOD OF SOLUTION** - As a finite-element program, AXICRP uses many displacement functions with each function restricted to a small element of the solid. From these, stiffness and load matrices for individual elements are derived. Matrix superposition of the individual element stiffness and load matrices is done to obtain the equilibrium equations for the solid, resulting in a system of linear algebraic equations which AXICRP solves. An incremental procedure is used to extend the elastic finite-element program to calculate the nonlinear effects arising from creep.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Maxima of -
 550 nodal points
 500 elements
 12 different materials
 8 different temperatures for which properties are given
 200 boundary pressure cards
 The direct incremental treatment of time used restricts the program to the consideration of creep under constant load.
6. **TYPICAL RUNNING TIME** - For a job of 22 nodal points and 10 elements, an iteration can be completed within 1 second. A job requiring 7 iterations and on-line plots was completed in 8 seconds. Program compilation time is less than 1 minute. NESC executed the sample problem in 70 seconds on a CDC6600.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The finite-element method used in AXICRP is capable of handling arbitrary geometries, mixed boundary conditions, and structural discontinuities.
8. **RELATED AND AUXILIARY PROGRAMS** - CRASIB and BEAMCRP (NESC Abstract 701).
9. **STATUS** - Abstract first distributed October 1978.
 CDC CYBER74 version submitted May 1975, sample problem executed without plotting by NESC September 1978 on a CDC6600 and a CDC7600.
10. **REFERENCES** - W. H. Sutherland, A Finite Element Computer Code (AXICRP) for Creep Analysis, BNWL-1142, October 1969.
 J. A. Schur, Supplement to Appendix A of AXICRP Document BNWL-1142 and Appendix A of AXICRP Document BNWL-SA-2608, CSC-RL-SCI-112, January 27, 1975.
 C. A. Felippa, Refined Finite Element Analysis of Linear and Nonlinear Two-Dimensional Structures, Structural Engineering Laboratory Report 66-22, University of California Berkeley, October 1966.
11. **MACHINE REQUIREMENTS** - Disk storage is required and use of a CalComp plotting device is optional. 142,000 (octal) words of memory are needed when the segmented load is used.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 3.4.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - NESC supplied dummy routines for the CalComp routines FACTOR, LINE, NUMBER, PLOT, PLOTS, and SYMBOL. These dummy routines should be removed if a local CalComp plotter is to be accessed. Due to machine differences, the results obtained for the RZ stress may differ from those provided in the

sample problem output. These differences will be evident also in the on-line graph of SIGMA RZ versus TIME. These values should, however, be numbers of very small magnitude.

15. NAME AND ESTABLISHMENT OF AUTHORS -

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16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (2822 cards)
Sample problem (33 cards)
Control information (24 cards)
Sample problem output (20 pages)
Reference reports, BNWL-1142 and CSC-RL-SCI-112

17. CATEGORY - I

KEYWORDS - finite element method, stresses, creep, strains, LMFBR reactors, CRASIB codes, BEAMCRP codes

18. SPONSOR - DOE Division of Reactor Research and Technology

1. NAME OR DESIGNATION OF PROGRAM - CONDYN
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600, 7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - The CONDYN program fits a Polya (negative binomial) frequency distribution to an observed secondary electron spectrum. Secondary-electron yields measured by a spectrometer are fit to the Polya statistical model by a nonlinear least squares technique. There are two basic assumptions in the Polya model: (1) the mean secondary-electron yield from each small, thin element of surface area of an ion-converter dynode follows a Poisson distribution, and (2) the frequency of these mean yields follows a gamma distribution.
4. METHOD OF SOLUTION - The Polya and Cauchy frequency distributions are used to describe secondary-electron emission from the target dynode and subsequent charge amplification of those electrons in a silicon solid-state detector, respectively, and the Fletcher-Powell minimization method is applied to obtain the nonlinear least squares fit of the model to the observed secondary-electron spectrum.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - A maximum of 6 parameters can be fitted.
6. TYPICAL RUNNING TIME - The Li-7 test problem requires about 50 seconds of CP time on a CDC6600 and the Rb-85 problem about 120 seconds. In NESC testing the two problems took 26 seconds on a CDC7600. The time required for the analysis of a spectrogram depends on the accuracy of initial estimates and the number of parameters to be fitted.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed October 1978.
CDC6600 version submitted January 1977, sample problem executed by NESC September 1978 on a CDC7600.
10. REFERENCES - L. A. Dietz, DESCRIPTION OF CONDYN COMPUTER PROGRAM, KAPL Note, December 1976.
L. A. Dietz and J. C. Sheffield, Spectrometer for Measuring Secondary Electron Yields Induced by Ion Impacts on Thin Film Oxide Surfaces, Review of Scientific Instruments, Vol. 44, pp. 183-191, February 1973.
L. A. Dietz and J. C. Sheffield, Secondary Electron Emission Induced by 5-30-keV Monatomic Ions Striking Thin Oxide Films, Journal of Applied Physics, Vol. 46, pp. 4361-4370, October 1975.
R. Fletcher and M. J. D. Powell, A rapidly convergent descent method for minimization, Computer Journal, Vol. 6, pp. 163-168, 1963-64.
11. MACHINE REQUIREMENTS - 16K (octal) words of memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.4 (CDC6600), SCOPE 2.1 (CDC7600).
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
L. A. Dietz and J. C. Sheffield
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301
16. MATERIAL AVAILABLE -
Source deck (503 cards)

NESC ABSTRACT 786

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Sample problem (87 cards)
Sample problem output (4 pages)
Reference reprints by Dietz and KAPL Note

- 17. CATEGORY - W**
KEYWORDS - electron spectra, spectrometers, electron multipliers, ion beams,
photomultipliers, secondary emission, collisions
- 18. SPONSOR -** ERDA Division of Naval Reactors

1. **NAME OR DESIGNATION OF PROGRAM** - ATM
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - ATM can be used to estimate the transport of a pollutant from an emitting source to some receptor point. It is based on a Gaussian plume model and is capable of calculating wet and dry deposition and air concentration of non-radioactive pollutants at various receptor points located within 50 kilometers of a source or sources. The model can treat point, area, and line sources, including wind blown sources. The use of either the Pasquill-Gifford or the Briggs-Smith dispersion parameters can be specified.
4. **METHOD OF SOLUTION** - This program uses a Gaussian plume formalism, incorporating plume depletion via wetfall and dryfall processes, for multiple sources and multiple receptor points.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Current storage allocation of the program allows maxima of -
 - 10 receptor points
 - 14 time periods
 - 10 each of point, area, and line sources
 - 5 pollutants
 The wind rose data must have 16 directions, a maximum of 7 stabilities, and a maximum of 8 wind speeds.
6. **TYPICAL RUNNING TIME** - A test case involving a single source, 2 pollutants, 4 time periods and 8 receptor points requires approximately 40 seconds of CPU time on the IBM360/91.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The model includes the effect of aerodynamic roughness on dispersion constants, incorporates a tilting plume for heavy particulates, and includes an episodic calculation for exposure maxima. The depth of the plume is specified so as not to exceed that of the planetary boundary layer.
8. **RELATED AND AUXILIARY PROGRAMS** - The model can be coupled to the Wisconsin Hydrologic Transport Model, WHTM (NESC Abstract 808), to provide estimates of input wetfall and dryfall depositions.
9. **STATUS** - Abstract first distributed October 1978.
IBM360 version submitted October 1977, sample problem executed by NESC September 1978 on an IBM370/195.
10. **REFERENCES** - W. M. Culkowski and M. R. Patterson, A Comprehensive Atmospheric Transport and Diffusion Model, ORNL/NSF/EATC-17, April 1976 with Errata, October 1977.
11. **MACHINE REQUIREMENTS** - 210K bytes of storage are used with a unit for input and output printer and punch units.
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV (96%) and BAL (4%)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360,370.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Input is assigned logical unit 50, print output on logical unit 51 and punch output on logical unit 7.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
 - W. M. Culkowski
 - Atmospheric Turbulence and Diffusion Laboratory,
 - NOAA
 - M. R. Patterson-
 - Nuclear Division
 - Union Carbide Corporation

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Oak Ridge, Tennessee 37830

• Contact

16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (FORTRAN-1500 cards, BAL-66 cards)
Sample problem (1627 cards)
Reference report with Errata
17. **CATEGORY** - R
KEYWORDS - air pollution, diffusion, environmental effects, power plants, meteorology, plumes, aerosols, earth atmosphere, health hazards, forecasting, sulfur dioxide
18. **SPONSOR** - NSF Ecology and Analysis of Trace Contaminants Program

1. NAME OR DESIGNATION OF PROGRAM - SULCAL
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - SULCAL models the chemical reactions of sulfur species in the plume of a fossil fuel power plant, their transport through the atmosphere and deposition on the land surface. The model employs averaged concentrations based on the Gaussian plume and can calculate deposition rates for gaseous and particulate material as a function of such variables as distance from the source, wind speed, meteorological stability class, temperature, relative humidity, and the ambient concentrations of OH radical, ozone, and ammonia.
4. METHOD OF SOLUTION - A control volume of material emerging from the power plant stack is followed down the plume. The chemical rate equations are integrated in time as the control volume expands at a rate determined by the empirical dispersion coefficients of the Gaussian plume model. Ambient reactants are incorporated in the plume as the volume expands, while sulfur species are depleted by deposition on the land surface.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - SULCAL models the following features of the chemical behavior of sulfur emitted to the atmosphere from fossil-fuel burning power plants:
 - (a) the rapid reactions of sulfur dioxide with aerosol droplets to produce dissolved sulfite species,
 - (b) the rapid reactions of sulfur trioxide to produce the dissolved sulfate acid species,
 - (c) the neutralization of the acid thus produced by atmospheric ammonia,
 - (d) the eventual formation of particulate ammonium sulfate,
 - (e) the slow oxidation of sulfur dioxide to sulfate species by hydroxyl radical, and
 - (f) the slow oxidation of species of sulfur dioxide in aerosol droplets to sulfate species by dissolved ozone and oxygen.
6. TYPICAL RUNNING TIME - 16 seconds is a typical problem execution time on the IBM360/91.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The sulfur chemistry model, SULCAL, was developed as a component of the Atmospheric Transport Model, ATM (NESC Abstract 787).
9. STATUS - Abstract first distributed October 1978.
IBM360 version submitted October 1977, sample problem executed by NESC September 1978 on an IBM370/195.
10. REFERENCES - C. F. Baes, Jr., J. T. Holdeman, W. M. Culkowski, SULCAL, A Model of Sulfur Chemistry in a Plume, ORNL/NSF/EATC-21, April 1976.
11. MACHINE REQUIREMENTS - 76K of memory is required along with input and output units.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360,370.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The program assumes input on logical unit 20, and printer output is written on logical unit 21.
15. NAME AND ESTABLISHMENT OF AUTHORS -
C. F. Baes, Jr.
Chemistry Division
Oak Ridge National Laboratory
W. M. Culkowski

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Atmospheric Turbulence and Diffusion Laboratory,
NOAA
J. T. Holdeman
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16. MATERIAL AVAILABLE -

Source deck (830 cards)
Sample problem (6 cards)
Reference report

17. CATEGORY - R

KEYWORDS - aerosols, air pollution, ammonium sulfates, ammonia, chemical effluents, droplets, fossil-fuel power plants, oxygen, oxidation, plumes, ph value, sulfates, sulfites, sulfur

18. SPONSOR - NSF Ecology and Analysis of Trace Contaminants Program

1. NAME OR DESIGNATION OF PROGRAM - ODMOD
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - ODMOD is a transport model which predicts the coupled movement of both water and trace contaminants through a layered and unsaturated soil-moisture zone. In order to achieve computation speeds suitable for watershed implementations, moisture properties are approximated as exponential functions of pressure head, and lateral flows are treated as sinks in a basically vertical one-dimensional analysis. In addition, only advection by the Darcy-flow velocities and linear absorption by the soil-matrix are considered in depicting movement of the trace contaminant.
4. METHOD OF SOLUTION - Formal solution of the transport equations is obtained through use of both eigenfunction-expansion and coordinate-transformation methods.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Current storage allocation of the program allows maxima of -
 - 10 layers
 - 3 types of boundary conditions
 - 200 eigenvalues
 - 1000 time-steps
 - 21 spatial locations for output of results
6. TYPICAL RUNNING TIME - A test case involving ten layers with ten changes of boundary conditions required approximately 1 minute of CPU time on the IBM360/91.
7. UNUSUAL FEATURES OF THE PROGRAM - Because solutions to the transport equations are found analytically, both storage and computing time are significantly smaller than is the case for numerical solutions.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed October 1978.
 - IBM360 version submitted October 1977, sample problem executed by NESC September 1978 on an IBM370/195.
10. REFERENCES - N. M. Larson and M. Reeves, Analytical Analysis of Soil-Moisture and Trace-Contaminant Transport, ORNL/NSF/EATC-12, March 1976.
11. MACHINE REQUIREMENTS - Approximately 240K bytes of storage are required for execution.
12. PROGRAMMING LANGUAGES USED - FORTRAN IV (97%) and BAL (3%)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360,370.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The overlay structure must be used for ODMOD as certain parameters are initialized each time the subroutines are called into core. A timing function ICLOCK, measuring time in centiseconds, is assumed to be available in the installation subroutine library. This function should be provided before executing the program.
15. NAME AND ESTABLISHMENT OF AUTHORS -
 - N. M. Larson and M. Reeves
 - Nuclear Division
 - Union Carbide Corporation
 - P. O. Box X
 - Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
 - Source decks (FORTRAN-2763 cards, BAL-66 cards)
 - Sample problem (27 cards)

NESC ABSTRACT 789

03/79

Control information (45 overlay cards)
Reference report

17. **CATEGORY - R**
KEYWORDS - soils, pollution, moisture, elements, trace amounts, water
18. **SPONSOR -** NSF Ecology and Analysis of Trace Contaminants Program

1. NAME OR DESIGNATION OF PROGRAM - NUBOW-2D Inelastic
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM370
3. DESCRIPTION OF PROBLEM OR FUNCTION - This program solves the two-dimensional mechanical equilibrium configuration of a core restraint system, which is subjected to radial temperature and flux gradients, on a time increment basis. At each time increment, the code calculates the irradiation creep and swelling strains for each duct from user-specified creep and swelling correlations. Using the calculated thermal bowing, inelastic bowing and the duct dilation, the corresponding equilibrium forces, beam deflections, total beam displacements, and structural reactivity changes are calculated.
4. METHOD OF SOLUTION - The calculational history is defined by a constant time increment which should be determined from the system peak flux. Each row is represented by one single duct. All the ducts are subdivided into equal number of segments, and each segment is divided into the same number of equal area cells. Linear radial temperature distribution across the segments and flats is assumed. The thermal bow is linearly proportional to temperature difference. Parabolic flux distribution across each duct is assumed. Based on the assumption that constant force acts on the beam during the small time increment, using the cell temperature and fluences and creep and swelling correlations, the creep and swelling strains are calculated for each cell. Then these strains are numerically integrated along each beam to give the beam prebow shape. The new equilibrium forces and deflections are obtained by block relaxation. The structural reactivity changes are calculated by numerical integration along the beam.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 25 beam segments
 - 16 rows
 - 6 load points
 - 144 cellsAll the ducts are treated as thin shell hexagons, and only the radial direction effects of creep and swelling are considered. The peak fluence increment must be less than or equal to $2.5 \times 10^{-21} \text{ n/cm}^2$ for the purpose of determining the time increment.
6. TYPICAL RUNNING TIME - Running time depends on the complexities of the user-specified input data. Finer subdivisions take more computer time. For a problem with 16 rows, 21 nodes, and 30 cells, approximately 3 seconds are required for each time increment.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The calculational procedure and the block relaxation method of NUBOW-2D Inelastic are essentially the same as in NUBOW (NESC Abstract 643). Subroutines have been added to calculate time histories of inelastic changes in bowing shapes and forces induced by creep and swelling in reactor fuel assemblies (ducts).
9. STATUS - Abstract first distributed November 1978.
IBM370 version submitted September 1977, sample problem executed by NESC September 1978 on an IBM370/195.
10. REFERENCES - B. K. Cha, G. A. McLennan, and P. J. Fulford, NUBOW-2D: A FORTRAN Program for Static Two-dimensional Structural Analysis of Bowed Reactor Cores, Including Effects of Irradiation Creep and Swelling, ANL-CT-77-34, June 1977.
11. MACHINE REQUIREMENTS - 250K bytes of storage are used. The program requires a card reader, a line printer, and two disk units for temporary storage of inelastic strain data. If the restart option is desired, another disk or tape unit is used for restart file data.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/370.

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The program inelastic strain data are stored on FORTRAN logical unit numbers 10 and 12 using DCB=(RECFM=VBS,BLKSIZE=3000). If the restart option is chosen, FORTRAN logical unit 8 is used to hold the restart file. TLEFT, an installation-dependent routine which provides the job time remaining in hundredths of a second, permits the exercise of the restart option when 7 seconds or less remain. In the package a substitute TLEFT returns a constant value. This routine will have to be replaced with an appropriate local routine to implement the restart facility.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
B. K. Cha and G. A. McLennan
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16. **MATERIAL AVAILABLE** -
Source deck (1360 cards)
Sample problem (67 cards)
Reference report
17. **CATEGORY** - 1
KEYWORDS - hexagonal configuration, beams, swelling, creep, reactor core restraints, strains, stresses, deformation, temperature, two-dimensional, neutron flux, LMFBR reactors
18. **SPONSOR** - ERDA Division of Reactor Development and Demonstration

1. **NAME OR DESIGNATION OF PROGRAM** - TRANSPORT
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM370
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - The first- and second-order optical properties of static-magnet charged particle beam transport systems are analyzed. The program can vary some of the physical parameters of the elements comprising the system and impose various constraints on the beam design.
4. **METHOD OF SOLUTION** - The user describes the beam line as a sequence of elements which may be magnets, the intervals between them or special configurations of the magnets, specifications of the input beam, calculations to be done, and printout required. The program steps through the beam line calculating the appropriate transfer matrix for each element and the products of these matrices.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The effects of space charge are assumed to be negligible.
6. **TYPICAL RUNNING TIME** - Running time is dependent on the number of elements in the beam line. A typical problem requires 10 CPU seconds on the IBM370/168. The NESC executed the sample problems in 35 seconds on an IBM370/195.
7. **UNUSUAL FEATURES OF THE PROGRAM** - All calculations are done using double-precision arithmetic.
8. **RELATED AND AUXILIARY PROGRAMS** - TURTLE (NAL-64, 2041.000, December 1971) is a ray tracing program which uses input compatible with TRANSPORT. TURTLE takes into consideration some higher-order effects that TRANSPORT cannot calculate.
9. **STATUS** - Abstract first distributed November 1978.
IBM370 version submitted July 1975, sample problems executed by NESC September 1978 on an IBM370/195.
10. **REFERENCES** - K. L. Brown, D. C. Carey, Ch. Iselin, and F. Rothacker, TRANSPORT A Computer Program for Designing Charged Particle Beam Transport Systems, SLAC-91 Rev. 1, February 1974.
Karl L. Brown, A First- and Second-order Matrix Theory for the Design of Beam Transport Systems and Charged Particle Spectrometers, SLAC-75 Rev. 3, August 1972.
11. **MACHINE REQUIREMENTS** - 320K bytes of memory, a card input unit, and printer and punch output units are used. Numerous versions of TRANSPORT are available for other computers as well as overlayed versions for IBM computers.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/370.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Transfer matrices are written on FORTRAN logical unit 4 for punching.
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
F. Rothacker
Computation Research Group 88
Stanford Linear Accelerator Center
P. O. Box 4349
Stanford, California 94305
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (5499 cards)
Sample problems (1046 cards)

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Sample problems output (40 selected pages, 2 microfiche)
Reference reports

17. CATEGORY - V

KEYWORDS - charged-particle transport, magnets, accelerators, beam dynamics, beam transport, phase space, TURTLE codes

18. SPONSOR - AEC Division of Physical Research

1. **NAME OR DESIGNATION OF PROGRAM - EVITS**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** EVITS was developed for estimating steady-state, incompressible, isothermal flow fields in complex two-dimensional geometries. A velocity-stream function formulation is used along with a model to resolve viscous effects at solid boundaries. A number of geometry and ten boundary type options are included to permit specification of a variety of flow situations.
4. **METHOD OF SOLUTION -** EVITS (an acronym for Explicit Vorticity Iterative Time Step) is a synthesis of well-known two-dimensional fluid mechanics, proven iterative solution techniques and plane geometry concepts. In addition, the program includes boundary condition options resulting from numerical experimentation. EVITS uses the solution procedure developed by Roache and Mueller (references 2 and 3). The formulation is in terms of vorticity and stream function. Viscous effects are generated at solid no-slip surfaces. Vorticity is treated using the vorticity transport equation. Conservation of mass is assured by using the Poisson equation for the stream function.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Maxima of -
50 connected line segments to define solution domain
40*40 grid for calculation
6. **TYPICAL RUNNING TIME -** The NESC executed sample problem 1 utilizing a grid size of 20*10 in 51 seconds on an IBM3033. A typical problem should require about a minute for execution.
7. **UNUSUAL FEATURES OF THE PROGRAM -** EVITS is capable of solving many complex geometric boundary value problems. The solution region is defined as being on the right of ordered connected line segments which may be either straight lines (2-points) or circular arcs (3-points).
8. **RELATED AND AUXILIARY PROGRAMS -** A FORTRAN listing of a streamline plot routine, PLOTS, is included in the Users' Manual. PLOTS is intended for local interactive plotting on a Tektronix 4014 of the EVITS unit 10 output.
9. **STATUS -** Abstract first distributed November 1978.
IBM360 version submitted October 1976, sample problem executed by NESC September 1978 on an IBM3033.
10. **REFERENCES -** H. M. Domanus, Users' Manual for EVITS: A Steady State Fluids Code for Complex Two-Dimensional Geometries, ANL-CT-76-37, July 1976.
P. J. Roache and T. J. Mueller, Numerical Solutions of Laminar Separated Flows, American Institute of Aeronautics and Astronautics Journal, Vol. 8, No. 3, pp. 530-538, March 1970.
P. J. Roache, Computational Fluid Mechanics, Hermosa Publishers, Albuquerque, New Mexico, 1972.
11. **MACHINE REQUIREMENTS -** 270K bytes of memory, system card input and print output units, and, optionally, disk or tape units used for storage of problem data for subsequent plotting or problem input and error messages.
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/360.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** The program has the capability of writing and reading problem data to and from a disk which can be used to initialize another execution of EVITS or, with the use of a plotting routine, to obtain a streamline plot of the distribution. These data are written on FORTRAN logical unit 10, in card-image format. The application using the data will read FORTRAN logical unit 9. FORTRAN logical unit 20 is used for error messages.

15. NAME AND ESTABLISHMENT OF AUTHOR -

H. M. Domanus
Components Technology Division
Argonne National Laboratory
9700 South Cass Avenue
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16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (1680 cards)
Sample problems (33 cards)
Reference memorandum, ANL-CT-76-37

17. CATEGORY - H

KEYWORDS - two-dimensional, boundary conditions, incompressible flow, isothermal processes, steady flow, vortex flow, viscous flow

18. SPONSOR - ERDA Division of Reactor Development and Demonstration

1. **NAME OR DESIGNATION OF PROGRAM - CHNSE**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** CHNSE is an expanded model of hydrologic response of a watershed. It includes the simulation of trace contaminant transport through the watershed. Within the stream channel system trace contaminant is transported in dissolved and adsorbed form. CHNSE includes both SEDTRN, a model of sediment transport through a rectangular stream channel system, and the Wisconsin Hydrologic Transport Model, WHTM (NESC Abstract 808), a processes model. Processes considered in CHNSE include particulate mobilization (sheet erosion and overland transport) and dissolved contaminant transport (associated with run off, interflow, and base flow inputs to the channel system). An ion exchange submodel simulates the soil-contaminant-water interaction at the land surface, and sediment transport and partitioning of trace contaminant between water and sediment in the channel system are also included. Following its entry into the channel system, dissolved contaminant transport is derived from flow routing algorithms of the WHTM. Routing of the adsorbed fraction is controlled by sediment transport dynamics, which are governed by bedload and suspended load sediment transport.
4. **METHOD OF SOLUTION -** The sediment transport formulation is an extension of that described by R. A. Bagnold in 1966, and includes Manning's equations to determine flow rate and modification to Stokes' law to allow calculation of particulate fall velocity in both the viscous and inertial particle settling regions. Sediment is separated into three components: resident sediment in the stream bed, sediment in transit as bedload, and sediment in transit as suspended load. Each of these components is partitioned into as many as 12 size classes of logarithmically varying ranges. The partitioning of a contaminant between water and sediment is based on the assumption of an equilibrium distribution being attained within each simulation interval.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Current computer storage allocation allows a watershed to be divided into three segments while the channel system is broken down into seven separate reaches.
6. **TYPICAL RUNNING TIME -** A test simulation of a one-year real time duration for a two-segment watershed and three-reach channel system required approximately 5 minutes of CPU time on the IBM System 360/91.
7. **UNUSUAL FEATURES OF THE PROGRAM -** This is primarily a research model, constructed to be as mechanistic as possible; as such, it requires a rather complete parametric description of the watershed, the channel system, and the initial distribution of sediment within the channel system.
8. **RELATED AND AUXILIARY PROGRAMS -** CHNSE is one of a suite of models termed collectively the unified transport model (UTM).
9. **STATUS -** Abstract first distributed November 1978.
IBM360 version submitted October 1977, sample problem executed by NESC October 1978 on an IBM3033.
10. **REFERENCES -** D. E. Fields, Simulation of Sediment and Trace Contaminant Transport with Sediment-Contaminant Interaction, ORNL/NSF/EATC-19, March 1976.
M. R. Patterson, J. K. Munro, D. E. Fields, R. D. Ellison, A. A. Brooks, and D. D. Huff, A User's Manual for the FORTRAN IV Version of the Wisconsin Hydrologic Transport Model, ORNL/NSF/EATC-7, October 1974.
R. A. Bagnold, An Approach to the Sediment Transport Problem from General Physics, Geological Survey Professional Paper 422-1, U.S. Government Printing Office, 1966.
D. E. Fields, LINED: A One Dimensional Multireach Sediment Transport Model, ORNL/CSD-15, October 1976.
D. E. Fields and D. M. Hetrick, HOTSED: A Discrete Element for Simulating Hydrodynamic Conditions and Adsorbed and Dissolved Radioisotope Concentrations in Estuaries, NUREG/TM-266 (in press).

11. **MACHINE REQUIREMENTS** - 350K bytes of storage are required and FORTRAN logical units 1 through 4 are utilized for temporary files during problem execution.
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV (96%) and BAL (4%)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - An overlay structure is used to reduce main storage requirements. CHNSED is compiled with the FORTRAN H compiler using OPT=2 and the XL option.
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
D. E. Fields
Nuclear Division
Union Carbide Corporation
P. O. Box X
Oak Ridge, Tennessee 37830
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (FORTRAN-5403 cards, BAL-179 cards)
Sample problem (334 cards)
Control information (JCL 114 cards)
Reference report, ORNL/NSF/EATC-19
17. **CATEGORY** - R
KEYWORDS - sediments, ion exchange, water quality, hydrology, particles, water pollution, trace amounts, soils, erosion, WHTM codes
18. **SPONSOR** - NSF Ecology and Analysis of Trace Contaminants Program

1. **NAME OR DESIGNATION OF PROGRAM -** OPTRM
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** OPTRM is utilized to determine an optimal set of model parameters for the Wisconsin Hydrologic Transport Model, WHTM (NESC Abstract 808). An optimal set of parameters is defined as that set which gives in a mathematical sense the best simulation; i.e., which provides the best match on either a monthly or daily basis between observed outflows and simulated outflows. The term outflow applies here to either water or trace contaminant values.
4. **METHOD OF SOLUTION -** OPTRM utilizes a pattern search technique to minimize an objective function designed to quantify the dissimilarity between observed and simulated hydrologic flows or contaminant transport values. The method is an unconstrained nonlinear optimization technique not requiring gradients.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** As currently structured, OPTRM optimizes a set of either six hydrologic response parameters or three contaminant transport-related values. OPTRM determines a set of parameters for a single segment of a watershed. A segment may be considered a normally homogeneous region of the watershed.
6. **TYPICAL RUNNING TIME -** A test case optimizing six hydrologic parameters for a real-time simulation interval of 31 days required 5 minutes of CPU time excluding wait time on an IBM360/91. Approximately 70 interactions of the WHTM submodel were made within this time. For a simulation period of one year with a set of six parameters being optimized, approximately one minute of execution time is required per iteration and typically 25 iterations are needed to attain an objective function equal to about 90 percent of its minimum value.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -** The capability to simulate the hydrologic transport of selected radio-aerosols was added to SWM, the Stanford Watershed Model, originally developed at Stanford in 1960, by Huff and associates at the University of Wisconsin. This model, WHTM, was then modified at ORNL to include parameter optimization.
9. **STATUS -** Abstract first distributed November 1978.
IBM360 version submitted October 1977, sample problem executed by NESC October 1978 on an IBM3033.
10. **REFERENCES -** D. E. Fields and S. B. Watson, OPTRM - A Hydrologic Transport Model with Parameter Optimization, ORNL/NSF/EATC-14, September 1975.
R. K. Linsley and N. H. Crawford, Computation of a Synthetic Streamflow Record on a Digital Computer, International Association of Scientific Hydrology, Pub. No. 51, pp. 526-538, 1960.
D. D. Huff, Simulation of the Hydrologic Transport of Radioactive Aerosols, Ph.D. Thesis, Stanford University, 1968.
M. R. Patterson, J. K. Munro, D. E. Fields, R. D. Ellison, A. A. Brooks, and D. D. Huff, A User's Manual for the FORTRAN IV Version of the Wisconsin Hydrologic Transport Model, ORNL-NSF-EATC-7, October 1974.
11. **MACHINE REQUIREMENTS -** OPTRM utilizes an overlay structure requiring 290K bytes of storage. FORTRAN logical units 1 through 4, disk storage, are used as temporary files. The LAND and CHANL input are read from disk logical unit 5 with other input data read from unit 10. In addition to the print output on logical unit 15, units 6 and 13 are used for daily observed and simulated flow print and plot output.
12. **PROGRAMMING LANGUAGES USED -** FORTRAN IV (96%) and BAL (4%)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/360.

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The program should be compiled with the XL option of the FORTRAN H compiler. OPTRM uses a CalComp package to plot observed and simulated watershed responses.
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
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16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (FORTRAN-4900 cards, BAL-179 cards)
Sample problems (LAND and CHANL input-182 cards, other input-539 cards)
Control information (JCL 113 cards)
Reference report, ORNL/NSF/EATC-14
17. **CATEGORY** - R
KEYWORDS - atmospheric precipitations, chemical effluents, environment, ground water, hydrodynamics, surface waters, water pollution, hydrology, land pollution, regional analysis
18. **SPONSOR** - NSF Ecology and Analysis of Trace Contaminants Program

1. NAME OR DESIGNATION OF PROGRAM - SHOCK
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600, 7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - SHOCK calculates the dynamic response of a structure modeled as a spring-mass system having one or two degrees of freedom for each mass when subjected to specified environments. The code determines the behavior of each lumped mass (displacement, velocity, and acceleration for each degree of freedom) and the behavior of each spring or coupling (force, shear, moment, and displacement) as a function of time. Two types of models, axial, having one degree of freedom, and lateral, having two degrees of freedom at each mass can be processed. Damping can be included in all models and shock spectrums of responses can be obtained.
4. METHOD OF SOLUTION - Two methods of numerical integration of the second-order dynamic equations are provided: the Runge-Kutta-Gill method with variable step-size is recommended for highly nonlinear problems, and a variation of the Newmark-Beta method is available for use with large linear problems.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
100 masses
200 springs or couplings
Complex arrangements of nonlinear options must be carefully checked by the user.
6. TYPICAL RUNNING TIME - The time required to process a problem is a function of an integration step which is determined from an estimated maximum frequency existing in the model. Representative times on the CDC6600 are 3 seconds for 1500 steps for a 6 mass lateral problem and 24 seconds for 2000 steps for a 20 mass axial problem.
7. UNUSUAL FEATURES OF THE PROGRAM - The program's primary attributes are convenient input procedures and plot capabilities.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1978.
CDC6600 version submitted March 1978, sample problem executed by NESC October 1978 on a CDC7600.
10. REFERENCES - V. K. Gabrielson and R. T. Reese, SHOCK Code Users Manual: A Computer Code to Solve the Dynamic Response of Lumped Mass Systems, SCL-DR-69-98, November 1969, reprinted September 1975.
V. K. Gabrielson, Supplement to SHOCK Report SCL-DR-69-98, SCL-DR-720361, January 1973, reprinted August 1974.
11. MACHINE REQUIREMENTS - 125,000 (octal) words of storage are used.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.4 or NOS/BE.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The memory must be preset to zero prior to problem execution. Calls in subroutines SHOK835 and SHSP to local SLL CalComp and SCORS plotting package routines ENDPLOT, EXTFLM, NUMBER, NUMBER3, QUICK, QUICKML, and SYMBOL, not included in the package, are returned by a dummy subroutine supplied by NESC. Appropriate local routines are required to replace these routines for implementation of the program's plotting capabilities. The HOROLOG routine at SLL returns the job time remaining in seconds. The HOROLOG routine in the package returns a constant value of 100 seconds. This, too, should be replaced with the appropriate local routine.
15. NAME AND ESTABLISHMENT OF AUTHOR -
V. K. Gabrielson
Numerical Applications Division 832

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16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (3707 cards)
Sample problems (99 cards)
Sample problems output (46 selected pages)
Reference reports
17. **CATEGORY** - I
KEYWORDS - equations of motion, damping, dynamic loads, mechanics
18. **SPONSOR** - ERDA Division of Military Application

1. **NAME OR DESIGNATION OF PROGRAM** - PACT2
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - PACT2 computes the probability distribution of the coolant and cladding outside (film) temperatures for an LMFBR wire-wrap fuel assembly at the start of life under a steady-state operating condition. It uses a mathematical model that considers both thermal-hydraulics in coolant subchannels and Monte Carlo sampling of the thermal-hydraulic calculation. The coolant temperature is defined as a function of enthalpy, flowrate, crossflow between adjacent subchannels, heat flux, and position.
4. **METHOD OF SOLUTION** - Monte Carlo simulation is used to obtain the probability distributions of the subchannel coolant and associated fuel pin cladding outside (film) temperatures. Each Monte Carlo sample (response) is determined from performing a subchannel analysis for the fuel assembly in a flat-to-flat or a corner-to-corner direction. A whole assembly temperature field mapping is obtainable by carrying out a sequential combination of flat-to-flat and corner-to-corner analyses. The equations of the mathematical model for the thermal-hydraulic calculation are solved by using a forward-marching finite-difference scheme. This scheme gives an initial-value energy solution for steady-state when the boundary conditions are the inlet enthalpy, inlet mass velocity and channel wall temperature. In marching forward the integral node temperature is used to improve accuracy.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Hexagonal assemblies with 7 to 271 fuel pins can be treated. The mathematical model neglects the redistribution of subchannel coolant flow; therefore, it is limited to fuel pin assemblies in which there is no flow blockage. All the crossflow interactions are lumped into a single parameter.
6. **TYPICAL RUNNING TIME** - A 217-pin assembly having 1000 samples takes 95 seconds to run on the CDC7600.
7. **UNUSUAL FEATURES OF THE PROGRAM** -
8. **RELATED AND AUXILIARY PROGRAMS** - PACT2 is an improved edition of the earlier PACT program. The numerical scheme employed is more accurate than the implicit scheme used in PACT.
9. **STATUS** - Abstract first distributed December 1978.
CDC7600 version submitted June 1978, sample problem executed by NESC October 1978 on a CDC7600.
10. **REFERENCES** - K. H. Chen and D. G. Hoover, PACT 2, Probabilistic Analysis of Coolant and Cladding Temperatures, GEFR-00417, June 1978.
J. P. Wei, Thermal-Hydraulic Evaluation of Advanced Wire-Wrap Assemblies, American Institute of Chemical Engineers Symposium Series No. 164, Vol. 73, pp. 105-113, 1977.
11. **MACHINE REQUIREMENTS** - 170K (octal) words of memory are used.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV, FTN4 compiler
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 2.1.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The plotting (subroutines OUTPUT and DRAW) utilizes CalComp system routines peculiar to the Lawrence Berkeley Laboratory's computer environment. Calls to CCEND, CCGRID, CCLTR, CCNEXT, CCPLT, and LINEUP are returned by a dummy subroutine supplied by NESC. This must be replaced with local plotting routines to obtain the optional plots of cladding and coolant temperatures and histograms.

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15. NAME AND ESTABLISHMENT OF AUTHORS -

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16. MATERIAL AVAILABLE - Special Distribution

Magnetic Tape Transmittal
Source deck (3683 cards)
Sample problem (51 cards)
Reference report draft

17. CATEGORY - H

KEYWORDS - coolants, cladding, temperature, Monte Carlo method, heat transfer, steady-state conditions

18. SPONSOR - DOE Division of Reactor Research and Technology

1. NAME OR DESIGNATION OF PROGRAM - HAARM3
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC CYBER73, 6400, 7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - HAARM3, an acronym for Heterogeneous Aerosol Agglomeration Revised Model 3, is the third program in the HAARM series developed to predict the time-dependent behavior of radioactive aerosols under postulated LMFBR accident conditions. HAARM3 was developed to include mechanisms of aerosol growth and removal which had not been accounted for in the earlier models. In addition, experimental measurements obtained on sodium oxide aerosols have been incorporated in the code. As in HAARM2, containment gas temperature, pressure, and temperature gradients normal to interior surfaces are permitted to vary with time.
The effects of reduced density on sodium oxide agglomerate behavior and of nonspherical shape of particles on aerosol behavior mechanisms are taken into account and aerosol agglomeration due to turbulent air motion is considered. Also included is a capability to calculate aerosol concentration attenuation factors and to restart problems requiring long computing times.
4. METHOD OF SOLUTION - HAARM3 assumes the time-dependent particle size distribution is log-normal and converts the integro-differential equation describing the concentration decay of aerosol into three first-order differential equations which are integrated using a standard library subroutine. The present model allows the method of integration to be specified. The choices are: Adams Moulton with either a fixed or variable step-size and Runge-Kutta with a fixed step-size.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
1000 time-steps
42 discrete radii for the distribution calculations
6. TYPICAL RUNNING TIME - The sample problem took 1 second of CP time on a CDC7600.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - Various models have been developed to describe aerosol behavior under postulated accident conditions including the TRAP code at Brookhaven National Laboratory (Nuclear Science and Engineering, Vol. 42, pp. 58-63, 1970), the PARADISEK03 code at Karlsruhe (KFK 2151, May 1975), and the HAA3B code at Atomic International (NESC Abstract 443). HAARM3 can be used to provide the input data for dose calculations, such as COMRADEX4 (NESC Abstract 663).
9. STATUS - Abstract first distributed November 1978.
CDC CYBER73 version submitted September 1978, sample problem executed by NESC October 1978 on a CDC7600.
10. REFERENCES - J. A. Gieseke, K. W. Lee, and L. D. Reed, HAARM-3 Users Manual, BMI-NUREG-1991 with Errata, January 5, 1978.
J. A. Gieseke, L. D. Reed, H. Jordan, and K. W. Lee, Characteristics of Agglomerates of Sodium Oxide Aerosol Particles, BMI-NUREG-1977, August 1, 1977.
L. D. Reed and J. A. Gieseke, HAARM-1 Users Manual, BMI-X-658, May 15, 1975.
L. D. Reed and J. A. Gieseke, HAARM-2 Users Manual, BMI-X-665, October 31, 1975.
R. S. Hubner, E. U. Vaughan, and L. Baurmash, HAA-3 User Report, AI-AEC-13038, March 1973.
11. MACHINE REQUIREMENTS - 117,000 (octal) words of storage are required.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV, FTN4.5 (7600)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - NOS/BE 1.0 (CE CYBER73), SCOPE 2.1.3 (CDC7600).

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHORS -

J. A. Gieseke, K. W. Lee, and L. D. Reed
Columbus Laboratories
Battelle
505 King Avenue
Columbus, Ohio 43201

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (2943 cards)
Sample problem (13 cards)
Reference report, BMI-NUREG-1991 with Errata

17. CATEGORY - G

KEYWORDS - radioactive aerosols, accidents, containment systems, deposition, diffusion, radioactivity transport, LMFBR reactors, HAA3B codes, COMRADEX codes

18. SPONSOR - NRC Division of Reactor Safety Research

1. **NAME OR DESIGNATION OF PROGRAM** - MSF21,VTE21
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - MSF21 and VTE21 perform design and costing calculations for multistage flash evaporator (MSF) and multieffect vertical tube evaporator (VTE) desalination plants. An optimization capability is available, if desired.
The MSF plant consists of a recovery section, reject section, brine heater, and associated buildings and equipment. Operating costs and direct and indirect capital costs for plant, buildings, site, and intakes are calculated. Computations are based on the first and last stages of each section and a typical middle recovery stage. As a result, the program runs rapidly but does not give stage by stage parameters.
The VTE plant consists of vertical tube effects, multistage flash preheater, condenser, and brine heater and associated buildings and equipment. Design computations are done for each vertical tube effect, but preheater computations are based on the first and last stages and a typical middle stage.
4. **METHOD OF SOLUTION** - The general method is to solve for a heat and mass balance in each part of the plant.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - In the MSF program the loss of tray brine temperature is the same for each stage in the heat recovery section and in the heat reject section. The temperature and the flow rate of the heat reject stream are always greater than zero, and there is no option to consider a once-through type plant.
The VTE plant design is limited to 30 effects.
6. **TYPICAL RUNNING TIME** - A single MSF computation typically requires 1.5 seconds on the IBM360/65. An optimization requiring 300 iterations is accomplished in about 75 seconds. On the IBM360/91 an optimized case typically runs about 3 seconds. The four trial cases including MSF21 and VTE21 runs, with and without optimization, for a 2.5 Mgd plant using program-defined default parameters, required a total of 6.5 seconds on the IBM370/195.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The programs include default or built-in values for all design parameters. Only those values which are to be changed must be entered as problem input data.
8. **RELATED AND AUXILIARY PROGRAMS** -
9. **STATUS** - Abstract first distributed November 1978.
IBM360 version submitted October 1976, sample problems executed by NESC October 1978 on an IBM370/195.
10. **REFERENCES** - W. G. S. Fort, Computer Codes for Office of Saline Water Program Analysis Part V: MSF-21: A Fortran Code for the Rapid Calculation or Optimization of Multistage Flash (MSF) Desalination Plants, ORNL-TM-3535 Part V, February 1972.
W. G. S. Fort and J. V. Wilson, Computer Codes for Office of Saline Water Program Analysis Part VI. VTE-21: A FORTRAN Code for the Rapid Calculation or Optimization of Vertical Tube Evaporator (VTE) Desalination Plants, ORNL/TM-3535 Part VI, September 1976.
P. Glueckstern, J. V. Wilson, and S. A. Reed, Modifications of ORNL's Computer Programs MSF-21 and VTE-21 for the Evaluation and Rapid Optimization of Multistage Flash and Vertical Tube Evaporators, ORNL/TM-5230 and Errata, June 1976.
W. G. S. Fort, S. H. Moore, and J. V. Wilson, Computer Codes for Office of Saline Water Program Analysis Part III, Programs and Subprograms Common to Several Desalination Processes, Including Code PROC21, ORNL-TM-3535 Part III, January 1973.
NESC Note 79-17, NESC No. 798.360, Description of MSF21,VTE21 Input Data, October 11, 1978.
U. S. Department of Interior Office of Saline Water and the Bureau of Reclamation, Desalting Handbook for Planners, First Edition, May 1972.

- 11. MACHINE REQUIREMENTS** - MSF21,VTE21 requires 272K bytes of storage for execution. Standard system card-image input and printer output units are needed.
- 12. PROGRAMMING LANGUAGES USED** - FORTRAN (97%) and BAL (3%)
- 13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360,370.
- 14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Programs MSF21 and VTE21 are packaged together because they have many subprograms in common. The type of plant to be calculated is specified in the input data.
Subroutines MAINM, PLANTM, SIZEM, COSTM, and RITEM are specific to program MSF21. Subroutines MAINV, PLANTV, SIZEV, COSTV, RITEV, and UVE are specific to program VTE21. If only one type of plant is to be calculated, the amount of storage required by the program can be reduced by omitting unnecessary subroutines. When subroutines MAINM or MAINV are omitted, dummy subroutines should be substituted or the statements calling the missing subroutine deleted.
- 15. NAME AND ESTABLISHMENT OF AUTHOR** -
Contact J. V. Wilson
Engineering Technology Division
Oak Ridge National Laboratory
P. O. Box Y
Oak Ridge, Tennessee 37830
- 16. MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (FORTRAN-5345 cards, BAL-155 cards)
Sample problems (9 cards)
Sample problem output (30 pages)
Reference reports, ORNL-TM-3535 Parts V and VI, ORNL/TM-5230 with Errata, NESC Note, and ORNL-TM-3535 Part III (2 microfiche)
- 17. CATEGORY** - D
KEYWORDS - evaporators, desalination, flash heating, design, optimization, seawater, tubes, cost, economics, performance
- 18. SPONSOR** - ERDA Division of Nuclear Research and Applications
DOI Office of Saline Water

1. **NAME OR DESIGNATION OF PROGRAM** - TDIST2
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM370,303x
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - The TDIST2 program designs and performs an analysis of community size total energy systems supplying thermal and electrical energy to a multi-consumer-type metropolitan area. The program models the time-dependent energy requirements of building unit consumers, distributes these demands within a Thermal Utility System (TUS), simulates the TUS performance and determines the required behavior of the power station and thermal-energy storage reservoir. The energy requirements of the community fall into three categories: space conditioning demands (heating and cooling), electric non-space conditioning demands (load from use of lights, motors, etc.), and hot water demands.
4. **METHOD OF SOLUTION** - The analysis is performed using an iterative-boundary technique on the quasi-steady state energy supply and demand in a community. The analysis includes the response of the power source to energy demand, as well as varying consumer loads. Using an estimated mass flow rate based on consumer demand and fixed source water temperature, ambient losses (or gains) of the water travelling in buried piping to the consumer are calculated. At the consumer load center the supplied thermal power is computed and compared with the thermal demand. If the match is not within a specified tolerance, a mass flow rate correction is applied and another iteration is begun. Iteration continues until the supply satisfies the demand or a set number of iterations has been performed.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - TDIST2 can handle a maximum of 20 different building types. Piping systems used in the total energy system can have only one energy source.
6. **TYPICAL RUNNING TIME** - The most complex problem would require a maximum of 3 minutes on an IBM370/168. The NESC executed the sample problem involving a 24-hour total energy simulation of a community with a 35,000 population and incorporating 15 building types in 7 seconds on an IBM3033.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The TDIST2 user may specify the subroutines to be executed. Some of the subroutines obtain data required for execution either from assigned COMMON memory or from card-image input. Since most subroutines punch results as well as store them in COMMON for use by succeeding subroutines, the user may choose to selectively substitute card input rather than re-execute subroutines and recompute data on occasion.
8. **RELATED AND AUXILIARY PROGRAMS** - NBSLD, the National Bureau of Standards program (reference 3). An earlier edition of this thermal distribution system simulation code, TDIST1, did not include as many computational options.
9. **STATUS** - Abstract first distributed December 1978.
IBM370 version submitted July 1978, sample problem executed by NESC October 1978 on an IBM3033.
10. **REFERENCES** - Steven B. Goldman, Frederick R. Best, and Michael W. Golay, TDIST2, A Computer Program for Community Energy Consumption Analysis and Total System Design, FESA-RT-2047, December 1977.
J. W. Stetkas and M. W. Golay, User's Manual: TDIST, A Program for Community Energy Demand Analysis and Total Energy System Response Simulation, MIT Department of Nuclear Engineering and MIT Energy Laboratory, August 31, 1976.
T. Kusuda, NBSLD, Computer Programs for Heating and Cooling Loads in Buildings, NBSIR-74-574, National Bureau of Standards, Washington, DC, November 1974.
11. **MACHINE REQUIREMENTS** - 250K bytes of memory, card-image input unit, and printer and card-punch output units
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV, IBM FORTRAN G compiler

13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/370 MVT, Release 21.7.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Use of the FORTRAN G compiler is recommended. Only large-size H compilers can accommodate subroutine TUS requirements. Hourly plant data including the community electrical demand, TUS energy demand, plant waste heat, and energy to the reservoir can be punched for use as input to a separate plotting program (not included) to plot these plant parameters over time.
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
M. W. Golay
Department of Nuclear Engineering
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (1874 cards)
Sample problem (548 cards)
Reference report, FESA-RT-2047
17. **CATEGORY** - T
KEYWORDS - energy analysis, economics, energy demand, heat distribution systems, urban areas, total energy systems, electric power, electric utilities
18. **SPONSOR** - DOD U. S. Army Facilities Engineering Support Agency

1. NAME OR DESIGNATION OF PROGRAM - LINPACK

2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370 (designed to be machine-independent)

3. DESCRIPTION OF PROBLEM OR FUNCTION - LINPACK is a collection of FORTRAN subroutines which analyze and solve various classes of systems of simultaneous linear algebraic equations. The collection deals with general, banded, symmetric indefinite, symmetric positive definite, triangular, and tridiagonal square matrices, as well as with least squares problems and the QR and singular value decompositions of rectangular matrices.

A subroutine-naming convention is employed in which each subroutine name consists of five letters which represent a coded specification (TXXYY) of the computation done by that subroutine. The first letter, T, indicates the matrix data type. Standard FORTRAN allows the use of three such types: S REAL, D DOUBLE PRECISION, and C COMPLEX. In addition, some FORTRAN systems allow a double-precision complex type: Z COMPLEX*16. The second and third letters of the subroutine name, XX, indicate the form of the matrix or its decomposition:

GE General
GB General band
PO Positive definite
PP Positive definite packed
PB Positive definite band
SI Symmetric indefinite
SP Symmetric indefinite packed
HI Hermitian indefinite
HP Hermitian indefinite packed
TR Triangular
GT General tridiagonal
PT Positive definite tridiagonal
CH Cholesky decomposition
QR Orthogonal-triangular decomposition
SV Singular value decomposition

The final two letters, YY, indicate the computation done by the particular subroutine:

FA Factor
CO Factor and estimate condition
SL Solve
DI Determinant and/or inverse and/or inertia
DC Decompose
UD Update
DD Downdate
EX Exchange

The following chart shows all the LINPACK subroutines. The initial 'S' in the names may be replaced by D, C or Z and the initial 'C' in the complex-only names may be replaced by a Z.

	FA	CO	SL	DI	DC	UD	DD	EX
SGE	x	x	x	x				
SGB	x	x	x	x				
SPO	x	x	x	x				
SPP	x	x	x	x				
SPB	x	x	x	x				
SSI	x	x	x	x				
SSP	x	x	x	x				
CHI	x	x	x	x				
CHP	x	x	x	x				
STR		x	x					
SGT			x					
SPT			x					
SCH					x	x	x	x
SQR			x		x			
SSV					x			

The LINPACK package also includes a set of routines to perform basic vector operations called the Basic Linear Algebra Subprograms (BLAS).

4. **METHOD OF SOLUTION** - Gaussian elimination, Cholesky decomposition, QR, and singular value decomposition methods are used.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - There are no subroutines for general sparse matrices or for iterative methods for very large problems.
6. **TYPICAL RUNNING TIME** - Running time varies with problem size. NESC executed each test case in about 8 seconds on Argonne's IBM370/195.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The LINPACK subroutines contain no machine-dependent constants, input or output statements, character manipulations, COMMON or EQUIVALENCE statements, nor mixed-mode arithmetic. All subroutines except those with names beginning with Z use the portable subset of ANSI FORTRAN.

The LINPACK project supports this software in the sense that detailed information on the testing procedures is available, and reports of poor or incorrect performance in conventional FORTRAN operating environments will gain immediate attention from the developers.

8. **RELATED AND AUXILIARY PROGRAMS** -

9. **STATUS** - Abstract first distributed February 1979.
LINPACK submitted January 1979, revised March 1979, sample problems executed by NESC January 1979 on an IBM370/195 and an IBM3033.

10. **REFERENCES** - J. J. Dongarra, J. R. Bunch, C. B. Moler, G. W. Stewart, LINPACK Users' Guide, Society for Industrial and Applied Mathematics, Philadelphia, Pennsylvania, 1979.
C. L. Lawson, R. J. Hanson, D. R. Kincaid, and F. T. Krogh, Basic Linear Algebra Subprograms for Fortran Usage, SAND-77-0898, October 1977 (to be published in Association for Computing Machinery, Transactions on Mathematical Software).
J. J. Dongarra and C. B. Moler, LINPACK WORKING NOTE #13 Implementation Guide for LINPACK, ANL Applied Mathematics Division Technical Memorandum No. 330, February 1979.

11. **MACHINE REQUIREMENTS** - The entire coefficient matrix will usually be stored in the computer memory, although there are provisions for band matrices and for row-by-row processing of large rectangular matrices. 240K bytes of storage are required for execution of a typical sample problem on the IBM360,370 system.

12. **PROGRAMMING LANGUAGE USED** - FORTRAN

13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360,370 on the IBM360,370.

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The test drivers call a subroutine TRAPS to set the number of underflows permitted. The call is TRAPS(I1,I2,I3,I4,I5) where

- I1 should be set to zero,
- I2 is the number of floating-point overflows permitted,
- I3 is the number of floating-point underflows permitted,
- I4 is the number of fixed-point divides by zero permitted, and
- I5 is the number of floating-point divides by zero permitted.

Each installation will have to provide a subroutine TRAPS, which in turn, should call the local error handling routine which should be set to permit a large number of underflows (5000). If the error-handling procedures are determined by the operating system control language this will have to be set appropriately and a dummy subroutine TRAPS supplied. TRAPS is the standard routine used in WATFIV. On the IBM360,370 the routine is ERRSET.

The sample problems, or testing aids, have been run at the computer installations listed below using a variety of compiler and operating systems.

Test Site	Machine
Argonne National Laboratory	IBM370/195
Bell Laboratories at Murray Hill	Honeywell6080
College of William and Mary	IBM370/148
International Mathematical and Statistical Libraries (IMSL)	EclipseC330
Iowa State University	Itel-AS/5

Lawrence Livermore Laboratory	CDC7600
Los Alamos Scientific Laboratory	CDC7600, CRAY1
Monash University, Australia	Burroughs6700
NASA Langley Research Center	CDC Cyber175
National Center for Atmospheric Research	CDC7600, CRAY1
National Defense Research Institute,	IBM360/75
Tumba, Sweden	
Naval Weapons Center, China Lake	UNIVAC1110
Northwestern University	CDC6600
Oak Ridge National Laboratory	IBM360/91
Purdue University	CDC6500
Stanford University, SLAC	IBM370/168
University of California, San Diego	Burroughs6700
University of Kentucky	IBM370/158
University of Illinois, Chicago Circle	IBM370/168
University of Illinois at Urbana-Champaign	CDC Cyber175
The University of Michigan	Amdahl 470/V6
The University of Texas at Austin	CDC6600-6400
University of Toronto, Toronto, Canada	IBM370/165
The University of Wisconsin-Madison	UNIVAC1110
Yale University	DEC-KL-20, KA-10

15. NAME AND ESTABLISHMENT OF AUTHOR -

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 Argonne National Laboratory
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 Argonne, Illinois 60439

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (LINPACK S-6861 cards, D-6867 cards, C-8771 cards, Z-8935 cards, BLAS S-562 cards, D-560 cards, C-575 cards, Z-580 cards)
 Machine-readable documentation (S-2708 cards, D-2714 cards, C-3189 cards, Z-3189 cards)
 Reference report and Memorandum, SAND-77-0898 and ANL-AMD Technical Memorandum No. 330

17. CATEGORY - P

KEYWORDS - numerical solution, matrices, least square fit

18. SPONSOR - DOE Division of Engineering, Mathematical and Geo-Sciences

NSF Mathematical and Computer Science Division

1. **NAME OR DESIGNATION OF PROGRAM - SKILLS INVENTORY**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC6400,7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** The personnel SKILLS INVENTORY system consists of the three programs SKILLS, SKLFORM, and SEARCH. Each program is run independently of the others. SKILLS is designed to add, change, and delete personal data; build, search and/or print one master record for each employee entered into the system, whether active or terminated; delete an employee's entire master record; insert indicative comments when required; and perform a general check against an employee personnel card deck to ensure compatibility of data. Using skills search parameter cards, SEARCH can perform a complex variety and combination of searches, including a reverse search, and print various listings on a selective basis. Listing information includes educational degrees, professional licenses, professional society memberships, education, and employment status. SKLFORM converts employees' coded data into readable English language and prints their entire record.
4. **METHOD OF SOLUTION -** There are eight SKILLS update cards, each identified by a card code (01-08), which provide the capability to add, change, and/or delete employee information. SEARCH parameter cards establish the high-low ranges on selective data and determine whether the search is to be on a Boolean 'AND' or 'OR' basis.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Each employee's record is limited to 999 ten-character words, including comments. Each update is limited to 999 SKILLS cards. A SKILLS update transaction for an employee cannot be performed during the same processing that the employee is being added to the personnel skills inventory file, but must be performed in a separate, subsequent run. The SEARCH program has a maximum of 19 search items per process. The SKLFORM program allows a maximum of 50 employees, called by a payroll identification number, per process.
6. **TYPICAL RUNNING TIME -** NESC executed the sample problems in 14 CP seconds on a CDC7600.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -**
9. **STATUS -** Abstract first distributed February 1979.
CDC6400 version submitted May 1975, sample problems executed by NESC January 1979 on a CDC7600.
10. **REFERENCES -** R. Aaron, Personnel Skills Inventory System User Manual, Rev. 2, March 28, 1974.
11. **MACHINE REQUIREMENTS -** The number of words (octal) of small core memory (SCM) required to execute each of the three programs is: SKILLS-62,000, SKLFORM-55,000, and SEARCH-21,000.
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** SCOPE.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** The programs were initially written for the RUN compiler and were converted by NESC to execute under the FTN compiler. CDC system routines DATE and CLOCK are used. 6K (octal) words of SCM are required to compile the SKLFORM code. If an alphabetized individual and/or cross-index listing is desired from the SEARCH program, an external SORT must be applied to the master file before executing SEARCH. These lists are produced only when files are selected in the search.
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
Author W. Boschea

NESC ABSTRACT 801

04/79

Contact **R. Aaron**
 Holmes & Narver, Inc.
 P. O. Box 14340
 Las Vegas, Nevada 98114

- 16. MATERIAL AVAILABLE - Magnetic Tape Transmittal**
 Source decks (SKILLS 994 cards, SKLFORM 1974 cards, SEARCH 639 cards)
 Sample problems (SKILLS 536 cards, SKLFORM 22 cards, SEARCH 29 cards)
 Control information (57 cards)
 Sample problems output (16 selected pages)
 Reference manual
- 17. CATEGORY - M**
 KEYWORDS - inventories, personnel, data base systems
- 18. SPONSOR - AEC Division of Military Application**

1. NAME OR DESIGNATION OF PROGRAM - SCHAFF
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - The SCHAFF (Slightly Compressible Heat and Fluid Flow) program was developed for numerical modeling of liquid geothermal systems involving natural convection and hot spring discharge. For one-, two-, or three-dimensional porous media, the single-phase fluid and heat transfer equations are solved interlaced in time, using an integrated finite difference method. The mathematical model describing the physical behavior of hot-water geothermal systems is used to analyze natural or cellular convection in permeable layers heated from below.
4. METHOD OF SOLUTION - The model consists of a set of coupled partial differential equations for heat and mass transfer in porous media and an equation of state relating fluid density to temperature. Simultaneous solution of the flow and energy equations is accomplished by interlacing the solutions in time, first assuming temperatures and fluid densities constant over an interval and solving for new fluid pressure and velocity distributions, then using the new pressure and velocity distributions to compute new temperature and fluid density distributions and so on. These equations are solved numerically using an integrated finite difference method which treats arbitrary nodal configurations in up to three dimensions. The concepts of fluid and thermal time constants as indicators of nodal response times and numerical stability limits is an inherent part of the numerical scheme.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The equations used do not include source terms. With a mass source, such as a recharge or discharge well, the flow field would not necessarily equilibrate within each thermal cycle.
6. TYPICAL RUNNING TIME - SCHAFF requires approximately 30 seconds CP time to complete the sample problem on a CDC7600.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed November 1978.
CDC7600 version submitted June 1976, sample problem executed by NESC March 1978 on a CDC7600.
10. REFERENCES - Michael L. Sorey, Numerical Modeling of Liquid Geothermal Systems, (Ph.D. thesis), University of California, Berkeley, California, 1975.
Marcelo J. Lippmann, Preparation of Input Data for Program Schaff, LBL Notes, May 1976.
11. MACHINE REQUIREMENTS - The program requires approximately 110K words of central memory for execution. Standard system input and print and punch output units are required along with units for temporary storage of two tape or disk files.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 2.1.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - A dummy HOUR subroutine has been supplied by NESC as a substitute for the LBL system routine of that name which returns the current wall-clock time in A10 format. The user will have to supply an alternative routine applicable in the local environment.
15. NAME AND ESTABLISHMENT OF AUTHORS -
M. L. Sorey and M. J. Lippmann
Lawrence Berkeley Laboratory

NESC ABSTRACT 802

04/79

Berkeley, California 94720

• Contact

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (2252 cards)

Sample problem (90 cards)

Sample problem output (47 selected pages, 1 microfiche)

Reference Ph.D. thesis and LBL Notes

17. CATEGORY - H

KEYWORDS - geothermal systems, fluid flow, heat transfer, natural convection, hot springs, equations of state, finite difference method, porous materials, pressure dependence, temperature dependence

18. SPONSOR - U. S. Geological Survey

Lawrence Berkeley Laboratory

1. **NAME OR DESIGNATION OF PROGRAM - BASIC2 INTERPRETER**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
MCS-80, 8080-based microcomputers
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** The BASIC2 INTERPRETER was developed to provide a high-level easy-to-use language for performing both control and computational functions in the MCS-80. The numerical operations are done using Advanced Micro Device's Am9511 arithmetic processor chip, or alternatively, by using a software simulation of that chip. To minimize system size and cost, the interpreter was constrained to fit in 8K bytes, requiring implementation of a customized subset of BASIC. The package is supplied as two alternative implementations, hardware and software. The "software" implementation provides the following capabilities: entry and editing of BASIC programs, device-independent I/O, special functions to allow access from BASIC to any I/O port, formatted printing, special INPUT/OUTPUT-and-proceed statements to allow I/O without interrupting BASIC program execution, full arithmetic expressions, limited string manipulation (10 or fewer characters), shorthand forms for common BASIC keywords, immediate mode BASIC statement execution, and capability of running a BASIC program that is stored in PROM. The allowed arithmetic operations are addition, subtraction, multiplication, division, and raising a number to a positive integral power. Numbers in BASIC2 may be considered to be stored in floating-point notation with seven-digit accuracy. The smallest and largest normalized numbers are 2.710505 E-20 and 9.223372 E+18 . The BASIC statements allowed are: DIM (to declare one-dimensional arrays), LET, GO TO, GO SUB, and RETURN, IF-THEN, FOR-TO-STEP-NEXT, REM, END, STOP, INPUT, PRINT, GET, PUT, and CALL (to call a user-written assembly language subroutine). The built-in functions are ABS (for absolute value) and INT (for least integer part). Interpreter commands include FREE, RUN, LIST, PLIST (to LIST to a peripheral device), PTAPE (to input a program from a peripheral device), and SCR (to clear user memory). In the second, or "hardware", implementation of BASIC2 requiring an Am9511 Arithmetic Processing Unit (APU) interfaced to the 8080 microprocessor, arithmetic operations are performed by the APU. The following additional built-in functions are available in this implementation: square root, sine, cosine, tangent, arcsine, arccosine, arctangent, exponential, logarithm base e, and logarithm base 10. For this implementation, in raising to a power only non-negative bases are allowed, but they may be raised to any power as long as the result is within the valid number range.
4. **METHOD OF SOLUTION -** Commands and BASIC2 statements are interpreted interactively.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** User program size is limited by the amount of RAM available for its storage. The user is allowed maxima of -
 26 string variables
 26 singly-subscripted arrays
 286 unsubscripted variables
 Line numbers and dimensions must fall within the range of 1 through 32767; subscripts, 0 through 32766.
6. **TYPICAL RUNNING TIME -** The test program runs in approximately 5 minutes.
7. **UNUSUAL FEATURES OF THE PROGRAM -** Functions GET(X) and PUT(X) input and output a byte of data from any 8080 I/O port. The arithmetic processor unit is used for floating-point operations and built-in functions.
8. **RELATED AND AUXILIARY PROGRAMS -** The BASIC2 COMPILER, a cross compiler, is still in development status.
9. **STATUS -** Abstract first distributed November 1978.
 MCS-8080 versions submitted May 1978, test programs for the software and hardware implementations executed by NESC November 1978 on an IMSAI 8080 system.
10. **REFERENCES -** P. R. McGoldrick, J. Dickinson, and T. G. Allison, LLL 8080 BASIC-II INTERPRETER User's Manual, UCID-17752, April 3, 1978.

W. McDowell, Arithmetic Processing Unit, S100 Bus Compatible, ANL Electronics Division Drawing L3987-7901-DB-00, June 18, 1978.

Richard O. Parker and Joseph H. Kroeger, Algorithm Details for the Am9511 Arithmetic Processing Unit, AM-PUB072, Advanced Micro Devices, Inc., March 1978.

BASIC2 INTERPRETER, NESC No. 803.8080, NESC Note 79-3, February 8, 1979.

11. **MACHINE REQUIREMENTS** - Approximately 8K bytes of RAM to store the assembled interpreter, additional user program space, and necessary peripheral devices. The hardware implementation requires an Am9511 Arithmetic Processing Unit and an interface board (reference 2).
12. **PROGRAMMING LANGUAGE USED** - 8080 Assembly language
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** -
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - As coded, the assembled interpreter resides at locations 8000 through A536 (hexadecimal). A jump table occupies 800 through 810 (hexadecimal) with user program storage extending from 1000 to the stack top (less than 8000). The built-in function RND, a pseudo-random number generator, is not implemented in the current editions of BASIC2.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
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J. Dickinson
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University of Idaho
Moscow, Idaho 83843
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (BASIC2 1st part-4105 cards, software implementation 2nd part-2226 cards,
hardware implementation 2nd part-1084 cards)
Test program (software implementation-268 cards, hardware implementation-268 cards)
Sample problem output (6 pages)
Reference report, UCID-17752, drawing, and NESC Note 79-3
17. **CATEGORY** - P
KEYWORDS - BASIC, microprocessors, translators
18. **SPONSOR** - ERDA Division of Military Application

1. **NAME OR DESIGNATION OF PROGRAM - CHART**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360,370,303x
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** CHART was developed for the thermal analysis of the charcoal adsorber in a reactor containment system; maximum temperatures caused by iodine adsorption under accident conditions are estimated. A differential equation relating the charcoal slab temperature to the heat generation rate, air flow rate, and the heat parameters of air and charcoal is solved in both one and three dimensions. Principal consideration is given very low flow rates and times soon after accident onset, the conditions which pose the greatest threat to the charcoal.
4. **METHOD OF SOLUTION -** The general heat transfer computer program HEATING (NESC Abstract 517) was modified to solve the CHART model. In HEATING3 the extrapolated Liebmann method and a modification of the Aitken delta-squared extrapolation process are used to solve the finite difference equations which approximate the partial differential equations for a steady-state problem. The difference equations for a transient problem are solved using a first forward time difference technique with the solution expressed explicitly. In CHART the heat generation routine of HEATING3 was modified to express heat generation as a function of position, time, and temperature. The cooling gas temperature is calculated as a function of temperature along the flow direction and included in the heat generation term making it possible for this basically heat conduction code to handle combined conduction and convection adsorber problems. New criteria were developed for insuring stability.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** CHART is limited to maxima of -
 - 1750 lattice points
 - 100 regions
 - 50 materials
 - 50 boundary conditions
 - 100 fine lattice lines along any axis
 - 50 gross lattice lines along any axis
 - 20 heat generation functions
 - 25 initial temperature functions
 - 50 position-dependent functions
 - 20 time-dependent functions
6. **TYPICAL RUNNING TIME -** Execution of the sample problem required less than 15 seconds on an IBM3033.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -** CHART uses as its base the HEATING3 program.
9. **STATUS -** Abstract first distributed November 1978.
IBM360 version submitted July 1978, sample problem executed by NESC October 1978 on an IBM3033.
10. **REFERENCES -** R. P. Shields and M. Siman-Tov, The Effect of Iodine Decay Heat on Charcoal Adsorbers, ORNL-4602, April 1971.
W. D. Turner and M. Siman-Tov, HEATING3 - An IBM 360 Heat Conduction Program, ORNL-TM-3208, February 1971.
W. D. Turner and J. S. Crowell, Notes on HEATING - An IBM360 Heat Conduction Program, CTC-INF-980, November 1969.
R. P. Shields, Ignition of Chemical Adsorbers by Fission Product Decay Heat, Proceedings of the 11th Air Cleaning Conference, Hanford, Washington, August 31-September 3, 1970, pp. 770-790, 1970.
11. **MACHINE REQUIREMENTS -** CHART requires approximately 465K bytes of storage for execution and the standard input and output units.
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV

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- 13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360,370.**
- 14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -**
- 15. NAME AND ESTABLISHMENT OF AUTHORS -**
R. P. Shields and M. Siman-Tov*
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830
* Contact
- 16. MATERIAL AVAILABLE - Magnetic Tape Transmittal**
Source deck (2663 cards)
Sample problems (67 cards)
Sample problems output (33 selected pages)
Reference report, ORNL-4602
- 17. CATEGORY - G**
KEYWORDS - fission products, iodine, adsorption, heat transfer, activated carbon, accidents, containment systems, reactors, filters, HEATING codes
- 18. SPONSOR - AEC Division of Operational Safety**

1. NAME OR DESIGNATION OF PROGRAM - DOPSEL
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM370
3. DESCRIPTION OF PROBLEM OR FUNCTION - DOPSEL evaluates the temperature- and composition-dependent self-shielded cross-sections and self-shielding factors for neutron capture, fission, and scattering processes in both resolved and unresolved regions. The generalized resonance integrals under the NR approximation for both fissile and fertile materials and infinite dilution cross sections are also calculated.
4. METHOD OF SOLUTION - In the resolved region, a modification of Hwang's criterion for determining the number of resonances contributing to overlap effects is used and interference scattering effects are included. In the unresolved resonance region, averaging of the functions is done over appropriate distributions of partial widths and level spacings. Gauss-Hermite quadrature is used to evaluate the integrals involved in the unresolved region effective cross-section equations.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Twenty resonances on either side of the reference resonance are tested for inclusion in the overlap effect, and the following assumptions are made: the velocity of the target nucleus is small compared to the neutron velocity, the partial widths are independent of energy, and the nuclei have a Maxwellian velocity distribution.
6. TYPICAL RUNNING TIME - 3 minutes is required on the IBM370/155 to execute a fissile material case with 210 resolved resonances and 3 unresolved groups.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed February 1979.
IBM370 version submitted May 1977, sample problem executed by NESC February 1979 on an IBM3033.
10. REFERENCES - S. Ganesan, P. Bhaskar Rao, and R. Shankar Singh, DOPSEL - A Program for Evaluation of Self Shielding Factors in Resolved and Unresolved Resonance Region, India Atomic Energy Commission Report RRC-6, 1975.
S. Ganesan, P. Bhaskar Rao, and R. Shankar Singh, Modification of Hwang's criterion for determining the number of resonances contributing to overlap effects, Atomkernenergie, Bd. 27, pp. 27-29, 1976.
R. N. Hwang, Efficient Methods for the Treatment of Resonance Cross Sections, Nuclear Science and Engineering, Vol. 52, pp. 157-175, 1973.
P. Bhaskar Rao and S. Ganesan, Study of the relative merits of various computational models for evaluation of resonance $J(\theta, \beta)$ function, Atomkernenergie, Bd. 29, pp. 255-258, 1977.
11. MACHINE REQUIREMENTS - 250K bytes of memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/370 MVT.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
S. Ganesan, P. B. Rao, and R. S. Singh
Reactor Research Centre
Kalpakkam - 603 102
Tamil Nadu, India

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16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (2009 cards)

Sample problem (64 cards)

Sample problem output (7 pages)

Reference report, RRC-6, and Atomkernenergie Bd. 27 reprint

17. CATEGORY - A

KEYWORDS - self-shielding, fission, capture, neutron reactions, cross sections, resonance integrals, scattering, Breit-Wigner formula

18. SPONSOR - India Atomic Energy Commission

1. NAME OR DESIGNATION OF PROGRAM - 2DEPEP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6500,7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 2DEPEP solves the partial differential equation system:

$$C1(X,Y,U,V,T) \cdot DU/DT = D(OXX)/DX + D(OXY)/DY + F1(X,Y,U,V,T)$$

$$C2(X,Y,U,V,T) \cdot DV/DT = D(OYX)/DX + D(OYY)/DY + F2(X,Y,U,V,T)$$
 in a general two-dimensional region, R, with

$$U = FB1(S)$$

$$V = FB2(S) \text{ for } S \text{ on } BR1, \text{ and}$$

$$OXX \cdot NX + OXY \cdot NY = GB1(S,U,V,T)$$

$$OYX \cdot NX + OYY \cdot NY = GB2(S,U,V,T) \text{ for } S \text{ on } BR2,$$
 where BR1 and BR2 are distinct parts of the boundary. (NX,NY)= unit outward normal.

$$U = U0(X,Y)$$

$$V = V0(X,Y) \text{ for } T = T0, \text{ and}$$

$$OXX = OXX(X,Y,DU/DX,DU/DY,DV/DX,DV/DY,T)$$

$$OXY = OXY(X,Y,DU/DX,DU/DY,DV/DX,DV/DY,T)$$

$$OYX = OYX(X,Y,DU/DX,DU/DY,DV/DX,DV/DY,T)$$

$$OYY = OYY(X,Y,DU/DX,DU/DY,DV/DX,DV/DY,T).$$
 The Jacobian matrices of derivatives of OXX,OXY,OYX,OYY with respect to DU/DX,DU/DY,DV/DX,DV/DY and of F1,F2 with respect to U,V and of GB1,GB2 with respect to U,V must be symmetric.
 The related elliptic and eigenvalue problems are also solved by 2DEPEP and single equations can be handled efficiently. Examples of applications of the program are elasticity, one- or two-component diffusion, heat conduction, minimal surface, potential problems and the time-independent and time-dependent Schrodinger equations.
4. METHOD OF SOLUTION - The user supplies an initial triangulation which defines the region R. This triangulation is refined as controlled by a user-supplied function. For singular elliptic problems, optimal order convergence is possible if this function approximates the function D3MAX(UV), which is the maximum of the third derivatives of U and V.
 The problem is discretized by Galerkin's method, using a trial function space of piecewise quadratic polynomials with respect to the triangulation. An approximate solution is calculated, using either the implicit or the Crank-Nicolson method for each time-step. The non-linear equations which must be solved each time-step are solved by Newton's method. One iteration is sufficient since the solution on the previous time-step is used for starting values. In each application of Newton's method the symmetric, banded Jacobian matrix is inverted directly by Gaussian elimination, with the matrix stored out-of-core when necessary, according to the frontal method. For linear time-independent problems the Jacobian is the same each time-step, so the Cholesky factorization done in the first step is used on all following steps. The isoparametric method is used to handle curved boundaries.
 When C1=C2=0 and all functions are independent of T, that is, when the problem is a steady-state (elliptic) problem, each time-step corresponds to one iteration of Newton's method. (One iteration is sufficient for linear problems.) An eigenvalue problem can be converted to a related parabolic problem where each time-step is equivalent to an iteration of the inverse power method for finding the smallest eigenvalue and the corresponding eigenfunction. A single equation can be handled with no loss of efficiency in storage or execution time.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - At most two simultaneous partial differential equations can be solved. The input data set is limited to 200 cards. This can be increased by changing the value of the variable MXCARD and increasing the dimensions of the arrays L, INDX, and LNAM in the preprocessor.
6. TYPICAL RUNNING TIME - Execution time is problem dependent. NESC executed the sample problems in 30 seconds on a CDC7600.

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7. **UNUSUAL FEATURES OF THE PROGRAM** - Local mesh refinement capability makes 2DEPEP ideal for singular problems, such as elastic crack problems.
8. **RELATED AND AUXILIARY PROGRAMS** -
9. **STATUS** - Abstract first distributed May 1979.
IBM360 version submitted February 1978, replaced by CDC6500 version submitted December 1978, revised April 1979, sample problems executed by NESC April 1979 on a CDC7600.
10. **REFERENCES** - Granville Sewell, 2DEPEP, 2-D Elliptic, Parabolic and Eigenvalue Problems, User's Manual, Purdue University, October 1978.
11. **MACHINE REQUIREMENTS** - 120K (octal) words of memory are required together with an auxiliary storage device, such as disk or tape, for temporary use in large problems (unit 2), and another storage device for temporary use to store the preprocessor output (unit 4).
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The program is written to process input data for one problem only per execution.
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
E. G. Sewell
Computer Science Department
Purdue University
West Lafayette, Indiana 47907
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (Preprocessor-538 cards, Subroutines-1061 cards)
Sample problems (171 cards)
Control information (70 cards)
Reference User's Manual
17. **CATEGORY** - P
KEYWORDS - eigenvalues, two-dimensional, iterative methods, finite element method, partial differential equations, banded matrix
18. **SPONSOR** - Purdue University
Oak Ridge National Laboratory

1. **NAME OR DESIGNATION OF PROGRAM - SLACKLY**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** SLACKLY performs a one-dimensional analysis of a multicavity Klystron tube. Its formulation is based on the application of polarization variables to the physics of the propagation of a confined beam of electrons within a drift tube and the interaction of this beam with the cavities of the Klystron. By specifying the geometry of the Klystron and an appropriate set of initial conditions, a comprehensive analysis of the tube's characteristics will result. Space charge effects and higher-order harmonics are included in the simulation.
4. **METHOD OF SOLUTION -** The system of differential equations that is the basis of this simulation is solved by a fourth-order Adams-Bashforth predictor followed by one correction using an Adams-Moulton corrector. A fourth-order Runge-Kutta method is used to start the solution. An iterative technique is used to solve the implicit equations for the large signal case using the small signal estimate as a starter.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Highly relativistic simulations may fail.
6. **TYPICAL RUNNING TIME -** 4 to 6 minutes are required for a 5-cavity s-band type tube. The sample problem executed in about 7 minutes of CPU time on the IBM3033.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -**
9. **STATUS -** Abstract first distributed December 1978.
IBM360 version submitted December 1977, sample problem executed by NESC November 1978 on an IBM3033.
10. **REFERENCES -** Garland M. Branch, Jr., Electron Beam Coupling in Interaction Gaps of Cylindrical Symmetry, Institute of Radio Engineers Transactions on Electron Devices, pp. 193-207, May 1961.
SLACKLY Input Format, SLAC Memorandum, December 1977.
ABNORMAL-END PROGRAM TERMINATOR, SLAC Computer Program Library Program Description No. N2-42, August 1, 1967.
Real and Imaginary Part Functions of a Double Precision Complex Number, SLAC Computer Program Library Program Description No. A2-64, March 14, 1968.
Tore Wessel-Berg, Relativistic Klystron Theory, MIT Lincoln Laboratory report (unpublished).
11. **MACHINE REQUIREMENTS -** The program requires 172K bytes of memory and standard input and output units for execution.
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** OS/360,370.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** Dummy routines are included in the package for several SLAC system subroutines that were not supplied. Subroutine ABD1 provides a dump when called to terminate a program. Function TIMER1 returns elapsed time in milliseconds as an integer quantity, and function DATE1 returns an alphanumeric representation of the current date in A8 format. The package includes the subroutines DREAL and DIMAG for use if system-supplied inline routines are not available.
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
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Stanford, California 94305

• Contact

- 16. MATERIAL AVAILABLE - Magnetic Tape Transmittal**
Source deck (3447 cards)
Sample problem (8 cards)
Sample problem output (21 pages)
Reference SLAC Memorandum and Computer Program Library Descriptions
- 17. CATEGORY - V**
KEYWORDS - klystrons, drift tubes, electron beams, performance testing
- 18. SPONSOR - AEC Division of Physical Research**

1. NAME OR DESIGNATION OF PROGRAM - WHTM
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - WHTM is the Wisconsin Hydrologic Transport Model which treats the movement of water and trace amounts of chemicals from the place and time of introduction onto the land area segments of a watershed, through these segment vertical profiles to the water table or laterally to streams, and through the stream channel network to the watershed outfall. Overland and stream flow are governed by the Chezy-Manning equation. Trace chemical transport is represented by an ion-exchange model which uses a single distribution coefficient $K(d)$ for each chemical species. Operation of the program requires historical hourly precipitation data and daily or monthly climatological data in addition to the parameters used to describe the watershed.
4. METHOD OF SOLUTION - Most of the submodels used in the WHTM are based on a lumped-parameter description of the transport processes. Amounts of water and chemical in each soil layer are treated using a simple box model description where the change in the box contents in a given time interval is the amount of material entering minus the amount leaving. Movement of the trace chemical is modeled by allowing it to ride in tandem with the water. Analytic expressions are used to compute the amount of water diverted to the various compartments. The program tests a variety of conditions to decide when to branch around many sections of the program, partly to allow treatment of different processes that depend on whether certain thresholds have been reached and partly to skip detailed computations when they are not needed (e.g. during long dry periods).
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Current version of the problem allows treatment of three land segments, seven reaches in the stream network, and one chemical element. The program has been used typically for 12-14 month simulations at one execution. Simulations for a series of years typically are executed one year at a time. Currently, the major limitation on applying the model to problems is the amount of available direct access storage used to store temporary data sets. WHTM does not consider any chemical element or sediment interactions in the stream network. Amounts of these materials entering the stream are carried, with proper attention to flow timing in the same way the water is treated, to the watershed outfall.
6. TYPICAL RUNNING TIME - A watershed model with three segments and seven reaches executed for a one-year simulation typically takes 3-4 minutes of CPU time on the IBM360/91, depending on the amount and time distribution of rainfall.
7. UNUSUAL FEATURES OF THE PROGRAM - WHTM generates an outflow hydrograph for a watershed instead of using a unit hydrograph.
8. RELATED AND AUXILIARY PROGRAMS - WHTM is an extension of the Stanford Watershed Model IV including the additional capability of modeling the transport of trace chemicals through a watershed and a treatment of surface soil erosion. Other modifications of this basic program are OPTRM (NESC Abstract 794) and CHNSEED (NESC Abstract 793). OPTRM was created to allow optimization of a set of parameters, used by WHTM, difficult to determine experimentally. CHNSEED extends the detailed modeling of sediment interactions in the stream beds. Sediment transport is modeled by considering movement of bedload and suspended load. Chemical interactions are treated again using a simple ion-exchange model. WHTM can also be coupled with the Atmospheric Transport Model (ATM) (NESC Abstract 787) to form one version of the Unified Transport Model (UTM).
9. STATUS - Abstract first distributed January 1979.
IBM360 version submitted October 1977, sample problem executed by NESC December 1978 on an IBM3033.
10. REFERENCES - M. R. Patterson, J. K. Munro, D. E. Fields, R. D. Ellison, A. A. Brooks, and D. D. Huff, A User's Manual for the FORTRAN IV Version of the Wisconsin Hydrologic Transport Model, ORNL-NSF-EATC-7 (EDFB-IBP-74-9), October 1974.

J. K. Munro and D. D. Huff, Corrections and Revisions to the FORTRAN IV Version of the Wisconsin Hydrologic Transport Model, ORNL/NSF/EATC-29, May 1977.

D. E. Fields and S. B. Watson, OPRM: A Hydrologic Transport Model with Parameter Optimization, ORNL-NSF-EATC-14, September 1975.

D. E. Fields, CHNSD: Simulation of Sediment and Trace Contaminant Transport with Sediment/Contaminant Interaction, ORNL-NSF-EATC-19, March 1976.

11. **MACHINE REQUIREMENTS** - 410K bytes of storage are required for execution.
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV (96%) and Assembler (4%)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360 (IBM360), OS/370 (IBM370,3033).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - An overlay structure is used to reduce the main memory size required to run the program. and most of the large data arrays are INTEGER*2 data, again to reduce main memory requirements. The program must be compiled using the 'XL' option available with the FORTRAN H compiler. Four direct access storage units are used to store inventory data, precipitation data, runoff data, and channel characteristics, respectively. WHTM uses several utility routines (IDAY, TIME, ERROR, CVBCBIDK) written in Assembly language.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
R. J. Baridon, J. K. Munro, Jr.,
M. R. Patterson, and D. E. Fields
Computer Sciences Division
Nuclear Division
Union Carbide Corporation
D. D. Huff
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Oak Ridge, Tennessee 37830
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (FORTRAN 4615 cards, Assembler 179 cards)
Sample problem (436 cards)
Control information (Overlay-107 cards)
Sample problem output (28 selected pages, complete-1 microfiche)
Reference reports, ORNL-NSF-EATC-7 and ORNL/NSF/EATC-29
17. **CATEGORY** - R
KEYWORDS - hydrology, cadmium, copper, environmental transport, lead, soils, streams, sulfur, water pollution, watersheds, zinc, CHNSD codes, OPRM codes
18. **SPONSOR** - NSF RANN Environmental Aspects of Trace Contaminants Program

1. NAME OR DESIGNATION OF PROGRAM - TVENT
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - TVENT predicts flows and pressures in ventilation systems caused by pressure transients such as a tornado. A ventilation system model includes system elements (components such as filters, dampers, ducts, blowers) connected at nodal points to form networks. The program solves one-dimensional lumped parameter, incompressible flow equations augmented by fluid storage. The user can identify points of excessive depressurization and areas of high flow.
4. METHOD OF SOLUTION - The continuity equation is satisfied at each node in the flow network with the dependent variable (pressure) solved simultaneously by point-wise (local) relaxation techniques. The flows are determined from the calculated pressures with experimental or classical flow descriptions. The boundary conditions are specified as stated but are arbitrary functions of time.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 500 branches
 - 400 nodes
 - 60 rooms
 - 40 blowers
 - 20 boundary nodes
 - 5 time functions
 - 20 points per time function
 - 15 blower functions
 - 20 points per blower function
 - 10 frames
 - 4 plots per frame
 - 50 points per plot

Assumptions include one-dimensional, isothermal flow, lumped parameters (neglecting spatial distribution of components), and incompressible flow with fluid storage at nodes. TVENT does not include inertia or shock.
6. TYPICAL RUNNING TIME - Running time depends on problem complexity, as well as the number of branches or nodes. The simple ventilation system sample problem required 6 seconds on the CDC7600 computer. NESC executed all of the sample problems in 25 seconds on a CDC7600.
7. UNUSUAL FEATURES OF THE PROGRAM - TVENT is designed to be portable and is highly user-oriented for architect-engineers and heating, ventilation, and air conditioning (HVAC) designers. The program is self-contained and does not require nonstandard system utilities. Line printer plots are generated.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed February 1979.
CDC7600 version submitted August 1978, sample problems executed by NESC January 1979 on a CDC7600.
10. REFERENCES - K. H. Duerre, R. W. Andrae, and W. S. Gregory, TVENT A Computer Program for Analysis of Tornado-Induced Transients in Ventilation Systems, LA-7397-M, July 1978.
11. MACHINE REQUIREMENTS - 53,000 (octal) words of memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - NOS, LTSS, and SCOPE.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Only one set of input data may be processed per execution. The program is structured as a one-level overlay to permit use on medium-size computers and to provide for program expansion.

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15. NAME AND ESTABLISHMENT OF AUTHORS -

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16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (3270 cards)
Sample problems (384 cards)
Sample problems output (19 selected pages, 1 microfiche)
Reference report

17. CATEGORY - H

KEYWORDS - tornadoes, ventilation systems, pressure, flow models, transients, nuclear facilities

18. SPONSOR - DOE Division of Operational and Environmental Safety

1. NAME OR DESIGNATION OF PROGRAM - CREEP-PLAST2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - CREEP-PLAST2 is a special-purpose two-dimensional inelastic structural analysis program based on an incremental finite-element method. It is applicable to static and quasi-static loadings of plane structures (in-plane loadings, plane-stress conditions) and axisymmetric structures (axisymmetric loadings). The loadings can consist of combinations of applied forces, pressures, displacements, and/or temperatures. Cyclic as well as monotonic loadings can be treated, and loadings can be proportional or nonproportional. The structure can be composed of up to three different materials; each should be adequately represented by the thermoelastic-plastic-creep constitutive equation forms recommended for austenitic stainless steel in U.S. DOE RDT Standard F9-5T, (September 1974).
Two postprocessor graphics programs use plot output files from CREEP-PLAST2 to display the time and/or mechanical load histories of nodal displacement, stress, strain, and temperature (HISTORY-PLOT) and contour lines of whole field deformations and stress, strain or temperature (CONTOUR-PLOT).
4. METHOD OF SOLUTION - An incremental displacement finite-element method is used to solve the path-dependent problem. At any solution increment the field equations are reduced to a system of first-order algebraic equations relating the nodal displacement increments to the incremental nodal loads through the system stiffness matrix. The system is integrated using a modified Euler forward-difference method. Constitutive equations for time-independent plasticity and time-dependent creep behavior are handled through tangent stiffness and initial strain algorithms. The elastic and plastic strain rates are treated by the tangent stiffness algorithm. The creep and thermal strain rates are treated by the initial strain algorithm. Creep is treated by strain-hardening theory. The kinematic descriptions are linear and limit applications to small displacement, small strain problems.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
1200 nodes
2000 elements
500 solution increments
Restart capabilities are provided to extend the 500 steps to any number required.
6. TYPICAL RUNNING TIME - CPU times vary from 1 minute to about 3 hours, depending on the problem size. CREEP-PLAST2 requires approximately 50 seconds of CPU time to complete sample problem 1 and 125 seconds to complete sample problem 2 on an IBM370/195. The postprocessor plot programs each ran in less than 10 seconds on the IBM370/195.
7. UNUSUAL FEATURES OF THE PROGRAM -
(a) The analysis methods of RDT Standard F9-5T (September 1974) are incorporated.
(b) Creep descriptions for austenitic stainless steels are programmed.
(c) The program can treat three distinct inelastic materials in the same structure.
8. RELATED AND AUXILIARY PROGRAMS - CREEP-PLAST2 is the second-generation of CREEP-PLAST (NESC Abstract 707) offering some improvements from the point of view of the user. The original CREEP-PLAST contains auxiliary plasticity and creep models not recommended in F9-5T, and these are not included in CREEP-PLAST2.
9. STATUS - Abstract first distributed January 1979.
IBM360 version submitted September 1978, replaced May 1979 by revised version submitted March 1979, sample problems executed by NESC May 1979 on an IBM370/195.

10. **REFERENCES** - J. A. Clinard, CREEP-PLAST II User's Manual, ORNL/TM-5868, May 1978.
 P. G. Fowler, J. S. Crowell, and J. A. Clinard, User's Manual for ORNL CREEP-PLAST Graphics Package, ORNL-TM-4642, September 1974.
 J. A. Clinard, Example Problem for CREEP-PLAST II (R810) to Exercise the Graphics Package Postprocessors, ORNL-TM-4642 Supplement 2, March 21, 1979, with NESC revisions, May 1979.
 National Energy Software Center Note 79-49, CREEP-PLAST2 Tape Description and Implementation Information, NESC No. R810.360, May 31, 1979.
 RDT Standard F9-5T, Guidelines and Procedures for Design of Nuclear Systems Components at Elevated Temperatures, September 1974.
 Y. R. Rashid, Part I, Theory Report for CREEP-PLAST Computer Program, GEAP-10546, January 1972.
 J. A. Clinard, D. A. McKinley, W. C. Kroenke, and W. K. Sartori, "Verification by Comparison of Independent Computer Program Solutions," Pressure Vessels and Piping Computer Program Evaluation and Qualification, ASME PVP-PB-024, pp. 27-49, 1977.
11. **MACHINE REQUIREMENTS** - A minimum of 230K bytes of storage is required. Storage requirements may vary up to 1500K bytes for a non-overlay solution of larger problems. The program requires approximately 410K bytes of storage to execute the sample problems. Standard input and output units are needed. In addition, the KBSAM utility routines could require up to 5 direct-access storage units for scratch storage, and as many as 5 additional sequential files on peripheral units depending on user-selected program options. The plotting programs HISTORY-PLOT and CONTOUR-PLOT each execute in less than 170K bytes of storage.
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV (95%) and BAL (5%)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360,370, Level 21.6/21.7.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The KBSAM routines, which control the use of auxiliary direct-access storage units, are supplied in IBM Assembly language.
 CREEP-PLAST2 optionally produces as output a plot file (FT12F001) suitable for use as input to the postprocessor graphics programs HISTORY-PLOT and CONTOUR-PLOT. The plotting programs require the proprietary CalComp system routines PLOT, NUMBER, and SYMBOL.
 Sample problem 2 generates an underflow condition in subroutine LAW1 during the computation of the double-precision exponential $SAVE=DEXP(-R*TIME)$. This is caused by using the default maximum value for TIME of 100000 set in subroutine CREEP.
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
 J. A. Clinard
 Engineering Technology Division
 Oak Ridge National Laboratory
 P. O. Box Y
 Oak Ridge, Tennessee 37830
16. **MATERIAL AVAILABLE** - Restricted Distribution
 Magnetic Tape Transmittal
 Source decks (CREEP-PLAST2 FORTRAN 5477 cards, BAL 618 cards, HISTORY-PLOT 817 cards, IDAY BAL 63 cards, CONTOUR-PLOT 995 cards)
 Sample problems (CREEP-PLAST2 295 cards, output file 25 blocks, HISTORY-PLOT 30 cards, CONTOUR-PLOT 16 cards)
 Control information (Overlay 33 cards)
 Sample problem output (CREEP-PLAST2 29 selected pages)
 Reference reports, ORNL/TM-5868, ORNL-TM-4642, ORNL-TM-4642 Supplement 2, and Note
 * RECFM=VBS,BLKSIZE=3520
17. **CATEGORY** - I
KEYWORDS - two-dimensional, deformation, finite element method, stress analysis, static loads, creep, mechanical structures, plasticity, elasticity, LMFBR reactors, HISTORY-PLOT codes, CONTOUR-PLOT codes

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18. SPONSOR - DOE Division of Reactor Research and Technology

1. **NAME OR DESIGNATION OF PROGRAM** - COMB
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM370
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - COMB performs a steady-state one-dimensional analysis to predict overall behavior of a high-temperature coal combustor for use in open-cycle MHD power-generation systems. Following ignition a one-dimensional flow model with radiative heat loss is used to describe the subsequent vaporization of ash and devolatilization, combustion, and gasification of the coal. Combustion is considered to take place either at a flame sheet in the diffusion layer surrounding each particle or at the particle surface. Redistribution of combustion products in the main gas stream of the combustor is assumed to occur according to simplified chemical equilibrium criteria, and the various competing reactions within the coal particle are resolved by use of a simplified devolatilization rate formula.
4. **METHOD OF SOLUTION** - Coal ignition is described by an asymptotic solution technique. The combustion process is then determined by the integration of eight first-order, ordinary differential equations and evaluation of twenty simultaneous algebraic equations. Several subsets of these equations are solved implicitly using a secant method.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Assumptions include -
 - (a) spherical coal particles uniform in size,
 - (b) the single-particle combustion model,
 - (c) oxidation reactions combined into single, one-step, irreversible reaction,
 - (d) quasi-steady-state analysis through combustor, and
 - (e) heat loss by radiation only to a fixed-temperature wall.The coal composition of successive cases in a single run cannot be changed.
6. **TYPICAL RUNNING TIME** - Five to ten seconds CPU time are typical execution times for a single case. NESC compiled and executed the sample problem in 30 seconds on an IBM370/195.
7. **UNUSUAL FEATURES OF THE PROGRAM** -
8. **RELATED AND AUXILIARY PROGRAMS** - This program will be employed in conjunction with the MHD open-cycle system code (presently under development in the ANL Engineering Division), as well as in a stand-alone mode.
9. **STATUS** - Abstract first distributed January 1979.
IBM370 version submitted November 1977, sample problem executed by NESC November 1978 on an IBM370/195.
10. **REFERENCES** - Paul M. Chung and R. Scott Smith, An Analysis of a High-Temperature Coal Combustor According to a One-Dimensional Flow Model, ANL/MHD-77-2, October 1977.
C. S. Kim and P. M. Chung, An Asymptotic Thermo-Diffusion Ignition Theory of Porous Solid Fuels, Journal of Heat Transfer, Vol. 98, pp. 269-275, 1976.
C. S. Kim and P. M. Chung, Ignition of Porous Solid Fuel by Convective Heat and Mass Transfer at the Fuel Surface, Combustion Science and Technology, Vol. 15, pp. 75-82, 1977.
Errata to ANL/MHD-77-2, NESC Note 79-22, No. 811.370 February 5, 1979.
11. **MACHINE REQUIREMENTS** - 130K bytes of storage are needed.
12. **PROGRAMMING LANGUAGE USED** - PL/I
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/370.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** -

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15. NAME AND ESTABLISHMENT OF AUTHORS -

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* Contact

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (1727 cards)
Sample problem (80 cards)
Sample problem output (12 pages)
Reference report, ANL/MHD-77-2, and NESC Note

17. CATEGORY - R

KEYWORDS - combustors, steady-state conditions, one-dimensional, flow models, chemical reactions, combustion kinetics, devolatilization, coal-fired MHD generators, open-cycle MHD generators

**18. SPONSOR - DOE Office of Fossil Energy,
Division of Magnetohydrodynamics**

1. NAME OR DESIGNATION OF PROGRAM - MTRC0001
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - MTRC0001 was developed to convert SI metric units of measurement from engineering drawings to U.S. customary dimensions based on the rounding rules specified in the Mound Laboratory Design/Drafting Standard DWG No. SPA760290.
4. METHOD OF SOLUTION - Standard unit conversion from metric to inches, 25.4 mm per inch, is applied with special rounding procedures as specified in the referenced Mound document.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The conversion is only concerned with linear units. A maximum of 28 predefined labels to distinguish individual records is allowed.
6. TYPICAL RUNNING TIME - 30 seconds CPU time is typical on the IBM360/50. NESC executed the sample problem in 5 CPU seconds on an IBM370/195.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - METRICATION (NESC Abstract G668) converts to and from SI units and U.S. customary units.
9. STATUS - Abstract first distributed January 1979.
IBM360 version submitted May 1978, replaced by revised edition November 1978, sample problem executed by NESC December 1978 on an IBM370/195.
10. REFERENCES - American Society for Testing and Materials, Standard for Metric Practice, ASTM E380-76, IEEE Standard 268-1975.
American National Standards Institute, American National Standard Representations for U.S. Customary, SI, and Other Units to be Used in Systems with Limited Character Sets, ANSI X3.50-1976.
C. W. Schlosser, Preparation of Computerized SI Metric to US Customary Conversion Table, DWG No. SPA760290, Issue 5, October 2, 1978.
C. W. Schlosser, Units Abbreviations for Computerized Engineering Drawings (Limited Character Sets), DWG No. SPA770089, Issue 1, April 15, 1977.
11. MACHINE REQUIREMENTS - 50K bytes of memory are needed to execute MTRC0001, and 70K bytes are used by the IBM SORT utility.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The auxiliary program is used as a preprocessor to reformat input data so as to line up the decimal points. This produces 83-character data records used as input to the IBM utility SORT. The output of SORT is input to MTRC0001.
15. NAME AND ESTABLISHMENT OF AUTHOR -
S. Pai
ADP Applications Development-MISD
Mound Laboratory
Monsanto Research Corporation
P. O. Box 32
Miamisburg, Ohio 45342
16. MATERIAL AVAILABLE -
Source deck (380 cards)
Sample problem (82 cards)
Auxiliary information (15 cards)

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Control information (JCL-85 cards)
Reference documents, DSG Nos. SPA760290 and SPA770089

- 17. CATEGORY - P**
KEYWORDS - SI units, metric system, standards, engineering
- 18. SPONSOR -** DOE Division of Military Application

1. **NAME OR DESIGNATION OF PROGRAM - GLOVE CHANGE ANALYSIS SYSTEM**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
IBM360
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** The system uses the Glovebox Glove Data Base for analysis of the frequency, nature, and probable cause of glovebox glove failures, and for tracking and scheduling routine preventive-maintenance changes. The system provides edits of weekly data input, monthly summary of change activity and gloves scheduled to be changed, plus a maintenance-type program to annually remove old data from the active files. File retrieval language is then used to perform non-routine statistical analyses on any combination of data elements.
4. **METHOD OF SOLUTION -** The system consists of three COBOL programs: an Edit/Update, a Report Processor, and a History-To-Tape program. Schedule dates for routine change can be either entered or calculated based on the date of the most recent change. Three transaction codes are used for physical actions in the processing areas; others are available for initiating and maintaining the data base. Each gloveport is assigned a unique control number which is the master record for the gloveport; variable records are then used for each transaction occurring on the gloveport in question. The TOTAL Data Base Management System (DBMS) is used.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** The GLOVE CHANGE ANALYSIS SYSTEM was developed in support of an overall Glove Quality Program administered by the Rocky Flats Quality Engineering and Control organization. No controls are included on glove inventory or issues from stock, nor does the system provide validation of glove type correctness for various kinds of service. Administrative controls, often based on information from the computer system, are used instead.
6. **TYPICAL RUNNING TIME -** The average monthly computer resource usage is as follows: CPU time = 7 minutes; disk = 12 minutes; printer = 14 minutes; tape = 3 minutes. This is the average for all weekly, monthly, and yearly processing including reruns in support of about 12,000 gloveports with about 200 glove change or file maintenance transactions per week.
7. **UNUSUAL FEATURES OF THE PROGRAM -** Because a special transaction was used to initialize the data base, the programs contain logic pertaining to an artificial transaction date = 99-99-99. This logic does not interfere with processing of transactions having normal dates but makes the programs more difficult to follow despite the use of structured programming.
8. **RELATED AND AUXILIARY PROGRAMS -** Mark IV programs were written to help validate the data at system startup. These included a program to list all control numbers on the master file, a routine to print all data in the files for selected control numbers, and a routine to list data only for gloveports experiencing multiple changes. These are not included in the package. Mark IV is a proprietary file management system marketed by Informatics.
9. **STATUS -** Abstract first distributed January 1979.
IBM360 version submitted September 1978, program compiled by NESC November 1978 on an IBM370/195 and an IBM3033.
10. **REFERENCES -** Glove Change Analysis System Documentation, Rocky Flats Plant Document, September 1978.
Instructions to Users of the Glove Change Analysis System, Rocky Flats Plant Document, September 1978.
J. W. Sanders, Instructions for Using Glove Change Test Data, Rocky Flats Plant Note, October 18, 1978.
ABNORMAL EOJ SERVICE, Rocky Flats Plant Data Center Users Guide 6.35.01, November 15, 1976.
JULIAN, Rocky Flats Plant Data Center Users Guide 6.30.01, February 18, 1976.
11. **MACHINE REQUIREMENTS -**

12. **PROGRAMMING LANGUAGES USED** - COBOL with TOTAL DBMS (95%) and Assembler (5%)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360 HASP with CAPEX optimizer.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The TOTAL DBMS required for the GLOVE CHANGE ANALYSIS SYSTEM is a proprietary software product of CINCOM Systems, Incorporated. The two Assembly language routines JULIAN and ABEND included in the package are local RFP system routines to provide Julian-formatted date and abnormal end-of-job processing, respectively.
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
J. W. Sanders
Rocky Flats Plant
Rockwell International
P. O. Box 464
Golden, Colorado 80401
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (COBOL 2778 cards, Assembler 132 cards)
Sample problems (5 files*)
Reference documents, Note, and RFP Users Guide excerpts
*RECFM=F,LRECL=101,BLKSIZE=101
17. **CATEGORY** - M
KEYWORDS - gloveboxes, data base systems, gloves, statistics, failures, quality control, performance testing
18. **SPONSOR** - DOE Division of Military Application

1. NAME OR DESIGNATION OF PROGRAM - TRITMOD
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - TRITMOD is a steady-state advection model of tritium dispersion and cycling in underlying vegetation and soil from an atmospheric point source. Radial geometry is assumed. Tritium is in both gaseous and water vapor form.
4. METHOD OF SOLUTION - The Continuous System Modeling Program (CSMP) is used to solve the steady-state dispersion equation iteratively by integration from the furthest distance from the source back to the source.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Steady-state conditions and radial geometry are assumed.
6. TYPICAL RUNNING TIME - Running time is dependent on the radius of interest. Five minutes is a typical time for a 50 kilometer radius.
7. UNUSUAL FEATURES OF THE PROGRAM - TRITMOD takes into account the deposition of HT and the conversion of HT to HTO.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed January 1979.
IBM360 version submitted December 1978, sample problem executed by NESC December 1978 on an IBM370/195.
10. REFERENCES - C. E. Murphy, Jr., and M. M. Pendergast, Environmental Transport and Cycling of Tritium in the Vicinity of Atmospheric Releases, IAEA Symposium on Behavior of Tritium in the Environment, San Francisco, 1978, DP-MS-78-25, IAEA-SM-232/83 (in publication).
System/360 Continuous System Modeling Program User's Manual, International Business Machines Corporation, White Plains, New York.
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - CSMP
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/370.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
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Environmental Transport Division
Savannah River Laboratory
E. I. duPont de Nemours and Company, Inc.
Aiken, South Carolina 29801
16. MATERIAL AVAILABLE -
Source deck and sample input parameters (244 cards)
Sample problem output (9 pages)
17. CATEGORY - R
KEYWORDS - tritium, dispersions, deposition, simulation, advection, iterative methods, environmental transport, CSMP codes
18. SPONSOR - DOE Division of Biomedical and Environmental Research

1. **NAME OR DESIGNATION OF PROGRAM - ALVIN**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** ALVIN analyzes the consistency of a set of differential and integral nuclear data, adjusts the differential nuclear data to improve agreement with integral observations, and identifies inconsistent data. ALVIN also computes required sensitivities and related quantities such as sensitivity profiles.
4. **METHOD OF SOLUTION -** Linear perturbation theory is used for the sensitivity calculations. Data consistency and adjustment computations use least squares techniques.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** The DAFT2 consistency and adjustment subroutine treats fully or partially correlated differential and integral parameters, but only as many as the order of the largest matrix that can be inverted. The DAFT3 consistency and adjustment subroutine treats arbitrarily large differential data sets, but only if they are uncorrelated with the integral data. Due to the current dimensions of some arrays, maxima of 75 spatial mesh points, 41 groups, and 6th order Legendre polynomials are allowed. This can be changed by increasing the dimensions of the LCM arrays and the arrays in the labeled COMMON block S1 and blank COMMON.
6. **TYPICAL RUNNING TIME -** About 1 minute is required, depending on the size of the problem. NESC executed all three sample problems in 20 CP seconds on a CDC7600.
7. **UNUSUAL FEATURES OF THE PROGRAM -** Data set consistency is analyzed. A special algorithm is used in DAFT3 to treat arbitrarily large data sets.
8. **RELATED AND AUXILIARY PROGRAMS -**
9. **STATUS -** Abstract first distributed February 1979.
CDC7600 version submitted March 1976, sample problems executed by NESC December 1978 on a CDC7600.
10. **REFERENCES -** D. R. Harris, W. A. Reupke, and W. B. Wilson, Consistency Among Differential Nuclear Data and Integral Observations: The ALVIN Code for Data Adjustment, for Sensitivity Calculations, and for Identification of Inconsistent Data, LA-5987, December 1975.
D. R. Harris, Consistency Among Differential Nuclear Data and Integral Observations, Transactions of the American Nuclear Society, Vol. 18, p. 340, 1974.
11. **MACHINE REQUIREMENTS -** 55,000 (octal) words of small core memory (SCM) and 303,000 (octal) words of large core memory (LCM) are required to execute the program.
12. **PROGRAMMING LANGUAGE USED - FORTRAN IV**
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE.**
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** ALVIN makes use of the CDC7600 UPDATE program to modify the ALVIN code for the third sample problem. Therefore, extra programming effort will be necessary to implement this problem on machines without the CDC UPDATE utility.
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
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16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (1674 cards)
Sample problems (98 cards)
Direct and adjoint flux input (17,592 cards)
Cross section input (2718 cards)
Control information (56 cards)
Sample problems output (problem 1-6 pages)
Reference report, LA-5987

17. CATEGORY - A

KEYWORDS - cross sections, least square fit, data analysis, perturbation theory, comparative evaluations, sensitivity, ENDF/B, DTF codes

18. SPONSOR - ERDA Division of Reactor Development and Demonstration

1. **NAME OR DESIGNATION OF PROGRAM - DPOLE**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC6600,7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** DPOLE solves the Dirichlet problem for the Helmholtz equation over a general bounded three-dimensional region imbedded in a unit cube $-W(XX)-W(YY)-W(ZZ)+CC\cdot W=G1$ in the region $W=F$ on the boundary where F and $G1$ are given functions of X , Y , and Z , and CC is a real constant. The boundary is arbitrary.
4. **METHOD OF SOLUTION -** The program provides a solution of the well-known Shortley-Weller approximation of the differential equation. The mesh is uniform in each coordinate direction and a simple seven-point formula is used for interior mesh points. A capacitance matrix equation with discrete dipoles is used. The capacitance matrix equation is formulated as a least squares problem and solved using the conjugate gradient method.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -**
6. **TYPICAL RUNNING TIME -** A typical problem with 10,000 mesh points requires 1 to 2 minutes of CP time on a CDC6600. NESC executed the sample problem in 4 CP seconds on a CDC7600 and in 15 seconds on a CDC6600.
7. **UNUSUAL FEATURES OF THE PROGRAM -** The program was designed to keep storage requirements low. It was checked on the CDC ANSI FORTRAN verifier and run successfully on the CDC6600, CDC7600, DEC11/780 VAX, and the Amdahl 470V/6 by the developers.
8. **RELATED AND AUXILIARY PROGRAMS -**
9. **STATUS -** Abstract first distributed February 1979.
CDC6600 version submitted January 1979, sample problem executed by NESC January 1979 on a CDC6600 and a CDC7600.
10. **REFERENCES -** Dianne P. O'Leary and Olof Widlund, Capacitance Matrix Methods for the Helmholtz Equation on General Three-Dimensional Regions, COO-3077-155, October 1978.
W. Proskurowski and O. Widlund, On the Numerical Solution of Helmholtz's Equation by the Capacitance Matrix Method, Mathematics of Computation, Vol. 30, pp. 433-468, 1976.
A.S. L. Shieh, Fast Poisson Solvers on General Two Dimensional Regions for the Dirichlet Problem, Numerische Mathematik, Vol. 31, pp. 405-429, 1979.
11. **MACHINE REQUIREMENTS -** 52K (octal) words of memory are required.
12. **PROGRAMMING LANGUAGE USED -** FORTRAN IV, FTN 4.6+460 compiler
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** SCOPE 3.4.4 (CDC6600), SCOPE 2.1.3 (CDC7600).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** A serious attempt was made to facilitate future modifications of the program and to insure its transportability.
DPOLE should be converted to double-precision for use on computers with a short word length, such as the 32-bit IBM360,370 series.
15. **NAME AND ESTABLISHMENT OF AUTHORS -**
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- 16. MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (1683 cards)
Sample problem (driver-234 cards, data-2 cards)
Sample problem output (2 pages)
Reference report, COO-3077-155
- 17. CATEGORY** - P
KEYWORDS - three-dimensional, Dirichlet problem, matrices, finite difference method, numerical solution, Poisson equation
- 18. SPONSOR** - DOE Office of Basic Energy Sciences,
Division of Engineering, Mathematical and
Geo-Sciences
NSF Theoretical Computer Science Program

1. **NAME OR DESIGNATION OF PROGRAM** - COVE1
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - COVE1 is a time-dependent incremental creep collapse code that estimates the change in ovality of a fuel pin cladding tube. Application is intended primarily for tubes manufactured from zircaloy. Therefore, provision is made for the effects of anisotropy in the Prandtl-Reuss flow equations for inelastic incremental deformations by using the P and R strain ratio coefficients. The creep deformation is computed in terms of the length of the collapse zone and includes the effects of changes in temperatures, system pressure, fill gas pressure, and neutron flux levels.
4. **METHOD OF SOLUTION** - The solution is based upon an infinite tube. Corrections in the form of influence coefficients are used to correct for the collapse of a finite length tube segment. COVE1 uses a finite difference method of solving the differential equations describing the deflection of the tube walls as a function of time. The physical problem is nonlinear, both with respect to geometry and material properties, which requires the use of an incremental, analytical, path-dependent solution.
 The differential equation for the infinite tube solution is solved twice for each time-step. One solution evaluates the deflection due to creep and external pressure of a tube with an initial ovality. The second solution neglects the pressure loading and evaluates the new initial ovality including the changes due to creep for the next time-step. The influence coefficients for the finite length are applied at the end of each time-step to correct the incremental deflection. The stress distributions, both in and out of the plane, are corrected for stress relaxation and redistribution. Numerov's method is used for the solution to the second-order differential equation describing the deflection of the tube wall.
 This process is continued until one of the collapse criteria--(a) maximum ovality limit, and (b) maximum tangential stress equal to material yield stress--has been reached.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - COVE1 does not include the thermal gradient in either the stress or creep calculation. A uniform temperature through the thickness of the tube is assumed, and creep strains and thermal stress effects due to the thermal gradients are not included. This is valid for collapse calculations where densification has removed or displaced the fuel. However, for cases where the code is being used to compute creep down onto a fuel pellet, an error is incurred.
 The anisotropy and yield surface in the compression quadrant also have a significant effect on the solution. The present solution takes tension creep data and assumes that it can be used in compression. It is very doubtful if the material responds in the compression quadrant identically as in the tension quadrant.
 The finite length approximation in COVE1 has been selected only to indicate the effect of the active length zone. The method provides a quick way of assessing the effect of length. It must be recognized that it is only used as a correction for one incremental step in the total solution.
6. **TYPICAL RUNNING TIME** - Running time depends upon the complexity of the problem and the input options the user chooses. A typical case with time increments, internal pressure, temperature, and neutron flux may require approximately 15 CP seconds for execution.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The results provide detailed stress and strain information around the circumference of the collapse zone. The solution assumes an ovality of cosine 2theta for the initial deflection. After this point deflection is based upon the creep and geometric effects which can assume any general form dictated by the solution of the differential equations.
8. **RELATED AND AUXILIARY PROGRAMS** - The BUCKLE program (NESC Abstract 667).
9. **STATUS** - Abstract first distributed May 1979.
 CDC6600 version submitted February 1976, replaced by revised edition submitted February 1979, sample problems executed by NESC February 1979 on a CDC6600.

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10. **REFERENCES** - C. L. Mohr, COVE-1: A Finite Difference Creep Collapse Code for Oval Fuel Pin Cladding Material, BNWL-1896, March 1975.
R. M. Berman, F. O. Bingman, C. C. Busby, I. Cohen, R. G. Hoffman, S. Kass, O. M. Katz, J. J. Kearns, G. J. Salvaggio, E. J. Stofka, and C. R. Woods, Properties of Zircaloy-4 Tubing, WAPD-TM-585, December 1966.
C. L. Mohr, Non-Linear Stress Analysis of Indeterminate Structural Elements Subjected to Biaxial Stress States Using the Finite Element Technique, Ph.D. thesis, Washington State University, February 1973.
P. J. Pankaskie, BUCKLE, An Analytical Computer Code for Calculating Creep Buckling of an Initially Oval Tube, BNWL-1784, May 1974.
11. **MACHINE REQUIREMENTS** - 135K (octal) storage is required for execution.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 3.4.2.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - COVE1 expects the operating system to have preset the memory to zero infinity.
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
C. L. Mohr
Pacific Northwest Laboratories
Battelle
P. O. Box 999
Richland, Washington 99352
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (FORTRAN 1338 cards, CDC UPDATE 1091 cards)
Sample problem (10 cards)
Reference report, BNWL-1896
17. **CATEGORY** - I
KEYWORDS - temperature, cladding, neutron flux, creep, pressure, anisotropy, deformation, strains, stress relaxation
18. **SPONSOR** - NRC Office of Nuclear Reactor Regulation,
Division of Systems Safety

1. NAME OR DESIGNATION OF PROGRAM - CONTEMPT4/MOD2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - CONTEMPT4/MOD2 describes the long-term behavior of multicompartment pressurized water reactor (PWR) containment systems and experimental containment systems subjected to postulated loss-of-coolant accident (LOCA) conditions. The program calculates the time variation of compartment pressures, temperatures, mass and energy inventories, heat structure temperature distributions, and intercompartment mass and energy exchange based on user-supplied values for compartment descriptions, time-step and edit controls, and selected problem features. Analytical models available to describe containment systems include models for containment fans and pumps, cooling sprays, fan coolers, heat conducting structures, sump drain, and PWR ice condensers. Optional automatic time-step control allows the code to determine time-step sizes within limits dictated by the user.
4. METHOD OF SOLUTION - Using initial thermodynamic and geometric conditions supplied by the user, each compartment is initialized to input values and a steady-state solution of the heat conduction equation is performed for each containment structure. The time advancement proceeds in the following manner using discrete time-steps. The code calculates mass and energy transfer rates due to the effects of user-specified mass and energy additions, sump drain flow, cooling sprays, fans and fan coolers. An implicit calculation is made to determine intercompartment junction flow rates. A predictor-corrector scheme estimates heat structure effects. Mass and energy transfer rates are then used to update compartment conditions from the start of the time-step by solving the mass, energy and volume balance equations including ice condenser ice melting thermodynamic balances.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 999 lumped parameter compartments
 - 999 input tables
 - 99 intercompartment flow junctions
 - 99 of most other containment featuresCONTEMPT4/MOD2 can be used to model pressurized water reactor (PWR) dry containments, subatmospheric containments, dual containments, and can also be used to describe experimental containment systems in a detailed multicompartmental fashion.
6. TYPICAL RUNNING TIME - On the CDC7600, the sample problem requires approximately 30 seconds. Because of the modular construction of problems, estimating general running time is difficult.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The CONTEMPT4/MOD2 code is the most recent in the CONTEMPT series but does not replace earlier versions. CONTEMPT-LT/026 (NESC Abstract 433) should be used for boiling water reactor (BWR) containment studies.
9. STATUS - Abstract first distributed May 1979.
CDC7600 version submitted February 1978, sample problem executed by NESC February 1979 on a CDC7600.
10. REFERENCES - L. J. Metcalfe, W. J. Mings, J. E. Hartman, and A. C. Crail, CONTEMPT4/MOD2, A Multicompartment Containment System Analysis Program, TREE-NUREG-1202, February 1978.
L. J. Metcalfe, D. W. Hargroves, and R. A. Wells, Containment Accident Analysis Using CONTEMPT4/MOD2 Compared with Experimental Data, Transactions of the American Nuclear Society, Vol. 28, pp. 412-414, June 1978.
NESC No. 818.7600, CONTEMPT4/MOD2, Tape Description and Control Information, National Energy Software Center Note 79-50, May 31, 1979.
NESC No. 818.7600B, CONTEMPT4/MOD2, Description of Transmittal Tape for Other Than CDC7600 Use, National Energy Software Center Note 79-51, May 31, 1979.

11. **MACHINE REQUIREMENTS** - 160,000 (octal) small core memory (SCM) and 100,000 (octal) large core memory (LCM) are required for CONTEMPT4 compilation. CalComp or FR80 plotting devices are needed for graphical output.
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV (96%) and COMPASS (4%)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 2.1.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Water properties data, a companion plotting program (PLOTCT4), and a program for solving the one-dimensional heat conduction equations (HEAT1) are included. Since the CDC7600 edition tape is suitable for use on the CDC7600 only, a separate edition designated 7600B has been prepared for use on systems other than the CDC7600.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
L. J. Metcalfe
EDS Nuclear Inc.
220 Montgomery Street
San Francisco, California 94104
D. R. Meier
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (7600-239 records*, 7600B-22,941 cards)
Object modules (CONTEMPT4 7600-195 records*, PLOTCT4 7600-24 records*, HEAT1 7600-11 records*, ENVIRONMENTAL ROUTINES 7600-195 records*, IGS ROUTINES 7600-114 records*)
Core image modules (CONTEMPT4 7600-133 records*, PLOTCT4 7600-64 records*)
Sample problems (CONTEMPT4 7600-2 records*, 7600B-111 cards, PLOTCT4 7600-1 record*, 7600B-16 cards)
Steam tables library (7600-15 records*, 7600B-2544 cards)
Auxiliary routines (PLOTCT4 7600-24 records*, 7600B-2263 cards, HEAT1 7600-18 records*, 7600B-1619 cards, conversion program 7600B-8 cards)
Environmental subroutines (7600-137 records*, 7600B-14,432 cards)
IGS subroutines (7600-87 records*, 7600B-8914 cards)
Control information (loader cards CONTEMPT4 7600-1 record*, 7600B-12 cards, PLOTCT4 7600-1 record*, 7600B-5 cards)
Sample problem output (CONTEMPT4 31 pages, 7600-180 records*)
Reference report, TREE-NUREG-1202, and Note, as appropriate to machine edition
* 512-word maximum length
17. **CATEGORY** - G
KEYWORDS - accidents, containment, temperature distribution, ice condensers, pressure, reactor safety, mass transfer, energy transfer, PWR reactors, CONTEMPT codes
18. **SPONSOR** - NRC Office of Nuclear Reactor Regulation,
Division of Systems Safety

1. NAME OR DESIGNATION OF PROGRAM - ANOVA
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - ANOVA provides the analysis of variance techniques necessary to analyze experimental data. Four models can be used to analyze one, two, or three factor experiments, with the factors being either fixed or random. These models are: fully crossed, fully nested, factors A and C crossed with B nested in A, and factors A and B crossed with C nested in AB.
4. METHOD OF SOLUTION - Standard analysis of variance techniques are used to analyze the data. The sum of squares calculations are simplified by forming a table of C's which are combined according to the model being considered. The C table is provided as a program option and the details of how the C's are combined to form the sum of squares are shown in Appendix A of reference 1.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Due to current program dimensions, maxima of 40 levels of factor A, 20 levels of factor B, 20 levels of factor C, and 100 repeats are allowed.
6. TYPICAL RUNNING TIME - Run time is problem dependent. NESC executed the sample problem in less than 8 CP seconds on a CDC6600.
7. UNUSUAL FEATURES OF THE PROGRAM - The following options are available to the user: mean tables, standard deviation tables, EMS tables, analysis of variance table, selected variance components table, and a table of F ratios.
8. RELATED AND AUXILIARY PROGRAMS - The program is based on an ANalysis Of Variance (ANOVA) program written by J. W. Johnson, Case Institute of Technology, for an IBM650.
9. STATUS - Abstract first distributed May 1979.
CDC6600 version submitted August 1975, sample problem executed by NESC February 1979 on a CDC6600.
10. REFERENCES - J. H. Carder, Analysis of Variance (Three Factor), Bendix Kansas City Division Document 25, July 1975.
Carl A. Bennett and Norman L. Franklin, Statistical Analysis in Chemistry and the Chemical Industry, John Wiley & Sons, New York, 1954.
11. MACHINE REQUIREMENTS - 55,000 (octal) words of memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
J. H. Carder and G. M. Grogger
Bendix Kansas City Division
P. O. Box 1159
Kansas City, Missouri 64141
16. MATERIAL AVAILABLE -
Source deck (900 cards)
Sample problem (29 cards)
Reference report, BKC Document 25
17. CATEGORY - P
KEYWORDS - statistics, experiment planning, multivariate analysis

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18. SPONSOR - ERDA Division of Military Application

APPENDIX A: LIBRARY PROGRAMS BY SUBJECT CLASSIFICATION

A. CROSS SECTION AND RESONANCE INTEGRAL CALCULATIONS

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- 216 FSDP3** - FSDP3 computes pointwise cross sections from single-level Breit-Wigner resonance parameters.
- 247 FLANGE1** - FLANGE1 computes neutron scattering kernels for a large class of moderators. Neutron scattering kernels are obtained from the scattering law computed by the code GASKET. FLANGE1 allows the calculation of double differential cross sections, angular cross sections, total cross sections, and Legendre moments of the scattering kernel. The short collision time approximation is used for energy transfers larger than the maximum provided by GASKET.
- 263 GASKET** - GASKET calculates the thermal neutron scattering law, $s(\alpha, \beta)$, for a large class of moderators. Provision has been made in GASKET for the following dynamical modes of the scatterer -
- (1) free translation (gas),
 - (2) diffusive or Brownian motion,
 - (3) harmonic isotropic vibrations with continuous frequency spectrum,
 - (4) harmonic anisotropic vibrations with continuous frequency spectrum (as applied for instance to graphite),
 - (5) harmonic isotropic vibrations with discrete frequency spectrum.
- 289 GAKER** - The GAKER code evaluates the inelastic, double-differential neutron scattering cross sections for moderators with phonon spectra which can be represented as sums of delta-functions. It is based on the original model for light water by Nelkin, which consisted of a translator, a hindered rotator (treated as an isotropic oscillator), and several vibrational oscillators. The code has been modified several times to include more oscillators and to treat anisotropic effects. Final energy-integrated cross sections are also calculated.
- 292 PSEUDO** - Resonance parameters are constructed from average nuclear properties in the unresolved resonance region.
- 308 JUPITOR1(JP1)** - JUPITOR1 is used to perform coupled-channel calculations to evaluate the cross sections for the scattering of nuclear particles by various collective nuclei.
- 341 GANDY3** - GANDY3 evaluates temperature-dependent effective neutron capture, fission, and scattering cross sections in the unresolved resonance region from average resonance parameters.
- 347 CODILLI** - A least-squares analysis of neutron resonance data is performed using the multi-level expansion. The program can handle only one set of cross sections at a time. Options are provided for the analysis of reaction or total cross section data, and for the direct handling of transmission data. By option, one can include the multi-level interference or perform the fit in terms of superimposed symmetric Breit-Wigner lines, while the potential scattering interference is always included in the trial function for the total cross section. Provisions are given for Gaussian and non-Gaussian resolution functions. In the latter case, modification of one subroutine allows for adaptation to any kind of experimental conditions. The relevant convolution integrals involving the trial function are evaluated by Simpson integration with an optional number of integration steps. Besides the resonances to be fitted, the trial function contains an optional number of resonances having known parameters, which may represent resonances external to the region being fitted as well as resonances within the energy interval of interest, thus permitting impurity effects to be described, or, if needed, spin states separated.
- 359 PUN1** - PUN1 evaluates unresolved radiative capture integrals and related multigroup cross sections. The unresolved distributions may have various orbital angular momentum quantum numbers and the effects of Doppler broadening and self-shielding are included.
- 380 TOR** - The TOR program calculates the scattering law for a crystalline material in the incoherent approximation, from the phonon frequency distribution and a specified

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temperature. A proportional quantity is punched in the form of a table for interpolation of the double differential cross section. As an alternative, the program obtains the analogous quantities for a monatomic gas.

- 376 AVERAGE** - AVERAGE calculates average scattering, capture, and fission cross sections from s- and p-wave data of the unresolved parameters of File 2 of ENDF/B.
- 377 SIGPLOT** - SIGPLOT calculates the scattering, capture, fission, and total cross sections from resonance parameters of Version 1 data from File 2 of ENDF/B. Scattering cross sections may be calculated with or without level-level interference. Provision is also made to numerically Doppler-broaden any of the cross sections.
- 385 COHBE/PREP** - The programs, PREP and COHBE calculate the coherent one-phonon scattering law for polycrystalline beryllium, using an isotropic Debye-Waller factor as an approximation for beryllium. The Debye-Waller factor w is consistent with the definition $\exp(-2w \cdot \alpha)$ in the scattering law.
- 399 SUMOR(MO271)** - SUMOR calculates s-wave neutron cross sections at selected energies. The cross sections are calculated in three approximations to r-matrix theory - the Reich-Moore approximation, the Feshbach, Porter, and Weisskopf approximation, and the sums of single-level formulae approximation. These calculated cross sections or, alternatively, input lists of cross sections, are Doppler-broadened using exact calculation for target nuclei in Maxwellian motion. Calculated cross sections or cross sections divided by neutron energy can be integrated between arbitrary energy limits.
- 410 TACASI** - TACASI is used to determine the parameters of a single neutron resonance. The code accepts measured values of capture areas, self-indication areas, self-indication ratios and transmission areas and their associated uncertainties in any combination and determines best estimates of the neutron and radiation widths and their standard deviations.
- 417 ATHENA4** - ATHENA4 computes form factors for inelastic scattering calculations, using single-particle wave functions that are eigenstates of motion in either a Woods-Saxon potential well or a harmonic oscillator well. Two-body forces of Gauss, Coulomb, Yukawa, and a sum of cut-off Yukawa radial dependences are available.
- 465 RESEND/ADLER** - RESEND generates infinitely-dilute, unbroadened, point cross sections in the ENDF format by combining ENDF File 3 background cross sections with points calculated from ENDF File 2 resonance parameter data.
ADLER calculates total, capture, and fission cross sections from the corresponding Adler-Adler parameters in the ENDF/B File 2 Version 11 data and also Doppler-broadens cross sections.
- 470 GRAMP** - GRAMP randomly generates Reich and Moore parameters for multilevel unresolved resonances of fissile isotopes.
- 482 COMNUC/CASCADE** - COMNUC calculates neutron reaction cross sections using a statistical model for decay of the compound nucleus. Competing reaction types permitted are elastic, discrete and continuum inelastic, gamma ray emission, capture, fission, and n,2n.
CASCADE solves the intranuclear gamma ray cascade equation to determine secondary particle emission probabilities. Competing processes considered are gamma ray emission, neutron emission and fission.
- 492 RAMP1** - RAMP1 calculates scattering, capture, fission, and total cross sections from Reich-Moore resolved resonance parameters. The resonance parameters are assumed to be in ENDF/B Version 11 data format. Cross sections may be Doppler-broadened if so desired.
- 504 THRES2** - THRES2 calculates neutron-induced reaction cross sections from 0 to 20 MeV and fission spectrum averages for nuclides having 21 to 82 protons. Reaction products considered are 2n, 3n, p, d, t, He-3, alpha, np, nd, nt, n-He3, n-alpha, pn, 2p, p-alpha, alpha-n, alpha-p, and dn.

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- 506 JPIXR - JPIXR computes scattering cross sections and related quantities for the scattering of nucleons or composite particles from any collective nucleus, even or odd A, vibrational or rotational. The projectile can be charged or uncharged and can have spin 0, 1/2, or 1.
- 507 PHASER - PHASER computes the following quantities for the scattering of neutrons from nuclei: total, elastic, and reaction cross sections, differential shape and compound elastic cross sections, differential polarizations, differential and integrated compound level inelastic cross sections, compound and shape elastic Legendre moments in the center-of-mass system.
- 524 BESFIT - BESFIT calculates differential elastic scattering cross sections using a Bessel function expansion, based on a diffraction model. Constant terms may either be supplied as input data or obtained by a least squares fitting of the data.
- 531 CLEM - CLEM generates constrained Legendre moments for neutron scattering angular distributions. The constraint is that the angular distribution itself should be non-negative.
- 535 MULTI - MULTI computes scattering cross sections.
- 553 U3R - U3R numerically constructs a table of the cumulative probability distribution functions of unresolved resonance cross sections in a narrow energy range.
- 639 POLLA - The program transforms a set of r-matrix nuclear resonance parameters into a set of equivalent s-matrix (or Kapur-Peierls) resonance parameters.
- 757 GNASH - The preequilibrium, statistical nuclear model code GNASH calculates reaction and level cross sections, isomer ratios, and spectra (neutron, gamma-ray, and charged-particle) resulting from particle-induced reactions using the Hauser-Feshbach formalism along with simple preequilibrium corrections. Gamma-ray competition is considered in detail for every decaying compound nucleus.
- 805 DOPSEL - DOPSEL evaluates the temperature- and composition-dependent self-shielded cross-sections and self-shielding factors for neutron capture, fission, and scattering processes in both resolved and unresolved regions. The generalized resonance integrals under the NR approximation for both fissile and fertile materials and infinite dilution cross sections are also calculated.
- 815 ALVIN - ALVIN analyzes the consistency of a set of differential and integral nuclear data, adjusts the differential nuclear data to improve agreement with integral observations, and identifies inconsistent data. ALVIN also computes required sensitivities and related quantities such as sensitivity profiles.

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- 50 TEMPEST2** - TEMPEST2 is a neutron thermalization program based upon the Wigner-Wilkins approximation for light moderators and the Wilkins approximation for heavy moderators. A Maxwellian distribution may also be used. The model used may be selected as a function of energy. The second-order differential equations are integrated directly rather than transformed to the Riccati equation. The program provides microscopic and macroscopic cross-section averages over the thermal neutron spectrum.
- 51 FORM** - The FORM, or FORTRAN-MUFT, program is a Fourier transform slowing-down code. A library tape containing 54-group microscopic cross sections, resonance parameters, inelastic scattering matrices, and source spectra is used to generate a 54-group flux spectrum and few-group constants.
- 147 AILMOE** - AILMOE is a modified form of the ANL ELMOE program. The Fourier transform of the fast neutron flux is found for a mixture of moderators heavier than hydrogen with the moderator scattering law rigorously accounted for.
- 184 BRT1** - BRT1, like the original THERMOS code developed by H. Honeck of Brookhaven National Laboratory, computes the scalar thermal neutron spectrum as a function of position in a lattice by solving the integral transport equation with isotropic scattering. One-dimensional slab or cylindrical geometry may be used. As output the code supplies flux-averaged values of σ_a , σ_f , $\nu\sigma_f$, σ_s , and d for the cell composition and the values of σ_a , σ_f , $\nu\sigma_f$, σ_s , and σ_{tr} for the isotopic constituents.
- 185 GAMTEC2** - GAMTEC2 generates multigroup constants in the energy range from 0 to 10 MeV for either homogeneous mixtures or heterogeneous arrays consisting of cylinderized lattice cells. The thermal group constants are averaged over (1) Wigner-Wilkins light moderator spectrum, (2) Wilkins heavy moderator spectrum, or (3) a Maxwellian distribution. For heterogeneous arrays the spatial thermal flux is calculated by a monoenergetic P3 approximation. For epithermal energies, the slowing-down distribution is described by either a B1 or P1 approximation to the Boltzmann equation. Resonance absorption and fission are treated by the Adler-Nordheim method. An improved method over that used in GAM1 for averaging the resonance absorption contribution to the multigroup constants is included. Fuel lumping effects on the fast fission of U238 and Th232 are treated by an n-flight collision probability technique. Group constants are punched on cards in HFN (diffusion code) and DTF (SN transport code) formats.
- 249 LASER** - LASER is based on modified versions of the slowing-down program MUFT and the thermalization transport theory program THERMOS, and performs a calculation of the neutron spectrum in a uniform lattice made up of cylindrical rods, cladding, and surrounding moderator. The thermal cutoff in LASER is 1.855 eV. The program performs a burnup calculation for the lattice. The spatial distribution of burnup within the fuel rods is explicitly calculated. The program will, at option, account for all non-linearities and mutual connections in the system of burnup equations. This calculation accounts for the variation of the neutron flux in space and energy during each time-step. A buckling, and a boron poison, criticality search are provided as options. Output includes edits in the energy range 0 to 0.625 eV.
- 257 REAX** - REAX calculates epithermal flux, activities and cross sections as a function of radius and energy for a constant temperature fuel rod immersed in a homogeneous medium.
- 276 AVOID** - AVOID computes the equivalent diffusion coefficient and loss cross section of an annular void in a cylindrical reactor and the radial flux distribution in the void.
- 277 HAMMER/LITHE/HELP** - HAMMER performs infinite lattice, one-dimensional cell multigroup calculations, followed (optionally) by one-dimensional, few-group, multiregion reactor calculations with neutron balance edits.
- 279 LEOPARD/SPOTS** - LEOPARD is a unit cell homogenization and spectrum generation (MUFT-SOFOCATE type) program with a fuel depletion option.

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- 280 M0807** - M0807 solves the two-dimensional fixed-source diffusion equation for the absorption and removal macroscopic cross sections required to yield a specified reaction rate distribution.
- 285 RESQ2/RESQ0/DBF1** - RESQ2 calculates the resonance integral in a two-dimensional, hexagonal system consisting of fuel, clad and water with a reflecting boundary condition.
- 291 HEXSCAT** - HEXSCAT calculates P0 through P3 components of the polycrystalline coherent elastic neutron scattering cross section per nucleus for a hexagonal lattice. The code averages point values over input group boundaries to give smoothed group cross sections.
- 298 GGC4** - The GGC4 program solves the multigroup spectrum equations with spatial dependence represented by a single input buckling. Broad group cross sections (shielded or unshielded) are prepared for diffusion and transport codes by averaging with the calculated spectra over input-designated energy limits. The code is divided into three main parts. A fast (GAM) section which covers the energy range from 14.9 MeV to 0.414 eV, a thermal (GATHER) section which covers the energy range from 0.001 to 2.38 eV, and a combining (COMBO) section which combines fast and thermal cross sections into single sets. Basic nuclear data for the fast section which consists of fine group-averaged cross sections and resonance parameters is read from a data tape. The fine group absorption and fission cross sections may be adjusted by performing a resonance integral calculation. Utilizing a fission source and an input buckling, the code solves the P1, B1, B2, or B3 approximation to obtain the energy-dependent fast spectrum. Two or six spatial moments of the spectrum (due to a plane source) may also be evaluated. Instead of performing a spectrum calculation, the user may enter the Legendre components of the angular flux directly. For as many input-designated broad group structures as desired, the code calculates and saves (for the combining section) spectrum-weighted averages of microscopic and macroscopic cross sections and transfer arrays. Slowing down sources are calculated and saved for use in the lower energy range. Given basic nuclear data, the thermal section of GGC4 determines a thermal spectrum by either reading it as input, by calculating a Maxwellian spectrum for a given temperature, or by an iterative solution of the P0, B0, P1, or B1 equations for an input buckling. Time moments of the time and energy-dependent diffusion equations are calculated (as an option) using the input buckling to represent leakage. Broad group cross sections are prepared by averaging fine group cross sections over the calculated spectra. Broad group structures are read as input. The combining section of GGC4 takes the broad group-averaged cross sections from the fast and thermal portions of GGC4 and forms multigroup cross section tables. These tables are prepared in standard formats for transport or diffusion theory calculations. In addition, it is possible to use the combining section to produce mixtures not used in the spectrum calculation or to combine the results of different fast and thermal section calculations and so on. These options are described in reference 4.
- 306 FCC4** - FCC4 is a multipurpose data manipulation code for use in fast reactor analysis. The code can be used to - (a) compute resonance-shielded cross sections using data in the Russian format (shielding factors and infinite-dilution cross sections), (b) compute multigroup fundamental-mode flux and adjoint flux, (c) compute and punch group-collapsed microscopic or macroscopic cross sections in the DTF format, (d) compute fuel burnup at constant flux or power density.
- 307 HWOGR-SAFE** - HWOGR-SAFE is a Monte Carlo thermal reactor analysis program designed for use with proposed HWOGR lattice configurations. It is a benchmark tool to check multigroup diffusion and transport calculations and to evaluate the effect of their use of geometric approximations.
- 316 GAFGAR/P3T/PROC/TAPCCP** - The problem is to obtain very detailed neutron flux and current distributions as functions of energy considering explicitly the possible overlap effects between resonances of a resonance absorber and of mixtures of resonance absorbers and to use these distributions to prepare group-averaged cross sections and transfer arrays for use in fast reactor analyses.

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- 355 MC-2-2** - MC-2-2 solves the neutron slowing-down equations using basic neutron data derived from ENDF/B data files to determine spectra for use in generating multigroup neutron cross sections.
- 361 GLEN** - The GLEN program interpolates values of a factor proportional to the scattering law from the punched output of the TOR code (NESC Abstract 360). The differential cross section determined from these is integrated over the scattering angle to obtain coefficients of an expansion in Legendre polynomials of this angle for $L = 0, 1, 2, 3$. Integration over final energies yields values of the total scattering cross section and transport cross section. For each of a series of isotopic compositions (up to 10 compositions) the GLEN code calculates the diffusion length and values of the flux-weighted group average macroscopic scattering, absorption, fission, and transfer cross sections.
- 362 WELWING** - WELWING was developed to calculate the material buckling of reactor systems consisting of annular fuel elements in heavy water as moderator for various moderator to fuel ratios. The moderator to fuel ratio for the maximum material buckling for the particular system is selected automatically and the corresponding material buckling is calculated.
- 368 FLANGE2(71-1)** - FLANGE2 takes cross sections, angular distribution, resonance parameter, and thermal scattering law data from ENDF/B Format II or III data tapes and prepares thermal multigroup cross sections and scattering matrices.
- 374 1DX** - 1DX is a multipurpose, one-dimensional diffusion code for generating cross sections to be used in fast reactor analyses. The code is designed to -
- (a) compute and punch resonance shielded cross sections using data in the Russian (see reference 2) format,
 - (b) compute and punch group-collapsed microscopic and/or macroscopic cross sections averaged over the spectrum in any specified zone, and
 - (c) compute keff and perform criticality searches on time absorption, material concentrations, zone dimensions, and buckling using either a flux or an adjoint model.
- 388 ETOX3** - ETOX3 (ENDF/B to 1DX) calculates multigroup constants for nuclear reactor calculations using data from the Evaluated Nuclear Data File (ENDF/B) Version II or Version III format. It can also process Version I materials that do not call for partial energy distribution laws 1, 2, 4, 6, or 8 (see ENDF, File 5). The code is designed to compute and punch -
- (a) infinite dilute cross sections,
 - (b) temperature-dependent, self-shielding factors for arbitrary values of microscopic sigma₀ (total cross section per atom) in the Russian (Bondarenko) format, and
 - (c) inelastic-scattering probability matrices.
- 392 RAFFLE** - RAFFLE calculates neutron first-flight collision probabilities for a wide variety of three-dimensional cell geometry configurations. The outer boundaries of the cell cross section may be circular, square, or hexagonal. The cell may contain annular regions and/or clusters of rods.
- 416 PARTI** - PARTI is a group collapsing code which determines the optimum discrete representation of a variable for subsequent repetitive calculations.
- 420 GROUSE** - GROUSE computes effective multigroup cross sections as a function of position in the core of a reactor or the absorber region of a fuel or control element. The flux weighting uses synthesized fluxes generated in fine energy detail from parametric flux traverses supplied as input as a function of the core absorption and scatter cross sections.
- 426 PAX03** - PAX03 performs infinite medium, time-dependent calculations of neutron flux spectra in homogeneous, hydrogenous media. A HARMONY file containing few-group microscopic

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and/or macroscopic cross sections for PDQ7 problems may be generated. The one-dimensional multigroup transport equation may be solved using a P1 to P7 approximation in rectangular, cylindrical, or spherical geometry. Heterogeneous resonance integrals and thermal shielding factors are calculated for either plate or rod geometry. Blackness parameters are calculated and coefficients for temperature feedback calculations are obtained. Few-group constants are available in both the fast and thermal energy ranges.

- 431 SUPERTOG** - SUPERTOG accepts nuclear data in either a point by point or parametric representation as specified by ENDF/B. This data is averaged over each specified group width. The explicit assumption is made that the flux per unit lethargy is constant or that a suitable weight function will be supplied by the user. When resonance data is available, resolved and unresolved resonance contributions are calculated and used as specified by input options. Fine group constants such as one-dimensional reaction arrays (absorption, fission, etc.), PN elastic scattering matrices, and inelastic and (n,2n) scattering matrices are generated and placed on tapes in formats suitable for use by the GAM1, GAM2, ANISN, or DOT programs.
- 436 ETOM1** - ETOM1 processes basic nuclear information given in the ENDF/B format and produces data decks for use in generation of MUFT4 and MUFT5 libraries.
- 437 ETOG1** - ETOG1 processes basic nuclear information given in the ENDF/B format and produces data decks for use in generation of MUFT4, MUFT5, GAM1, GAM2, and ANISN libraries.
- 453 RICE** - The program calculates an energy exchange matrix which describes the probability that a neutron with energy E will produce a recoil atom with energy T in a given material. In addition, the program can calculate the primary recoil atom energy spectrum for a given neutron spectrum, the damage cross section for the material, and an optimum lower energy limit for use in comparing the relative damage in different reactor spectra. The program accepts neutron scattering data directly from the ENDF/B library tapes and, in the case of a resonance nuclide, from a tape generated by the program SUPERTOG (NESC Abstract 431).
- 461 EPOCH** - EPOCH solves for fine detail P1 flux spectra in simply-buckled media and is able to calculate neutron ages from the spectra. It obtains nuclear cross sections from the ENDF/B library, ignoring resonance files, and is most useful for higher energies where resonant reactions are weak or absent. The present version reads only ENDF/B Version 1 tapes.
- 466 APRFX1** - APRFX1 collapses and combines cross section sets for multigroup transport calculations. It performs group collapsing for as many isotopes, mixtures, and Legendre expansion sets as desired from the DLC-2B library. The DLC-2B library structure employs tenth lethargy unit intervals from 15 MeV to 111 keV and quarter lethargy intervals down to 0.414 eV. A 100th group 0.0 to 0.414 eV is used as a sink group. The code also determines the broad-group input source and generates averaged neutron velocities for use with transport calculations.
- 467 HRG3** - The code computes the slowing down spectrum over the energy range 10 MeV to 0.414 eV in either the B1 or P1 approximation, using 68 groups of neutrons with a constant group width of $\Delta u = 0.25$. The calculated flux and current spectra are used to reduce the original 68-group cross section data to average values over as many as 33 broad groups. Output is printed and may also be punched in formats for input to any of several spatial multigroup codes.
- 501 ENDRUN2** - ENDRUN2 is used to calculate multigroup constants from energy-dependent, microscopic cross sections, resonance parameters, and inelastic level data input in the evaluated nuclear data file (ENDF/B) formats. Data is processed for one material at a time and the output multigroup file includes both infinitely-dilute group cross sections and self-shielding, Bondarenko-type f-factors so that the resulting generalized file is independent of reactor composition. The multigroup data may be output on punched cards, a standard library tape, or plotted over any energy range.

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- 505 TDOWN** - TDOWN generates spatial and composition-dependent cross section sets from a Bondarenko type, generalized cross section file called GMUG. A TDOWN problem can be a simple description of material compositions with an input flux spectra or a problem can consist of a multi-region, two-dimensional reactor description with several zero- or one-dimensional flux solutions to provide the flux for spectral adjustments of the cross section sets.
- 509 ETOT2** - ETOT2 processes basic nuclear information given in the ENDF/B library tape Formats I and II and produces data decks for use in the generation of KATE, THERMOS (NESC Abstract 184), TEMPEST (NESC Abstract 50), and LASER (NESC Abstract 249) libraries.
- 520 PHROG** - PHROG generates energy dependent fast neutron spectra and associated multigroup cross section data suitable for use in diffusion and transport theory reactor design analysis. The solution utilizes 68 equal lethargy groups of cross section, source, and leakage data over an energy range extending from 10 MeV to 0.414 eV. These data are then coalesced into broad group form using the fluxes and currents as weighting functions.
- 526 CLUP77** - CLUP77 computes the collision probabilities in a multi-region square assembly of clustered fuel rods. The assembly can be made up of rods of infinite height and divided into rectangular pillars containing a nest of concentric annuli of different materials. The outer boundary of the assembly may be treated as reflective or a vacuum.
- 536 RAHAB Lattice Physics Modules** - RAHAB is a two-dimensional, multigroup, neutron integral transport code. Its capability includes full or subdivided annular, square and hexagon regions, clusters and multicell (mixed lattices). The multigroup structure can include thermal, epithermal, and fast energy regions. The number of energy groups is variable from 1 to 100. Buckling and time eigenvalue searches are allowed options.
- 538 ETOG3** - ETOG3 processes basic nuclear information given in ENDF/B Version III format producing data decks for use in generation of MUFT4, MUFT5, GAM1, GAM2, and ANISN libraries.
- 547 GAMB1T** - GAMB1T is a program that was designed to calculate multigroup neutron cross sections in the high energy and the thermal energy ranges. It was created by joining GAM, which does the high energy calculation, and B1T, which does the thermal calculation.
- 565 INCITE** - INCITE generates energy-dependent thermal neutron spectra and appropriate average multigroup cross sections using arbitrary scattering kernels. The physical model is a homogeneous, critical, one-dimensional bare slab core.
- 596 ENDFB2/GAND2/GFE2** - ENDFB2 converts ENDF/B cross section data from a card-image to a binary tape for use by the GAND2 and/or GFE2 codes.
 GAND2 prepares the cross sections needed for detailed computations of neutron energy spectra in reactors from a file of basic nuclear data in the ENDF/B Version II or III formats (also retains the ENDF/B Version I capability of GAND).
 GFE2 prepares 1/E or fission-spectrum weighted, zero temperature, infinite dilution group-averaged cross sections and scattering transfer arrays for use in the fast sections of the GGC and MICROX codes from a file of basic nuclear data in the ENDF/B Version II or III formats (the ENDF/B Version I format capability of the original GFE code is also retained).
- 628 ETOT-3** - ETOT-3 processes basic nuclear information given in the ENDF/B format (reference 3) and produces data decks for use in generation of KATE, THERMOS, TEMPEST and LASER libraries.
- 631 RAFFLE2/MOD2** - RAFFLE is a three-dimensional general-purpose Monte Carlo program for the solution of static neutron transport problems. Either fission source iteration or external source problems can be solved. Reaction rates and fluxes or cell-averaged P0 and P1 transfer matrices can be obtained for up to 100 input energy groups. Multiplication factors, lifetimes, generation times, and probable errors are also computed. Groupwise currents from any region to adjacent regions can be computed. A zone geometry option,

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designated "mixed" zone geometry, is included to simplify the preparation of input data for problems having an array of fuel pins. This option combines features of the rectangular, cylindrical r-z, and cylindrical r-theta-z zone geometries in a two-level zone search.

671 RECAP-0(M04B1) - RECAP-0 calculates detailed Doppler-broadened neutron resonance cross sections from unresolved and either single level or multilevel resolved resonance parameters, for up to 10 nuclides, within an arbitrary energy structure consisting of up to 49 epithermal groups and 1 thermal group. The highest energy groups are divided into as many as 500 energy intervals for resonance cross section detail. These groups also allow inelastic scattering, expressed through groupwise transfer matrices, for the resonance nuclides and for as many as 5 additional nuclides without detailed resonance descriptions. Subsequent epithermal groups may be subdivided into 1000 intervals, and the thermal group may contain 299 intervals. Elastic scattering for each nuclide is described by the first four components of the differential scattering cross sections in the CM system, and the thermal group will treat two P3 thermal kernels through 25 x 25 transfer matrices. All data used for construction of neutron job libraries are taken from a master neutron cross section library.

747 LINEAR,SIGMA1 - LINEAR and SIGMA1 are FORTRAN programs designed to convert ENDF/B File 3 cross section data to linear-linear interpolatable form, to thin these data, and to Doppler-broaden linear-linear data to one final temperature. The output is written in ENDF/B format.

LINEAR converts evaluated cross sections in the ENDF/B format to linear-linear interpolatable form and thins those sections already in that form. This eliminates any subsequent code's need to do this task.

SIGMA1 will Doppler-broaden the converted sections of ENDF/B File 3 cross-section data to the final temperature. The energy grid is selected to ensure that the broadened data is linear-linear interpolatable. If the original data is not at zero Kelvin the data are broadened by the effective temperature difference to the final temperature.

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- 9 **FIRE5** - FIRE5 solves the one-dimensional, multigroup, age-diffusion equations for slab (symmetric and asymmetric), cylinder, and sphere geometries. An extension of the original Los Alamos FIRE program written by F. W. Brinkley and C. B. Mills, it contains a 34-group library of 10 elements. FIRE5 can be used for cell calculations with the boundary condition that the current be zero on the outer boundary. The effective cross sections and diffusion coefficients for a homogenized region consisting of any number of neighboring regions can also be obtained, but only for cylindrical geometry. FIRE5 also computes the macroscopic flux-weighted cross sections for collapsed groups in each region.
- 28 **FOG** - The FOG program solves the one-dimensional few-group diffusion equations in any of three geometries slab, cylinder, or sphere. Provisions are made for calculating the flux, the adjoint flux, and various criticality searches as well as a buckling iteration and automatic Tschebyscheff polynomial computation of source extrapolation factors.
- 29 **AIM6** - AIM6 solves the one-dimensional multigroup diffusion equations utilizing a microscopic cross section library. Any of three geometries are available slab, cylinder, or sphere. Criticality searches are provided including a concentration search on one or two elements. Homogeneous and inhomogeneous problems may be solved with a variety of boundary condition options.
- 30 **PERT** - PERT is a perturbation program designed for use with the AIM6 and FOG programs. Punched card output from these codes is used as input to PERT. Using cross-section data, fluxes, and adjoint fluxes, the relative change in k_{eff} can be calculated. Cross sections may be weighted with the adjoint flux and/or direct flux. The neutron lifetime for the delay groups may also be determined.
- 120 **FAIMOS** - FAIMOS is a multigroup, one-dimensional neutron diffusion equation program based on AIM6 (NESC Abstract 29). The principal features are -
- (a) three geometries (planar, cylindrical, or spherical),
 - (b) calculation of fluxes and multiplication factor,
 - (c) one-iteration problems,
 - (d) choice of one of five sets of boundary conditions at both the inner and outer boundaries,
 - (e) criticality searches on transverse buckling, homogeneous poison, critical radius, location of a poison region boundary, location of a fuel region boundary,
 - (f) adjoint flux calculation, and
 - (g) extensive data edit.
- 136 **HERESY3** - HERESY3 solves the two-dimensional, few-group, static reactor eigenvalue problem using the heterogeneous (source-sink or Feinburg-Galanin) formalism. The solution yields the reactor k -effective and absorption reaction rates for each rod normalized to the most absorptive rod in the thermal level. Epithermal fissions are allowed at each resonance level, and lattice-averaged values of thermal utilization, resonance escape probability, thermal and resonance η values, and the fast fission factor are calculated. Kernels in the calculation are based on age-diffusion theory. Both finite reactor lattices and infinitely repeating reactor supercells may be calculated. Rod parameters may be calculated by several internal options, and a direct interface is provided to a HAMMER system (NESC Abstract 277) lattice library tape to obtain cell parameters. Criticality searches are provided on thermal utilization, thermal η , and axial leakage buckling.
- 156 **EXTERMINATOR2** - The multigroup, two-dimensional neutron diffusion equations are solved in x - y , r - z , or r - θ geometry.
- 167 **FLARE** - FLARE is an inexpensive calculational method to determine core reactivity and core power distribution. A scoping calculation of this type is valuable in appraising the physics characteristics of planned test modes of operation so that detailed analysis can be reserved for those core calculations of greater interest from either a technician or safety standpoint.

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- 173 **2DF** - 2DF is a two-dimensional, multigroup program written in FORTRAN for solving the neutron transport equation using the SN method. The program can determine the real or adjoint solution for x-y, r-z, or r-theta geometry. Isotropic, or a form of linear anisotropic, scattering may be considered. Various boundary conditions are allowed. The program also contains a number of search options whereby one can vary dimensions or concentrations to arrive at a predetermined eigenvalue. A distributed source may be specified. A library of cross sections is available on magnetic tape. Cross sections may be read from the library tape and/or from cards.
- 209 **DTF4** - The linear, time-independent, Boltzmann equation for particle transport is solved for the energy space, and angular dependence of the particle distribution in one-dimensional slabs, cylinders, and spheres. Independent source or eigenvalue (multiplication, time-absorption, element concentration, zone thickness or system dimension) problems are solved subject to vacuum, reflective, or periodic boundary conditions. A complete energy-transfer scattering matrix is allowed for each Legendre component of the scattering cross section matrices.
- 212 **VARI-QUIR** - The time-dependent, multigroup, two-dimensional neutron diffusion equations are solved in x-y or r-z geometry.
- 222 **GAMBLE5** - The homogeneous 2-dimensional multigroup diffusion theory equations with arbitrary group-to-group scattering and arbitrary fission transfer are solved for heterogeneous assemblies in x-y and r-z geometry. Homogeneous logarithmic boundary conditions are used at the outer surface of the assembly and at the surface of non-diffusion regions. The results include the group and point-dependent neutron fluxes, the power distribution, the neutron multiplication factor (k-effective), and a detailed neutron balance.
- 241 **HFN** - HFN solves the homogeneous or inhomogeneous one-dimensional multigroup diffusion equation for its lowest eigenvalue and the corresponding direct and/or adjoint eigenvectors. Inhomogeneous boundary conditions and a flexible scatter-transfer matrix structure are included. Optional calculations include criticality searches, detector activation traverses, and integrals for perturbation theory analysis.
- 262 **MACH1** - MACH1 performs one-dimensional multigroup diffusion solutions and associated calculations, including criticality searches, perturbation, reaction summary, beta effective, group collapsing, and pointwise reaction rates and ratios. Several card dumps of computed data are available on option. A spectral synthesis option is available in the IBM version.
- 270 **CAESAR4/LIBLST** - CAESAR4 solves the one-dimensional, multigroup, diffusion equations in any of three geometries and provides a wide choice of boundary conditions, criticality searches, edits and other auxiliary computations.
- 287 **BISYN** - BISYN solves the two-dimensional, multigroup, neutron diffusion equations in x-y or r-z geometry using a noniterative synthesis method. This approach is designed to greatly reduce the computer cost of running two-dimensional multigroup problems at the risk of some loss in accuracy of the detailed flux distribution.
- 304 **PERT4** - PERT4 computes reactivity coefficient traverses in x-y, r-z, or r-theta geometry using the first-order perturbation equations in the diffusion approximation. Flux and adjoint input can be taken directly from 2-D calculations or synthesized from radial and axial 1-D calculations. The code can also be used to compute activity traverses for any cross section of any material, the neutron generation time, and the effective delayed neutron fraction.
- 319 **GASP7** - GASP7 calculates the one-dimensional distribution of fissile and fertile materials in a nuclear reactor which will yield any desired power distribution during the burnup history of the reactor core. A poison and poison distribution search for a desired multiplication and minimum power distribution perturbation can also be performed.
- 320 **TEMC07** - TEMCO7 computes reactor temperature coefficients.

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- 342 M0648 - M0648 solves the one-dimensional slab transport problem with slowing-down for an arbitrary spatial external source and arbitrary scattering.
- 358 TWOTRAN2 - TWOTRAN2 solves the two-dimensional multigroup transport equation in (x,y), (r,theta), and (r,z) geometries. Both regular and adjoint, inhomogeneous and homogeneous (keff and eigenvalue searches) problems subject to vacuum, reflective, periodic, white or input-specified boundary flux conditions are solved. General anisotropic scattering is allowed and anisotropic inhomogeneous sources are permitted.
- 380 GATT - GATT is a three-dimensional few-group neutron diffusion theory program for calculating the detailed spatial flux and power distribution for reactors with hexagonal core configuration. The program uses a uniform triangular mesh in the horizontal mesh planes and assumes a relatively simple region structure in the axial direction. It was designed to represent the special patch-type core structure of the HTGR reactor as closely as possible.
- 398 BE21 - BE21 solves the few-group discrete ordinates equations in slab geometry. Either homogeneous or inhomogeneous problems can be solved.
- 401 GAMTRI - The homogeneous two-dimensional multigroup diffusion theory equations with arbitrary group-to-group scattering and arbitrary fission transfer are solved for heterogeneous assemblies in (uniform mesh) triangular geometry. Homogeneous logarithmic boundary conditions are used at the outer surface of non-diffusion regions. The results include the group- and point-dependent neutron fluxes, the power distribution, the neutron multiplication factor, and a detailed neutron balance.
- 430 GAZE2 - GAZE2 is a one-dimensional, multigroup, neutron diffusion theory program. It includes all four of the standard one-dimensional geometries - slab, sphere, radial cylinder, and axial cylinder, the last of which is identical to slab geometry except when the ZOOM albedo-type transverse boundary condition is used.
- 450 KENO2/KENO4 - KENO is a multigroup, Monte Carlo criticality code containing a special geometry package which allows easy description of systems composed of cylinders, spheres, and cuboids (rectangular parallelepipeds) arranged in any order with only one restriction. Each geometrical region must be described as completely enclosing all regions interior to it. For systems not describable using this special geometry package, the program can use the generalized geometry package (GEOM) developed for the O5R Monte Carlo code. It allows any system that can be described by a collection of planes and/or quadratic surfaces, arbitrarily oriented and intersecting in arbitrary fashion. Rectangular arrays of fissile units are allowed with or without external reflector regions. Output from KENO consists of keff for the system plus an estimate of its standard deviation and the leakage, absorption, and fissions for each energy group plus the totals for all groups. Flux as a function of energy group and region and fission densities as a function of region are optional output.
- 459 DOT25B - DOT25B solves both the multigroup, discrete ordinates transport theory and the multigroup, diffusion theory equations in two dimensions. Anisotropic scattering of any order Legendre expansion is allowed in the transport theory option. Anisotropic scattering in the diffusion theory option is treated with the transport approximation, using the P1 scattering matrix, when provided, to calculate the transport cross section. Options include solutions in (x,y), (r,z), (r,theta), and, in the diffusion theory option, triangular geometries. Both direct and adjoint fluxes may be computed for fixed volume-distributed source, multiplication-constant iteration, time-absorption iteration, concentration search, zone-thickness search, and fixed-boundary source problems. In addition to the fixed-boundary source problem, options include vacuum, reflection, periodic and white boundary conditions. Cross sections may be entered from cards or from tape in the DTF format. Activities for any material in the system may be output by interval (optional) and zone. Other output includes the interval fluxes and sources and a reaction summary table for each zone and for the system.
- 510 VIM1/VIM1X - VIM1 is a Monte Carlo code designed for the analysis of fast critical experiments. It has been expressly prepared for the analysis of fast critical assemblies

of the plate-drawer type such as ZPPR, ZPR-3, and ZEBRA. The library uses point cross section data, rather than multigroup constants.

- 523 ESP** - ESP is a general-purpose Monte Carlo reactor analysis code. It covers the complete energy range of interest in reactor calculations and is designed for both eigenvalue and fixed source reactor and reactor cell calculations. Basic data are accepted only in the Version I, II, and III ENDF/B format. In addition to smooth data, the cross section preparation includes a detailed treatment of resolved and unresolved resonances and the free gas and $s(\alpha, \beta)$ thermal models. The collision and source routines utilize the ENDF/B nonelastic secondary distributions, the anisotropic scattering data, and the fission spectra. The energy range may be divided into as many as 25,000 intervals, and over each interval the appropriately averaged cross sections are used as constant point-energy values. A general three-dimensional geometry description is available, as well as several specialized geometries. Use of fixed-source options allows calculations on non-multiplying systems. A steady-state analysis of neutron histories is performed in computer core for such quantities as neutron fluxes, reaction rates, and cross sections, averaged over arbitrary energy and spatial regions.
- 573 TWOTRAN-PNVW** - TWOTRAN-PNVW solves two-dimensional particle transport problems for x-y, r-z, and r-theta geometries. Both direct and adjoint, homogeneous (keff or parametric eigenvalue searches) or inhomogeneous time-independent problems are solved subject to vacuum, reflective, periodic or input specification of boundary flux conditions. Both anisotropic inhomogeneous problems and general anisotropic scattering problems are treated.
- 582 MONA** - MONA solves the multigroup, one-dimensional neutron diffusion equations in slab, cylindrical, or spherical geometry for either the direct or adjoint flux. Boundary sources and spatially dependent volume sources can be group dependent. Multiple thermal groups are allowed.
- 585 TRIAL** - TRIAL carries out a simple linking of several two-dimensional, multigroup neutron (direct or adjoint) flux sets to give a three-dimensional representation.
- 606 GAPER1D** - Reactivity coefficients are computed using first-order transport perturbation theory for one-dimensional multi-region reactor assemblies. The number of spatial mesh-points and energy groups is arbitrary. An elementary synthesis scheme is employed for treatment of two- and three-dimensional problems. The contributions to the change in inverse multiplication factor, $\Delta(1/k)$, from perturbations in the individual capture, net fission, total scattering, $(n, 2n)$, inelastic scattering, and leakage cross sections are computed. A multi-dimensional prompt neutron lifetime calculation is also available.
- 608 TRIPLET** - TRIPLET solves the two-dimensional multigroup transport equation in planar geometries using a regular triangular mesh. Regular and adjoint, inhomogeneous and homogeneous (keff and eigenvalue searches) problems subject to vacuum, reflective or source boundary conditions are solved. General anisotropic scattering is allowed and anisotropic distributed sources are permitted.
- 617 KEFF, MGBS, TGAN** - Three codes for nuclear criticality safety evaluations make up this package. The principal codes are a code for computing the buckling of fissile material moderated by water (MGBS) and a two-group diffusion theory code that uses parameters generated by the buckling code (TGAN). KEFF is an auxiliary code. KEFF computes keff from dimensions and extrapolation distances, or alternative dimensions, volumes, and masses corresponding to values of keff.
- 625 VARI-1D** - The VARI-1D code calculates estimates of changes in reactivity worths, keff, reaction rates, power fractions, prompt-neutron generation time, delayed neutron effectiveness, and flux integral ratios due to changes in nuclear data or composition by use of a variational formalism. The code is applicable to a wide range of reactor or critical experiment design problems and sensitivity studies.
- 626 ARC-DIF1D** - The ARC 1D-diffusion capability provides complete one-dimensional solutions of the multigroup diffusion equations with edits and a neutron inventory on option.

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- 670 RECAP-12** - RECAP-12 is a Monte Carlo program which estimates neutron capture rates over the energy range important to the fission process, i.e. 10 MeV to 0 eV. The geometry is a three-dimensional general geometry. General geometry is available through the use of a 'doubly repetitive subcell' concept with elliptical surfaces. There is an eigenvalue capability as well as the usual fixed source capability. Smooth and resonance absorption edits are performed in each composition by nuclide, by energy group. The probable errors on each quantity edited are also computed.
- 688 VENTURE** - VENTURE solves the usual neutronics eigenvalue, adjoint, fixed source, and criticality search (direct and indirect) problems, treating up to three geometric dimensions, maps power density and does first-order perturbation analysis at the macroscopic cross section level.
- 713 SYN3D** - SYN3D solves the direct and adjoint, diffusion theory, static eigenvalue equations in two and three dimensions. The geometries available are x-y, r-z, x-y-z and triangular-z.
- 741 TRIDENT** - TRIDENT solves the two-dimensional, multigroup transport equations in rectangular (x-y) and cylindrical (r-z) geometries using a regular triangular mesh. Regular and adjoint, inhomogeneous and homogeneous (k_{eff} and eigenvalue search) problems subject to vacuum, reflective, white, or source boundary conditions are solved. General anisotropic scattering is allowed and anisotropic distributed sources are permitted.

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- 58 SIZZLE** - SIZZLE solves the one-dimensional, multigroup burnup problem in the diffusion theory approximation for fast intermediate reactors. After the initial calculation at $t=0$, average cross sections are computed for further calculations using one to six energy groups. Criticality may be maintained by use of a concentration search. The concentration of the various isotopes is permitted to vary only from region-to-region. Chains included are Th232, U238, and a fission product poison chain.
- 146 NPRFCPP** - Nuclear fuel cycle costs in dollars per year (\$/yr), and in mills per kilowatt-hour (mills/ kwhr) are computed and tabulated for each region of a multiregion reactor core, on the basis of AEC-leased nuclear fuel material and of privately-owned nuclear fuel material. Fuel cycle costs are computed separately for each region or zone, for core designs of any configuration or combination of material depletion or enriched uranium fuel or other special nuclear material. Printed output of the program includes (a) detailed fuel cycle costs for each zone in tabular form, for AEC-leased and privately-owned nuclear fuel material, respectively, (b) a summary tabulation of nuclear fuel costs for all regions of the complete core, including fixed charges on working capital required for core fabrication and for nuclear fuel material, (c) a summary tabulation of certain computed performance and economic data, viz., average residence time, annual fuel throughput, unit electrical energy yield, annual power generation, and core fabrication costs, and (d) a tabulation of all input data for all regions. The printing of data described in (a) and (d) above is optional with program use.
- 179 ISOTOPES** - This program can be used to calculate for any neutron flux the optimum time of irradiation for maximum yield, the specific activity of the product isotope in curies per gram of target material, and the combined specific activity of the target and product isotopes. The product isotope may be produced by any simple reaction such as (n,γ) , (n,p) , $(n,2n)$, etc., or it may be produced by decay of a parent isotope.
- 224 WAMPUM** - This program calculates fuel cycle costs on a detailed basis, using results of nuclear depletion calculations and certain specified economics assumptions. The purpose is to provide a measure of performance for comparing or optimizing fuel cycles and associated reactor core and fuel element characteristics.
- 226 OPUS** - The code generates a flow network equivalent to a gas-cooled nuclear power plant of specified electrical output (in the range of 100 to 1000 MW) according to input data and programmed rules, proceeds to evaluate the plant performance and price of the turbogenerator set (according to General Electric price data), and prints as a result a coded list of all plant components and a detailed performance map.
- 275 PDQ8, PDQ7** - The PDQ series of programs is designed to solve the neutron diffusion-depletion problem in one, two or three dimensions. Very large problems can be accommodated. The three-dimensional spatial calculation may be either explicit or discontinuous trial function synthesis. Up to five lethargy groups are permitted. The fast group treatment may be simplified P(3), and the thermal neutrons may be represented by a single group or a pair of overlapping groups. Adjoint, fixed source, one iteration, additive fixed source, eigenvalue, and boundary value calculations may be performed. The programs utilize the HARMONY system to allow for time-dependent representation of cross section variation and generalized depletion chain solutions. In PDQ8 the depletion is a combination gross block depletion for all nuclides as well as a fine block depletion for a specified subset of the nuclides. The geometries available include rectangular, cylindrical, spherical, hexagonal, and, in PDQ8 only, a very general quadrilateral geometry with diagonal interfaces. All geometries allow variable mesh in all dimensions. Various control searches as well as temperature and xenon feedbacks are provided.
- 301 FREVAP6** - The FREVAP type of code for estimating the release of longer-lived metallic fission products from HTGR fuel elements has been developed to take into account the combined effects of the retention of metallic fission products by fuel particles and the rather strong absorption of these fission products by the graphite of the fuel elements. Release calculations are made on the basis that the loss of fission product nuclides such as strontium, cesium, and barium is determined by their evaporation from the graphite surfaces and their transpiration induced by the flowing helium coolant. The code is

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devised so that changes of fission rate (fuel element power), fuel temperature, and graphite temperature may be incorporated into the calculation. Temperature is quite important in determining release because, in general, both release from fuel particles and loss by evaporation (transpiration) vary exponentially with the reciprocal of the absolute temperature.

- 302 GAFFE** - A zero-dimensional calculation of feed fuel requirements is performed to produce a specified end of cycle multiplication factor for the equilibrium fuel cycle, given feed composition, length of cycle and reactor power. It is alternately possible to compute cycle length or feed enrichment. The code is a survey tool which assumes periodic refueling and permits complete or partial recycling of materials. The segregated fuel concept can be handled within the framework of the calculation.
- 313 CINDER(M0102)** - CINDER is a four-group, one-point depletion and fission product program based on the evaluation of a general analytical solution of nuclides coupled in any linear sequence of radioactive decays and neutron absorptions in a specified neutron flux spectrum. The desired depletion and fission product chains and all physical data are specified by the problem originator. The program computes individual nuclide number densities, activities, nine energy-group disintegration rates, and macroscopic and barns/fission poisons at each time-step as well as selected summaries of these data.
- 318 FEVER7** - FEVER7 performs a multigroup, 1-dimensional depletion calculation which allows fuel in various stages of irradiation to be homogenized into the same region for purposes of the diffusion calculation but follows the depletion of each of the subregions separately. The calculation may be interrupted periodically for refueling one or more regions. Recycling is optional and there is no limit to the number of refuelings which may be performed. A control poison search is available and concentration dependent self-shielding factors may be applied to a number of lumped poisons.
- 322 ISOSEARCH** - The program was developed to calculate the unknown reaction cross section, flux value, or product activity in an isotope-production scheme consisting of two or three nuclides.
- 325 2DB** - 2DB is a flexible, two-dimensional (x-y, r-z, r-theta, hex geometry) diffusion code for use in fast reactor analyses. The code can be used to:
- (a) Compute fuel burnup using a flexible material shuffling scheme.
 - (b) Perform criticality searches on time absorption (alpha), material concentrations, and region dimensions using a regular or adjoint model. Criticality searches can be performed during burnup to compensate for fuel depletion.
 - (c) Compute flux distributions for an arbitrary extraneous source.
- 339 GAUGE** - The two-dimensional few-group neutron diffusion theory equations for a uniform triangular mesh are solved to obtain the multiplication factor and the spatial flux and power distribution of reactors with hexagonal core configuration. Complete reactor life histories with partial refuelling at a number of reload time-points can be calculated. At each discrete time-point a control rod search may be performed to maintain criticality at all times. The depletion scheme of all burnable nuclides is specified by the user at execution time. Three modes of operation are possible - (1) straight burnup calculation, (2) control rod criticality search, allowing the adjustment of a number of control rod banks according to a prescribed rod sequencing scheme, and (3) a series of static calculations with insertion of rods into fixed, prescribed positions.
- 340 POWERCO** - POWERCO calculates the cost of electricity produced by nuclear power stations, assuming all cash expenses such as investment and fuel costs, operating expenses, and taxes are known. The power cost is held constant throughout the project life.
- 354 CINCAS** - CINCAS is a nuclear fuel cycle cost code which may be used for either engineering economy predictions of fuel cycle costs or for accounting forecasting of such costs. Features of CINCAS include -

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- (1) monthly calculation of dollar costs and mass inventory on a batch and case basis for each month of a period which is usually defined as (but not restricted to) beginning with the delivery of fuel to the reactor site and ending with the withdrawal of fuel from the reactor.
- (2) a general formula for the unit price of enriched uranium which allows for variable feed and tails enrichments, costs of feed, chemical conversion, separative work, and losses in conversion and fabrication.

367 ISOGEN - ISOGEN calculates radioisotope generation and decay, using two-group neutron cross sections.

372 RAPFU - RAPFU calculates equilibrium fuel cycle isotopics in fast breeder reactors. The recycled plutonium is permitted to have different isotopic compositions in two different core zones, and several recycle schemes are available as options. Output data includes the initial, average, and discharged fuel isotopic concentrations for each region of the core zones and the blankets, breeding ratio, doubling time, and (optionally) fuel costs calculated using simplified relationships.

418 CHAINS - CHAINS computes the atom density of members of a single radioactive decay chain. The linearity of the Bateman equations allows tracing of interconnecting chains by manually accumulating results from separate calculations of single chains. Re-entrant loops can be treated as extensions of a single chain. Losses from the chain are also tallied.

423 DOS - DOS computes the local neutron flux per reference reactor power level which will produce the measured activity of a dosimeter. Alternatively, if the flux value is supplied, the corresponding dosimeter activity will be calculated.

427 FARED - FARED contains an internal cross section averaging routine which is responsible for preparing broad group cross section sets for various material regions of the reactor. The cross section averaging is performed in program REGA, which computes a B1 flux and current in up to 20 reactor block compositions for use as weighting functions in the cross section collapsing calculation. A homogeneous or heterogeneous resolved and unresolved resonance treatment is provided to compute effective microgroup resonance cross sections for the block mixture or up to 2 cell types per block. Real and adjoint flux distributions are calculated for one-dimensional slab, cylindrical, or spherical geometries. The real fluxes are normalized to yield desired total reactor power. Criticality searches may be performed on the reactor dimension, transverse buckling or zone compositions. Enrichment searches may be performed to yield desired ratios of maximum (or average) power densities in several zones. Zonewise depletion is calculated either for a given time period or until specified criticality, burnup or nuclide concentrations are satisfied. Flexible fuel management is available permitting specified material units to be moved into, out of or shuffled within the reactor. A wide variety of edits may be performed, including perturbation and kinetic parameters calculations.

438 BUG2 - The two-dimensional, multigroup, neutron diffusion equations for x-y or r-z geometry are solved to obtain the multiplication factor and the spatial flux and power distributions. Complete reactor life histories with partial refueling at a number of reload points can be calculated. The depletion scheme of all burnable nuclides is specified by the user at execution time. A regionwise depletion scheme is used. Concentration dependent self-shielding factors may be applied to any nuclide.

439 BUGTRI - The 2-dimensional multigroup, neutron diffusion theory equations for triangular geometry are solved to obtain the multiplication factor and the spatial flux and power distributions. Complete reactor life histories with partial refueling at a number of reload time-points can be calculated. The depletion scheme of all burnable nuclides is specified by the user at execution time. A regionwise depletion scheme is used. Concentration dependent self-shielding factors may be applied to any nuclide.

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- 441 PWCOST** - PWCOST is used to calculate nuclear reactor fuel cycle costs. Input for all components of the fuel cycle are time-dependent. Working capital charge rates may be specified separately for in-core and out-of-core time periods.
- 454 PHENIX** - PHENIX is a two-dimensional, multigroup, diffusion-burnup-refueling code for use with fast reactors. The code is designed primarily for fuel-cycle analysis of fast reactors and can be used to calculate the detailed burnup and refueling history of fast breeder reactor concepts having any generalized fractional batch reloading scheme. Either ordinary keff calculations or searches on material concentration or region dimensions can be performed at any time during the burnup history. The complete fuel cycle history can be calculated in one run, or the individual burnup intervals can be treated separately. The refueling option of the code accounts for the spatial flux shifts over the reactor lifetime in the calculation of fuel discharge.
- 456 DBUFIT1** - DBUFIT1 is designed to extract integral cross section information from isotopic burnup data. This information is obtained by fitting burnup equations to the isotopic data using least-squares fitting techniques. Burnup equations for the following transmutation chains have been programmed - Pu239 to Pu242, U238 to Pu242, Pu242 to Cm244 and U235 to Pu238.
- 463 3DDT** - 3DDT is a three-dimensional (x-y-z or r-theta-z) multigroup, diffusion theory code for use in fast-reactor analysis. The code can be used to compute keff or to perform criticality searches on reactor composition, time absorption, and reactor dimensions by either the regular or the adjoint flux equations. Material burnup and fission-product buildup can be computed for specified time intervals, and criticality searches can be performed during burnup to compensate for fuel depletion and fission product growth.
- 477 3DXT/DEP3** - These two codes were developed for use with detailed reactor physics calculations to obtain 3-dimensional xenon transient (3DXT) and depletion (DEP3) calculations. They are well-suited for survey studies and because they incorporate three-dimensional effects with thermal feedback and rod search capabilities, are useful for assessing situations such as rod misalignments or fuel-loading and coolant-flow asymmetries which are time-consuming and often impossible to detect with detailed 1- or 2-dimensional codes.
- 480 FUMBLE** - FUMBLE computes the fuel burnup in reactor operations. This includes the evaluation of reactivity effects, breeding (or depletion) and inventories of fuel, and fuel costs for changing economic conditions and supplied fuel compositions throughout the reactor lifetime (or for as many refueling operating intervals as desired). Considerable flexibility is allowed in the specifications of reactor refueling, including fuel compositions for the startup reactor, recycle schemes and fissile makeup compositions for subsequent core loadings, amounts of fuel to be replaced in different positions of the reactor at any refueling, and shuffling of fuel from one part of the reactor to another or temporarily storing fuel discharged from the reactor for later additional burnup. The refueling specifications may be changed from one refueling operating interval to another, as well as operating interval time, power rating, and load factor. Fuel costs may be evaluated for several different sets of cost input data (different economic assumptions) and may be based on net costs accrued and energy produced by spent fuel batches and/or on net costs incurred for all fuel held and energy produced by the entire reactor for each operating interval.
- 495 SYN** - SYN contains two major segments, BISYN and BICYCL. The BISYN segment solves the two-dimensional multigroup neutron diffusion theory equations in r,z or x,y geometry using a noniterative synthesis method. This approach is designed to greatly reduce the computer cost of running two-dimensional multigroup problems at the risk of some loss in accuracy of the detailed flux distribution. This segment also contains a perturbation and effective delayed neutron fraction calculation.
- The BICYCL segment uses output from BISYN to solve the one-group neutron depletion equations. BICYCL allows the user to search on makeup or recycle isotopic compositions for a first cycle of a first core or for equilibrium concentrations. It also has provisions for fuel shuffling and the option to cycle back to BISYN in order to update the fluxes, one-group cross sections, etc.

D. DEPLETION, FUEL MANAGEMENT, COST ANALYSIS, AND POWER PLANT ECONOMICS 5/79

- 498 CONCEPT5/CONCEPT3** - The CONCEPT computer code system was developed to provide conceptual capital cost estimates for nuclear-fueled and fossil-fired power plants. Cost estimates can be made as a function of plant type, size, location, and date of initial operation. The output includes a detailed breakdown of the estimate into direct and indirect costs similar to the accounting system described in document NUS-531. Cost models are provided in CONCEPT5, the fifth generation in the development of the CONCEPT package, for single- and multi-unit pressurized water reactors, boiling water reactors, and coal-fired plants with and without flue gas desulfurization equipment. The CONCEPT5 models are updated models of those available in CONCEPT3 and, in addition, this edition contains historical factory equipment cost data for the generation of cost indices and escalation rates; indirect costs are calculated as a function of unit size rather than a function of direct costs; and an indirect cost account for owner's costs and an improved time-dependent escalation feature are included.
- 540 PACTOLUS/CLOTHO** - PACTOLUS is a code for computing nuclear power costs using the discounted cash flow method. The cash flows are generated from input unit costs, time schedules and burnup data. CLOTHO calculates and communicates to PACTOLUS mass flow data to match a specified load factor history.
- 567 3DB** - 3DB is a three-dimensional (x-y-z, r-theta-z, triangular-z) multigroup diffusion code for use in detailed fast-reactor criticality and burnup analysis. The code can be used to -
- (a) compute k_{eff} and perform criticality searches on time absorption, reactor composition, and reactor dimensions by means of either a flux or an adjoint model,
 - (b) compute material burnup using a flexible material shuffling scheme, and
 - (c) compute flux distributions for an arbitrary extraneous source.
- 576 GEM** - GEM is used to predict fuel cycle costs for any type nuclear system (i.e., BWR, HTGR, PWR, LMFBR, GCFR, . . .). The current version is limited to thermal reactors. GEM is designed for production use by large utilities which have several reactor types on their system. GEM has been written so as to accommodate all major fuel management activities undertaken by a utility -
- (1) fuel bid analysis,
 - (2) evaluation of actual day to day operation, and
 - (3) system simulation and optimization studies.
- 579 DWARF** - DWARF allows one-dimensional simulation of reactor burnup and xenon oscillation problems in slab, cylindrical, or spherical geometry using a few-group diffusion theory model.
- 588 ORCOST2** - ORCOST2 estimates the cost of electrical energy production from single-unit steam-electric power plants. Capital costs and operating and maintenance costs are calculated using base cost models which are included in the program for each of the following types of plants: PWR, BWR, HTGR, coal, oil, and gas. The user may select one of seven input/output options for calculation of capital cost, operating and maintenance cost, levelized energy costs, fixed charge rate, annual cash flows, cumulative cash flows, and cumulative discounted cash flows. Options include the input of capital cost and/or fixed charge rate to override the normal calculations. Transmission and distribution costs are not included. Fuel costs must be input by the user.
- 634 REBUS2** - Using one or more specified external fuel supplies to load the reactor and a fixed fuel management scheme, REBUS2 computes the equilibrium (i.e. infinite-time) operating conditions of a fast reactor. Optionally, reprocessing plants may be included in the specification of the external fuel cycle and discharged fuel may be recycled back into the reactor. The code will optimize, at user option -
- (a) the burn cycle time in order to achieve a specified discharge fuel burnup,
 - (b) the fresh fuel enrichment in order to achieve a specified effective reproduction constant at a specified time during

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the burn cycle, and

(c) the poison control to achieve a specified value of k_{eff} . Non-equilibrium problems consisting of an explicit sequence of burn/shutdown/refuel cycles may also be handled although fuel recycle is not allowed.

- 669 TPT01** - TPT01 solves the few-group neutron transport equation with P1 scattering in two dimensions using the discrete ordinate method. The geometries available are rectangular and cylindrical. The problem allows arbitrary up- and down-scattering between groups. Explicit solutions are available for both fixed-source and eigenvalue problems. The program performs gross block depletion for all isotopes in all depletable regions and also performs fine block depletion for any subset of the isotopes in selected regions.
- 683 NUFUEL** - Given a forecast of nuclear electric generating capacity, it is important to know the consequent time-related materials and services required to support it. These requirements depend on a number of parameters such as reactor types, plant operating capacity factor, expected availability of spent fuel reprocessing, policies concerning plutonium utilization (as breeder fuel and LWR recycle). These and other conditions are simulated by NUFUEL which calculates and prints annual requirements for separative work and uranium related to a schedule of nuclear plant additions. Related fuel cycle quantities such as plutonium production and requirements, requirements for conversion to UF(6), for fuel fabrication, and for spent fuel reprocessing are also calculated and reported on a real-time basis.
- 684 GEOCOST** - GEOCOST calculates the cost of generating electricity from geothermal energy. The version of GEOCOST in this release simulates the production of electricity using a steam power conversion cycle based upon either a dry steam or hydrothermal resource. Future extensions to the model will simulate the production of electricity using other power conversion technologies, particularly the binary fluid cycle.
- 688 OMCST** - OMCST estimates annual operating and maintenance expenses of steam-electric power plants exclusive of fuel. Base load nuclear and fossil-fueled plant types are included. Costs are adjusted for various waste heat rejection methods. Plants containing one through four units with unit net electrical output from 400 through 2000 MW(e) may be evaluated. OMCST includes the option of a limestone wet scrubbing system for flue gas desulfurization for coal- and oil-fired plants.
- 699 ORSIM** - ORSIM is an electric power generating system integration model which simulates the multi-year operation of a mixed power system consisting of fossil, nuclear, hydro, and pumped-storage units. For any specified refueling schedule for nuclear units and forecast of future load, the model determines a plan of operation for the system which attempts to minimize the total discounted operating cost over a specified study period.
The analysis considers the effects of forced outages, spinning reserve operating constraints, and scheduled introduction and retirement of generating stations. The model determines a maintenance schedule for the non-nuclear stations (nuclear stations are maintained during refueling outages) and the optimum allocation of energy-fixed nuclear and hydro resources. It calculates the expected energy generated by each station in the system, period by period over the planning horizon, based on input or calculated incremental operating cost. It also calculates the expected loss-of-load probability and unserved energy demand for each period in the planning horizon. An optimum operating plan, designed to minimize the discounted total production cost, is then calculated, as are the costs of operating each station in the system and the discounted total production cost for the derived plan of operation.
- 711 GEOCOST-BC** - GEOCOST calculates the cost of generating electricity from geothermal energy. The version of GEOCOST in this release, GEOCOST-BC, simulates the production of electricity using a binary fluid cycle based upon a hydrothermal resource.
- 739 PRP** - PRP calculates the production cost (product price) when the investments, operating costs, interest rate on debt, rate of return on equity, tax rates, by-product values, and similar related information are supplied. The program can also be used to calculate the rate of return on equity when the selling price of the product is supplied.

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744 SAGE-WASP - SAGE-WASP is designed to find the optimal generation expansion policy for an electrical utility system. New units can be automatically selected from a user-supplied list of expansion candidates which can include hydroelectric and pumped-storage projects. The existing system is modeled. The calculational procedure takes into account user restrictions to limit generation configurations to an area of economic interest. The optimization program reports whether the restrictions acted as a constraint on the solution. All expansion configurations considered are required to pass a user-supplied reliability criterion. The discount rate and escalation rate are treated separately for each expansion candidate and for each fuel type. All expenditures are separated into local and foreign accounts, and a weighting factor can be applied to foreign expenditures.

752 COROPT - COROPT was designed as a flexible system design tool. It is intended to address the question, "How should a core be designed to yield optimum performance given certain design constraints and limits." Simple models are used to describe the reactor nuclear, thermal-hydraulic, and mechanical performance as functions of independent design variables and operating conditions. The user specifies design constraints on the fuel, blanket, or control subassemblies which must be satisfied. An optimization algorithm is used to determine the set of independent core design and operating condition variables that yield the optimum user-specified performance index which can be cost, doubling time, or other parameters. The reactor core can be described by a set of mass, momentum, and energy conservation equations which determine the relation between independent core design variables and dependent operating and performance parameters.

798 MSF21,VTE21 - MSF21 and VTE21 perform design and costing calculations for multistage flash evaporator (MSF) and multieffect vertical tube evaporator (VTE) desalination plants. An optimization capability is available, if desired.

The MSF plant consists of a recovery section, reject section, brine heater, and associated buildings and equipment. Operating costs and direct and indirect capital costs for plant, buildings, site, and intakes are calculated. Computations are based on the first and last stages of each section and a typical middle recovery stage. As a result, the program runs rapidly but does not give stage by stage parameters.

The VTE plant consists of vertical tube effects, multistage flash preheater, condenser, and brine heater and associated buildings and equipment. Design computations are done for each vertical tube effect, but preheater computations are based on the first and last stages and a typical middle stage.

- 121 **AIREK3** - AIREK3 finds the numerical solution to the space-independent reactor kinetics equations based on the method developed by E. R. Cohen. Input and output are simplified and the power, inverse period, feedbacks, and precursors are displayed graphically.
- 168 **INVERSE KINETICS(R102)** - Given the space-independent, one energy group reactor kinetics equations and the initial conditions, this program determines the time variation of reactivity required to produce the given input of flux-time data.
- 255 **R101** - R101 solves the space-independent, one-energy group reactor kinetics equations to determine the time variation of neutron density given specified initial conditions. Any of four programmed representations of excess reactivity can be selected.
- 290 **GASA (GA Stability Analysis)** - GASA determines the stability of any physical system whose motion is describable by a set of first-order linear differential equations. In particular GASA evaluates the stability of a reactor described by the linear reactor kinetics equations with temperature feedback, against perturbations about any operating power level. The program will also calculate and plot the transfer function between any state variable of the system and a given external forcing function (such as an external reactivity perturbation) or another state variable of the system.
- 303 **BLOOST6** - BLOOST6 combines a reactor space-independent kinetics code with a two-dimensional heat transfer code, and a time-dependent spherical geometry heat transfer routine for fuel particles. The code is applicable to problems for which the space-independent form of the reactor kinetics equation is applicable.
- 317 **GAPOTKIN** - GAPOTKIN is a point-kinetics code that solves the space-independent kinetics equations for a very general form of the reactivity function.
- 326 **AIROS2A** - AIROS2A solves the space-independent reactor kinetics equations and provides for the determination of reactivity by solving in addition the discretized equations that represent the spatial heat and mass transfer model for several fuel channels. In addition, variation of the film coefficient with flow is accounted for along with the provision for flow decay and afterglow heating. Scrams can be initiated by delayed signals from instruments that sense any quantity calculated, e.g., power, inverse period or temperature. Generalized feedback equations are used to provide flexibility in the models that represent multichannel heat transfer including conduction and convection, energy, pressure and other phenomenon such as fuel melting, coolant boiling and voiding burn-out. The reactivity equation is also generalized. The reactivity feedback coefficients can be constant or vary as the square root or reciprocal of temperature. Furthermore, any feedback variable can be used to initiate a reactivity scram, each with a unique delay time. An input generator computes the conduction and convection coefficients for an $n \times m$ nodal, multichannel system using built-in tables of specific heat, density, conductivity and viscosity for the common fuel, structure and coolant materials, and performs an initial temperature calculation. The film coefficients may be specified or calculated using Lyon's equation or the Dittus-Boelter equation.
- 363 **BLAST** - BLAST has been developed to study accident conditions in critical and subcritical thermal multiplying systems. The program computes the time behavior of the thermal neutron density and the system temperature following a step-change in reactivity. The integrated thermal neutron density is also computed, from which the total number of fissions during an excursion may be obtained.
- 486 **ANCON** - ANCON solves the point-reactor kinetic equations including thermal feedback. Lump-type heat balance equations are used to represent the thermodynamics, and the heat capacity of each lump can vary with temperature. Thermal feedback can be either a linear or a non-linear function of lump temperature, and the impressed reactivity can be either a polynomial or sinusoidal function.
- 489 **TRIFIDO** - The code calculates the decay constant and the population of the fundamental prompt neutron mode extrapolated to initial time, using pulsed neutron experimental data. These data are the resulting time profile of the neutron density of a subcritical

multiplicative assembly which is repetitively pulsed with short bursts of neutrons. The time profile is measured with an appropriate detector and recorded with a time analyser. With the calculated parameters the code determines the values of $(k\text{-}\beta)/L$ and reactivity by means of the Garelis-Russell method, and reactivities using the Gozani and Sjostrand methods.

491 MOD5 - MOD5 calculates the time- and energy-dependent evolution of the neutron density in homogeneous media following initiation of a) a monoenergetic source distributed over a finite time interval, or b) a source of arbitrary spectrum with a delta-function distribution in time. Effectively the code produces Green's function solutions to the slowing-down equation in discrete numerical form. Leakage is treated in the diffusion approximation. The program a) calculates spectra and energy moments at selected times following the burst of source neutrons, b) evaluates the time-dependent neutron density and slowing-down density at selected energies and computes moments of these densities, c) calculates time-dependent distributions of capture, leakage and first fission, and moments of these distributions, d) calculates steady-state central core neutron flux and leakage flux in detail and in group-averaged form, and e) calculates parameters such as k_{eff} .

558 TASK - TASK solves the one-dimensional multigroup form of the reactor kinetics equations, using either transport or diffusion theory and allowing an arbitrary number of delayed neutron groups. The program can also be used to solve standard static problems efficiently such as eigenvalue problems, distributed source problems, and boundary source problems. Convergence problems associated with sources in highly multiplicative media are circumvented, and such problems are readily calculable.

**F. SPACE-TIME KINETICS, COUPLED NEUTRONICS-HYDRODYNAMICS-THERMODYNAMICS 5/79
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- 174 FORE2** - FORE2 is a coupled thermal hydraulics-point kinetics digital computer code designed to calculate significant reactor parameters under steady-state conditions, or as functions of time during transients. The transients may result from a programmed reactivity insertion or a power change. Variable inlet coolant flow rate and temperature are considered. The code calculates the reactor power, the individual reactivity feedbacks, and the temperature of coolant, cladding, fuel, structure, and additional material for up to seven axial positions in three channel types which represent radial zones of the reactor. The heat of fusion, accompanying fuel melting, the liquid metal voiding reactivity, and the spatial and the time variation of the fuel cladding gap coefficient due to changes in gap size are considered.
- 274 WIGL2** - WIGL2 is a one-dimensional two-group space-time diffusion theory program with zero, one, or six delayed neutron groups. The program will treat slab, cylindrical, and spherical geometries and includes non-boiling heat transfer. It accounts for xenon feedback and feedback effects due to fuel and coolant temperature. Control rod motion and control system feedback based on total core power or outlet coolant temperature can be simulated. Transients may be excited by prescribed changes in inlet coolant temperature, coolant flow rate, or rod position.
- 309 TSN** - The time-dependent neutron transport equation is solved. Energy deposition is allowed to cause variation in the neutron cross sections for the core region, in the core density, and in core height. The result is a kinetics calculation including spatial dependence both in feedback effects and in neutron density. The results are summarized in a manner similar to point-kinetics codes, and spatial distributions are also given. Graphical summaries of the significant variables and spatial distributions are given. In the IBM36C version, either the neutron yield from fission or the thickness of a specified zone can be changed as an independent function of time as specified by the user. This provides two ways of allowing explicit reactivity variation with time.
- 310 GAKIN2** - GAKIN2 solves the time-dependent multigroup neutron diffusion equations in one space dimension.
- 338 TWIGL/TWIGGLE** - TWIGL solves the two-dimensional, two-group, space-time neutron diffusion equations in rectangular or cylindrical geometry in the presence of temperature feedback. The neutron diffusion and delayed precursor equations are differenced in both space and time. The thermal-hydraulic description is based on a no-boiling, one-pass model formulated in terms of regionwise-averaged coolant and fuel metal temperatures.
- 352 RAUMZEIT** - RAUMZEIT solves systems of one-dimensional, time-dependent, multigroup diffusion-type equations using either of two treatments of the time dependence, finite differencing or the time-integrated approach (see reference 2).
- 370 GAKIT** - GAKIT solves the multigroup, one-dimensional, time-dependent diffusion theory kinetics equations including delayed neutron effects and temperature feedback based on two-dimensional heat transfer calculations. For the one-dimensional multigroup kinetics equations an arbitrary scattering matrix and arbitrary fission transfer are allowed, and plane, cylindrical, or spherical geometry can be used. A piecewise linear time-dependent inhomogeneous source can be specified. Feedback is available from xenon buildup and temperature dependence of cross sections. The heat transfer calculation is performed for two-dimensional r-z fuel element models assuming predetermined axial power shape functions and time-dependent power amplitudes obtained from the one-dimensional kinetics calculations. For the fuel elements average fuel and moderator temperatures are calculated which determine, based on tables, the temperature-dependent cross sections. Transients may be introduced by step changes of cross sections, by piecewise linear time-dependent cross sections (rod withdrawal accidents), by step changes of the flow rates or by step changes of the coolant inlet temperatures.
- 371 NOWIG** - NOWIG is used to solve the one-dimensional two-group neutron diffusion and delayed precursor equations using a shape-specified point-kinetics approximation. Feedback due to changes in the fuel metal temperature and coolant density is accounted for by using a model which is identical with that used in the WIGL2 (NESC Abstract 274) program.

**F. SPACE-TIME KINETICS, COUPLED NEUTRONICS-HYDRODYNAMICS-THERMODYNAMICS 5/79
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- 389 STINT3** - STINT3 solves static (eigenvalue) and time-dependent systems of coupled, one-dimensional, diffusion-type equations in slab geometry and is primarily intended for solving single-channel, flux-synthesis equations. The code provides for control rod motion and temperature feedback.
- 400 SAS1A** - SAS1A is used for the analysis of fast reactor power and flow transients. The program consists of four driver programs each called by the main program. These drivers handle the areas of (1) input/output, with diagnostics, (2) steady-state initialization, to define the core operating conditions before the initiation of the transient, (3) the transient portion, and (4) the disassembly (weak explosion) analysis.
- 405 NOAH** - NOAH solves the one-dimensional, one-group space-time diffusion equation accounting for the effects of fuel, clad, and coolant temperatures (or by changing subroutines fuel, coolant, and solid moderator temperatures) on fission and absorption cross sections, and on the diffusion coefficient and the transverse buckling. It can account for the effects of xenon-iodine feedback. If desired, it will determine long-time xenon-flux behavior assuming the temperatures to be in quasi-static equilibrium. Numerous methods of perturbation are allowed and control of the transient is also provided.
- 415 CEXE/INCEXE** - CEXE solves the three-dimensional xyz time-dependent xenon spatial oscillation problem using a modified one energy group theory and a nodal representation.
- 474 QX1** - QX1 solves the multigroup, one-dimensional, time-dependent diffusion equations. Problem geometry may be plane, cylindrical, or spherical. Steady-state initial conditions may be established either for a source-free system or for a system with an external neutron source. The reactor may be perturbed by changing material volume fractions and/or temperatures or by changing the neutron source level. A first-collision pulsed source distribution may be specified. Resonance absorption feedback is calculated by groupwise interpolation in a cross-section versus temperature table. A highly simplified fuel temperature model is included.
- 488 NOISY1** - Auto- and cross-spectral density functions are calculated for neutron fluctuations in nuclear reactors. The calculations are point-wise, space-dependent in cubical reactors which are homogeneous and bare. Either neutron fluctuations or the fluctuations seen by a neutron detector can be specified. Fluctuations between either two points or between two finite regions can be considered. The finite regions or simulated detectors must either fully overlap or not overlap and are restricted in shape to rectangular parallelepipeds.
- 494 ADEP** - The time-dependent few-group neutron diffusion equations are solved in one or two dimensions. Lumped parameter thermal-hydraulic equations are used to calculate feedback.
- 511 VENUS** - VENUS computes the power, energy release and space-time (r-z geometry) history of the temperature, pressure, density and material motion of an LMFBR during a disassembly excursion. Reactivity feedback due to Doppler broadening and motion of the reactor material is taken into account.
- 550 REXCO-H (Release 1)** - REXCO-H calculates the two-dimensional hydrodynamic response of primary reactor containment to a high-energy excursion.
- 615 REXCO-H (Release 2)** - REXCO-H calculates the two-dimensional hydrodynamic response of primary reactor containment to a high-energy excursion.
- 700 MELT3** - MELT3 is a multichannel, neutronics, thermal-hydraulics digital computer program developed to investigate the transient behavior of a fast reactor during postulated transient overpower conditions. Reactivity feedback resulting from Doppler broadening, coolant density change and expulsion, bulk core expansion, and fuel movement are explicitly taken into account. The bulk of the modeling detail has been addressed to the in-vessel portion of the reactor plant, although the friction and inertial aspects of up to three separate closed primary loops can be simulated. A wide variety of accident conditions may be investigated. Particular modeling emphasis has, however, been placed on the simulation capabilities required for an unprotected transient overpower accident sequence.

**F. SPACE-TIME KINETICS, COUPLED NEUTRONICS-HYDRODYNAMICS-THERMODYNAMICS 5/79
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- 708 WIGL3** - WIGL3 is a program for the steady-state and transient solution of the one-dimensional, two-group, space-time diffusion equations. The program will treat slab, cylindrical, and spherical geometries and includes nonboiling heat transfer. Control rod motion and control system feedback based on total core power or outlet coolant temperature can be simulated. Transients may be excited by prescribed changes in inlet coolant temperature, coolant flow rate, or rod position. For the steady-state option, criticality may be achieved by adjusting control rod position, reference coolant density, or reference fuel temperature.
- 756 TIMEX** - TIMEX solves the time-dependent, one-dimensional multigroup transport equation with delayed neutrons in plane, cylindrical, spherical, and two-angle plane geometries. Both regular and adjoint, inhomogeneous and homogeneous problems subject to vacuum, reflective, periodic, white, albedo or inhomogeneous boundary flux conditions are solved. General anisotropic scattering is allowed and anisotropic inhomogeneous sources are permitted.
- 775 HEMP** - The HEMP code solves the conservation equations of two-dimensional elastic-plastic flow, in plane x-y coordinates or in cylindrical symmetry around the x-axis. Provisions for calculation of fixed boundaries, free surfaces, pistons, and boundary slide planes have been included, along with other special conditions.

G. RADIOLOGICAL SAFETY, HAZARD AND ACCIDENT ANALYSIS

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- 47 **CLOUD** - The CLOUD program calculates the external gamma-ray dose rate and total integrated dose resulting from the continuous release of radioactive materials to the atmosphere.
- 172 **AISITE2/R153** - AISITE2 is largely based on methods proposed by the AEC in TID-14844 but differs in certain of the assumptions and models. The code automatically varies any one of 46 parameters such as reactor power, building leak rate, iodine clean-up rate, and halogen filter efficiency, computing the exclusion area, and low population boundary zones as functions of that parameter. The edit includes dose vs. distance data, fractional contribution by isotope group to the inhalation dose, and critical distances providing both printed and graphical data. Three models are available for fission product release with up to four levels of containment.
- 196 **CURIE** - CURIE calculates the fission product inventory decay history for fuel that has been in operation for a specified duration. The inventory decay history is provided for specified nuclides and elements, as well as the total fission products.
- 261 **GADOSE/DOSET** - The GADOSE program calculates radioactivity and doses resulting from instantaneous accidental release of activity while the companion program DOSET includes the effects of a time-dependent accidental fission product release for the HTGR type of plant. Given an initial fission product inventory released into a reactor vessel or containment volume, the quantity of each isotope is calculated at a number of times at a number of locations (in the containment, containment recirculating cleanup filters, leak collector, plant exhaust filters and in the atmosphere at a number of distances from the plant). Each decay chain is calculated separately considering buildup and decay of each isotope. Radiological doses are calculated for any three body organs and the whole body based on meteorological and physiological input parameters. Fallout and rainout are included.
- 265 **RSAC** - RSAC generates a fission product inventory from a given set of reactor operating conditions and then computes the external gamma dose, the deposition gamma dose, and the inhalation-ingestion dose to critical body organs as a result of exposure to these fission products. Program output includes reactor operating history, fission product inventory, dosages, and ingestion parameters.
- 278 **WHAM6** - WHAM6 is used to calculate pressure and velocity transients in liquid-filled piping networks. It can be applied to multiloop complex piping networks consisting of dead ends, elbows, orifices, multiple-branch tees, changes of flow passage cross section, check valves, pumps, pressurizers or tanks, and exit valves or breaks. Hydraulic losses are considered. Transients can be initiated either by closure or opening of one or more exit valves (equivalent to system ruptures) or by a prescribed gas pressure history in a pressurizer tank.
- 284 **M0555(ACT1)** - This program will predict the pressure transient in the containment vessel as a function of time as a result of a major rupture in the primary system of a pressurized water reactor. Means are available for introducing water and heat into the containment vessel. There are also provisions for specifying various types of heat sinks for energy absorption. The temperature distribution in these heat sinks is calculated as a function of time. Discharge rates of the containment may also be determined as a function of both time and the internal pressure.
- 295 **FLASH3** - FLASH3 determines the transient response of a water-cooled reactor to a loss-of-coolant accident or severe variable pressure operation.
- 328 **NURLOC-1.0** - NURLOC-1.0 performs core/ pressure vessel thermal analysis for a nuclear reactor loss-of-coolant accident.
- 330 **ECCSA4** - ECCSA4 predicts the thermal and hydraulic behavior of a single fuel rod and its associated core flow channel during a loss-of-coolant accident and subsequent emergency core cooling injection.
- 369 **RELAP4/MOD6** - RELAP4 has been developed to describe the behavior of water-cooled nuclear reactors subjected to postulated transients, such as those resulting from loss-of-coolant,

pump failure, or power excursions. The program calculates fluid conditions such as flow, pressure, mass inventory, and quality; thermal conditions such as surface temperatures, temperature profiles, and energy distributions; and heat fluxes in power generating and dissipating elements. The program also calculates reactor power, decay heat, and reactivity. In addition to describing transients in boiling-water and pressurized-water reactors, the program is sufficiently versatile to describe transients in experimental thermal-hydraulic systems. RELAP4/MOD6 was developed specifically to add a capability to the earlier RELAP codes for calculating PWR reflood phenomena.

- 433 CONTEMPT-LT/026** - CONTEMPT-LT was developed to predict the long-term behavior of water-cooled nuclear reactor containment systems subjected to postulated loss-of-coolant accident (LOCA) conditions. CONTEMPT-LT calculates the time variation of compartment pressures, temperatures, mass and energy inventories, heat structure temperature distributions, and energy exchange with adjacent compartments. The program is capable of describing the effects of penetration and small crack leakage on containment response. Models are provided for fan cooler and cooling spray engineered safety systems. One to four compartments can be modeled, and any compartment except the reactor system may have both a liquid pool region and a vapor atmosphere region above the pool. Each region is assumed to have a uniform temperature, but the two regions may be different. The user determines the compartments to be used, specifies input mass and energy additions, defines heat structure and leakage systems, and prescribes the time advancement and output options.
- 435 BURST1** - BURST1 provides for the study of pressurized liquid in a cylindrical system immediately after a rupture occurs at one or both ends of the system. Pressure, mass velocity, and enthalpy are calculated at equally-spaced mesh points along the length of the system. This is a one-dimensional representation, assuming uniform conditions throughout any given cross-sectional area. Forces on designated sections of the system can also be computed, with provision for directional changes.
- 443 HAA3B** - HAA3B was written to provide an engineering method for calculating heterogeneous aerosol behavior and transport following various hypothetical LMFBR accidents. HAA3B evaluates an approximation to the general integro-differential equation which describes aerosol behavior. The physical model includes particle generation, Brownian and gravitational agglomeration, settling, plating, and leakage for spherical particles. The approximation is the requirement that the size distribution function be lognormal.
- 448 FLASH6/FLASH4** - FLASH6 and earlier FLASH programs are used to determine the transient response of a water-cooled reactor or hydraulic system to severe variable pressure operation. As with previous editions, FLASH6 permits the user to model the reactor plant using a flexible combination of control volumes (nodes), connecting flow paths, pumps, and steam generators. A detailed representation of the core region may be obtained by using up to 80 pressure-determining nodes within the core. The core nodes are connected in one-dimensional chains to represent up to 20 core flow paths. A one-dimensional heat conduction model with up to five radial nodes is used to represent the flow of heat from the fuel element to each core fluid node. Thermal resistance of the fuel-clad gap is continuously calculated during the transient as a function of varying gap dimension, temperature, and pressure. Thirty nodes and 60 flow paths are available to model the non-core regions of the plant.
- 479 FREADM1** - FREADM1 is a fast reactor, multichannel, accident analysis program designed to efficiently simulate a reactor transient from initiation to the point of core disassembly. Models are included for nuclear kinetics (point model), core thermo-hydraulics, voiding, fuel redistribution, failure propagation, programmed reactivity insertion, and the dynamics of primary-system coolant flow. A broad range of assumed accident initiating and propagating activities may be simulated using triggering logic included in the code.
- 499 MIRAB/MIRAP** - The code MIRAB is used for BWR reactors and MIRAP is for PWR reactors. The codes calculate the removal of fission product iodine from a dry-type BWR/PWR containment system atmosphere under reactor accident conditions. The method considers the simultaneous removal by natural deposition on surfaces or absorption in water, by engineered spray system operation, by adsorption on filters, and by leakage from the containment. In

addition, the simultaneous behavior of three iodine forms is modeled - specifically elemental iodine, methyl iodine, and particulate iodine. The programs generate iodine concentrations and accumulations throughout the containment system as a function of time after start of the accident.

- 500 FRCL2** - The code calculates the cumulative fractional release of fission products from nuclear reactor fuel under postulated loss-of-coolant accident conditions. The mathematical model for release is based on simple volume diffusion theory and the equivalent-sphere approximation of fuel porosity. Both the operational preaccident release component and the accident core thermal transient-induced release component are calculated. Detailed core temperature data are needed to make the latter set of computations. In addition, specific core power distribution factors and fission product diffusion parameters must be supplied.
- 508 MUCHA1/MUCHA2** - MUCHA1 predicts the thermal and hydraulic behavior of any two reactor fuel rods and their associated parallel flow channels during a loss-of-coolant accident using as boundary conditions plenum fluid conditions determined by MUCHA2 or a system-oriented code. MUCHA2 predicts the thermal and hydraulic behavior of the primary coolant within the reactor pressure vessel during a loss-of-coolant accident. The heated core is represented by two equivalent fuel rods and their associated parallel flow channels. A plenum model has been developed to predict the upper and lower plenum fluid conditions throughout the accident sequence for use as boundary conditions for the parallel core channels.
- 512 THETA1B** - THETA1B computes the thermal response characteristics of a nuclear fuel rod subjected to a loss-of-coolant accident environment.
- 521 SOCOOL2** - SOCOOL2 calculates the transient temperatures, pressures, and mechanical work energy when a molten material is instantaneously and uniformly dispersed in liquid sodium which is initially under acoustic constraint.
- 528 PREP/KITT** - The PREP/KITT computer program package obtains system reliability information from a system fault tree. The PREP program finds the minimal cut sets and/or the minimal path sets of the system fault tree. (A minimal cut set is a smallest set of components such that if all the components are simultaneously failed the system is failed. A minimal path set is a smallest set of components such that if all of the components are simultaneously functioning the system is functioning.) The KITT programs determine reliability information for the components of each minimal cut or path set, for each minimal cut or path set, and for the system. Exact, time-dependent reliability information is determined for each component and for each minimal cut set or path set. For the system, reliability results are obtained by upper bound approximations or by a bracketing procedure in which various upper and lower bounds may be obtained as close to one another as desired. The KITT programs can handle independent components which are nonrepairable or which have a constant repair time. Any assortment of nonrepairable components and components having constant repair times can be considered. Any inhibit conditions having constant probabilities of occurrence can be handled. The failure intensity of each component is assumed to be constant with respect to time. The KITT2 program can also handle components which during different time intervals, called phases, may have different reliability properties.
- 529 ANVENT** - The ANVENT program was developed to analyze thermal effects of a loss-of-coolant accident (LOCA) in a Westinghouse ice condenser nuclear unit, similar to the Duke Power Company's McGuire units. The program is capable of evaluating (1) steady-state radial temperature distributions corresponding to fixed inside and outside temperatures, (2) radial temperature distributions in the steel containment shell and the concrete reactor (shield) building during the post-LOCA transient, (3) temperature and pressure in the annulus between the containment shell and reactor building during the post-LOCA transient, and (4) capability of the annulus ventilation fan to quickly attain and maintain a vacuum in the annulus after a LOCA occurs.
- 546 EMERALD REVISION 1** - The EMERALD program is designed for the calculation of radiation releases and exposures resulting from abnormal operation of a large pressurized water

reactor (PWR). The approach used in EMERALD is similar to an analog simulation of a real system. Each component or volume in the plant which contains a radioactive material is represented by a subroutine which keeps track of the production, transfer, decay and absorption of radioactivity in that volume. During the course of the analysis of an accident, activity is transferred from subroutine to subroutine in the program as it would be transferred from place to place in the plant. For example, in the calculation of the doses resulting from a loss-of-coolant accident the program first calculates the activity built up in the fuel before the accident, then releases some of this activity to the containment volume. Some of this activity is then released to the atmosphere. The rates of transfer, leakage, production, cleanup, decay, and release are read in as input to the program. Subroutines are also included which calculate the on-site and off-site radiation exposures at various distances for individual isotopes and sums of isotopes. The program contains a library of physical data for the twenty-five isotopes of most interest in licensing calculations, and other isotopes can be added or substituted. Because of the flexible nature of the simulation approach, the EMERALD program can be used for most calculations involving the production and release of radioactive materials during abnormal operation of a PWR. These include design, operational, and licensing studies.

- 548 CEBUG - The transient hydraulic behavior of the sodium in a sodium-heated steam generator in which a sodium-water reaction occurs due to a large water leak is calculated for flows in up to three dimensions.
- 554 DISPER1 - DISPER1 determines the aerosol particle source strength outside an enclosure due to a release of aerosol particles within the enclosure. The release is assumed to pressurize the enclosure and the airborne particles are carried by the escaping gas into leak paths in the enclosure walls. Here they may be deposited on the leak path walls or remain entrained and escape from the enclosure.
- 555 PARET - This program is designed for use in predicting the course and consequences of nondestructive reactivity accidents in small reactor cores.
- 559 SOFIRE2 1- and 2-CELL - SOFIRE2 ONE CELL, calculates the consequences of a sodium pool fire in a closed vault. Gas pressure in the vault is calculated from the gas density and temperature. SOFIRE2 TWO CELL, calculates the consequences of a sodium pool fire in a vault connected to a containment structure through a restricted opening. Cold gas flows from the containment to the vault due to mass differences while hot gas flows from the vault to the containment to equilibrate pressures. Pressure in the containment is calculated from the gas density and temperature. In both programs the sodium burning rate is governed by the rate of oxygen diffusion to the sodium surface.
- 583 STEFEG - STEFEG calculates gaseous source terms. It computes the gaseous releases through various paths from boiling water reactors and/or pressurized water reactors.
- 584 FPFM - FPFM is used in radiological safety analyses of line reactors (BWR's and PWR's only) to calculate: (1) maximum noble gas release to the fuel cladding gap for total core during steady-state operation, (2) noble gas released to the reactor primary system for selected pin perforations, and (3) internal pin pressure (optional).
- 590 INTEG/INSPEC - These programs analyze the characteristics of a general model developed to represent the safety aspects of an operating nuclear reactor. These characteristics are the frequencies of incidents that are departures from the expected behavior of the reactor. Each incident is assumed to be preceded by a sequence of events starting at some initiating event. At each member in this sequence there may be functions such as safety circuits, and personnel operations that stop the sequence at that member. When mechanical devices fail they are assumed to remain inoperative until repaired. The model accounts for scheduled inspection and maintenance of all equipment in the system.
- 600 EGAD - EGAD calculates gamma dose integrals to a ground level receptor, for incremental values of the vertical dispersion parameter sigma-z, as a function of gamma energy and spatial distribution of the radioactive material. The dose integrals are representative of sector averages since the distribution of material is assumed to be Gaussian in the

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vertical, homogeneous in the horizontal, and bounded between ground level and an inversion lid. Calculated dose integrals are independent of radioactive decay, transport velocity, downwind distance, and sector width. Space attenuation and buildup are taken into account.

653 MOCUS - From a description of the Boolean failure logic of a system, called a fault tree, and control parameters specifying the minimal cut set length to be obtained MOCUS determines the system failure modes, or minimal cut sets, and the system success modes, or minimal path sets.

658 FRAP-T/FRAP-T3 - FRAP-T and FRAP-T3 predict the thermal, mechanical and internal gas pressure response of a water-cooled, zircaloy-clad, oxide fuel rod during a loss-of-coolant accident (LOCA), power-coolant mismatch (PCM), or flow blockage accident.

They consider the coupled effects of these response parameters by iterating to convergence at each time-step in a transient. Transient heat conduction is analyzed.

663 COMRADEX4 - COMRADEX4 was developed to evaluate potential radiological doses in the near (<10⁺4 meters) environment of radioactive releases, especially postulated accident releases. Consequence-mitigating natural phenomena and engineered safety features, such as aerosol deposition inside and outside containment, meteorological dispersion, multiple containments, filtration, and shielding, may be calculated. Potential doses to body organs may be calculated from sources retained in containment, distributed in the atmosphere, and inhaled.

666 FTA - The FTA (Fault Tree Analysis) system was designed to predict probabilities of the modes of failure for complex systems and to graphically present the structure of systems. There are three programs in the system. Program ALLCUTS performs the calculations. Program KILMER constructs a CalComp plot file of the system fault tree. Program BRANCH builds a cross-reference list of the system fault tree.

674 SAFTAC - SAFTAC is a Monte Carlo fault tree simulation program that provides a systematic approach for analyzing system design, performing trade-off studies, and optimizing system changes or additions.

685 EMERALD-NORMAL - EMERALD-NORMAL is designed for the calculation of radiation releases and exposures resulting from normal operation of a large pressurized water reactor. The approach used is similar to an analog simulation of a real system. Each component or volume in the plant which contains a radioactive material is represented by a subroutine which keeps track of the production, transfer, decay, and absorption of radioactivity in that volume. During the course of the analysis, activity is transferred from subroutine to subroutine in the program as it would be transferred from place to place in the plant. Some of this activity is then released to the atmosphere and to the discharge canal. The rates of transfer, leakage, production, cleanup, decay, and release are read as input to the program. Subroutines are also included which calculate the off-site radiation exposures at various distances for individual isotopes and sums of isotopes. The program contains a library of physical data for the forty isotopes of most interest in licensing calculations, and other isotopes can be added or substituted. Because of the flexible nature of the simulation approach, the EMERALD-NORMAL program can be used for most calculations involving the production and release of radioactive material. These include design, operation, and licensing studies.

704 COMCAN - COMCAN is designed to analyze complex systems, such as nuclear plants for common causes of failure. A common cause event, or common mode failure, is a secondary cause that may contribute to the development of more than one component malfunction. A significant common cause event is a secondary cause common to all basic events in one or more minimal cut sets. These minimal cut sets are common cause candidates. If all components represented by the basic events in a minimal cut set share a common location, that minimal cut set is called a prime common cause candidate. Components share a common location if no barriers capable of insulating them from the secondary cause are present.

710 HAMOC - HAMOC determines the pressure transients in piping systems attached to a reactor vessel which has been perturbed, by a hypothetical core disruptive accident (HCDA) for

example. The continuity and momentum equations are solved. The energy equation is not programmed, but simplified column separation logic is included to treat vapor pressures below saturation. This simplified approach has been checked against experimental data. HAMOC was written specifically for problems in which forcing pressures are known as a function of time at certain end boundary conditions, rather than as a general purpose code for the solution of pump coastdown or valve closing problems.

- 712 **WREM-TOODEE2/MOD3** - WREM-TOODEE2 is a two-dimensional, time-dependent, fuel-element thermal analysis program. Its primary purpose is to evaluate fuel-element thermal response during post-LOCA refill and reflood in a pressurized water reactor (PWR).
- 714 **SPOOL-FIRE** - SPOOL-FIRE calculates the pressure and temperatures within a containment building as a result of a sodium fire. The fire is assumed to occur in two distinct phases: a spray and a pool. The spray fire is conservatively assumed to occur instantaneously. The code calculates all important temperatures, accounting for heat loss from the building to the environment, as well as leakage of the containment atmosphere under conditions of internal overpressure.
- 716 **SPRAY3** - SPRAY3 performs the calculations of thermodynamics, heat and mass transfer, and combustion of sodium spray droplets released in an LMFBR cell as a result of postulated piping failure. Droplet motion and large sodium surface area combine to produce rapid heat release and pressure rise within the enclosed volume.
- 717 **NAHAMMER** - NAHAMMER analyzes short-term pressure-pulse transients in a closed hydraulic system consisting of series or parallel piping, pipe junctions, diameter discontinuities, elbows, junctions of three to six branches, orifices, acoustic-impedance discontinuities, dummy junctions, dead ends, and free surfaces in surge tanks. The working fluid is assumed to be sodium without cavitation.
- 718 **NATTRANSIENT** - NATTRANSIENT analyzes short-term pressure-pulse transients in a closed hydraulic system consisting of series or parallel piping, pipe junctions, diameter discontinuities, junctions of three to six branches, closed ends, surge tanks, far ends, dummy junctions, acoustic impedance discontinuities, and rupture disks. The working fluid is assumed to be liquid sodium without cavitation. The source pressure pulse is assumed to be generated by a sodium-water reaction according to the dynamic model of Zaker and Salmon.
- 719 **NATRAN2** - NATRAN2 analyzes short-term pressure-pulse transients in a closed hydraulic system consisting of a two-dimensional axisymmetric domain connected to a one-dimensional piping network. The one-dimensional network may consist of series or parallel piping, pipe junctions, diameter discontinuities, junctions of three to six branches, closed ends, surge tanks, far ends, dummy junctions, acoustic impedance discontinuities, and rupture disks. By default, the working fluid is assumed to be liquid sodium without cavitation; but another working fluid can be specified in terms of its density, sonic speed, and viscosity. The source pressure pulse can arise from one of the following: a pressure-time function specified at some point in the two-dimensional domain, a pressure-time function or a sodium-water reaction specified at some point in the one-dimensional domain. The pressure pulse from a sodium-water reaction is assumed to be generated according to the dynamic model of Zaker and Salmon.
- 722 **CRAC** - The CRAC code was developed in support of the Reactor Safety Study (WASH-1400) to assess the risk from potential accidents at nuclear power plants.
- 726 **NAIAD** - NAIAD computes the transient (including LOCA) and steady-state flow of two-phase compressible light water in a network of heated channels. The momentum flux term is included and unequal phase velocities allowed. A lumped fuel model and detailed surface heat transfer are included. Thermodynamic equilibrium of the two phases is assumed. Discharge flow is calculated intrinsically from the hydraulic equations. The ANC pump model is included.
- 733 **RELAP3B/MOD110** - RELAP3B describes the behavior of water-cooled nuclear reactors during postulated accidents or power transients, such as large reactivity excursions, coolant

losses or pump failures. The program calculates flows, mass and energy inventories, pressures, temperatures, and steam qualities along with variables associated with reactor power, reactor heat transfer, or control systems. Its versatility allows one to describe simple hydraulic systems as well as complex reactor systems.

- 734 BOIL1** - BOIL was developed for use in the Reactor Safety Study (WASH-1400) to calculate core heatup and meltdown sequences in coolant boiloff accidents.
- 745 CORRAL2** - CORRAL2 describes fission product behavior in multicompartment LWR containments taking into account natural transport and deposition as well as the effects of engineered safety features. This program is specifically designed to handle fission product behavior in LWR accidents involving core meltdown, though less severe accidents can also be treated.
- 751 SOMIX1** - SOMIX1 analyzes transient free convection motion in low-oxygen gas environments of a cylindrical enclosure, representing a LMFBR heat transfer cell, following a sodium pipe rupture which releases a spray of sodium droplets. Calculated are the combustion and heat transfer from the falling spray to the gas atmosphere, droplet motion, gas temperature and pressure rise and internal gas circulation.
- 761 PTA1** - PTA1 (Pressure Transient Analysis) performs pressure-transient analysis of large piping networks. The program is particularly oriented toward the analysis of the effects of a sodium/water reaction on the intermediate heat-transport system of a liquid-metal-cooled fast breeder reactor, but may be applied to other pulse sources and piping systems. A variety of junction types are included, and complex piping networks can be treated. The effect of elastic-plastic deformation of piping on pulse propagation, pipe friction and nonlinear velocity terms are included in the formulation.
- 762 CACECO** - The CACECO program predicts the thermodynamic responses of primary and secondary containment to a variety of accidents in a Liquid Metal Fast Breeder Reactor (LMFBR) facility. The user defines these accidents in terms of the following: (a) sodium leakage as spray and spill, (b) air injection, (c) decay heat release, and (d) space cooler operation. CACECO is capable of providing pressure-temperature histories of four cells. Each cell may have connected to it any number of one-dimensional structures which can be used to model walls, floors, or equipment. The structures are linked to the cells or other structures by convective and/or radiative boundary conditions. The structures may be planar, cylindrical, or spherical and can be composed of a number of regions with different properties.
- 766 FRANTIC-NRC** - FRANTIC-NRC was developed to investigate periodic testing schemes and operational and design modifications as they affect system unavailabilities and accident probabilities. The program calculates both the instantaneous and the average unavailability for any general system model and gives a breakdown of the unavailability contributions from failures, testing, and repair. Non-repairable components, monitored components, and periodically-tested components are considered. Accident sequences, such as those constructed from event trees, can also be evaluated for their instantaneous and average probability behavior. The name FRANTIC is an acronym for Formal Reliability Analysis including Normal Testing, Inspection and Checking. The code represents one extension of the probabilistic methodology described in WASH-1400. Testing characteristics which can be input include the test interval, test duration time, repair time or allowed downtime, the test override capability, test efficiency, and associated human-caused failure probabilities. The output provides tables and plots of the system unavailability along with a breakdown of the unavailability contributions. Sensitivity studies can be performed.
- 767 BEACON/MOD2A** - The BEACON series of programs is designed to perform a best estimate analysis of the flow of a mixture of air, water, and steam in a nuclear reactor containment system under loss-of-coolant accident conditions. The code can simulate two-component, two-phase fluid flow in complex geometries using a combination of two-dimensional, one-dimensional, and lumped-parameter representations for the various parts of the system. BEACON/MOD2A contains mass and heat transfer models for wall film and for wall conduction, and is suitable for the evaluation of short-term transients in PWR dry containment systems.

The two-component (air and water), two-phase (vapor and liquid) capability permits simulation of complex nonequilibrium problems such as flashing, two-phase jets, and liquid deentrainment.

- 778 PROSA1** - PROSA1 is an implementation of the probabilistic response surface technique developed for use with accident analysis programs to conduct probability studies of hypothetical accidents. PROSA1 determines the distribution of a random variable that is a function of many other random variables when this functionality is not known analytically and can be obtained only through parametric studies with a deterministic computer code. The program first systematically provides input parameter combinations for evaluation by a deterministic code. Then, with the output from the deterministic code for each of these parameter combinations, multivariate quadratic response surfaces are generated approximating the functionality between the input and output of the deterministic code. Using these response surfaces PROSA1 calculates probability histograms and joint histograms for the output variables. Special features of the code generate or treat sensitivities, statistical moments of the input and output variables, regionwise response surfaces, correlated input parameters, and conditional distributions.
- 779 IMPORTANCE** - IMPORTANCE computes various measures of probabilistic importance of basic events and minimal cut sets to a fault tree or reliability network diagram. The minimal cut sets, the failure rates and the fault duration times (i.e., the repair times) of all basic events contained in the minimal cut sets are supplied as input data. The failure and repair distributions are assumed to be exponential. IMPORTANCE, a quantitative evaluation code, then determines the probability of the top event and computes the importance of minimal cut sets and basic events by a numerical ranking. Two measures are computed. The first describes system behavior at one point in time; the second describes sequences of failures that cause the system to fail in time. All measures are computed assuming statistical independence of basic events. In addition, system unavailability and expected number of system failures are computed by the code.
- 780 NALAP** - NALAP is an LMFBR system transient code. This code, adapted from the light water reactor transient code RELAP3B, simulates thermalhydraulic response of sodium-cooled fast breeder reactors when subjected to postulated accidents such as a massive pipe break as well as a variety of other upset conditions that do not disrupt the system geometry.
- 797 HAARM3** - HAARM3, an acronym for Heterogeneous Aerosol Agglomeration Revised Model 3, is the third program in the HAARM series developed to predict the time-dependent behavior of radioactive aerosols under postulated LMFBR accident conditions. HAARM3 was developed to include mechanisms of aerosol growth and removal which had not been accounted for in the earlier models. In addition, experimental measurements obtained on sodium oxide aerosols have been incorporated in the code. As in HAARM2, containment gas temperature, pressure, and temperature gradients normal to interior surfaces are permitted to vary with time. The effects of reduced density on sodium oxide agglomerate behavior and of nonspherical shape of particles on aerosol behavior mechanisms are taken into account and aerosol agglomeration due to turbulent air motion is considered. Also included is a capability to calculate aerosol concentration attenuation factors and to restart problems requiring long computing times.
- 804 CHART** - CHART was developed for the thermal analysis of the charcoal adsorber in a reactor containment system; maximum temperatures caused by iodine adsorption under accident conditions are estimated. A differential equation relating the charcoal slab temperature to the heat generation rate, air flow rate, and the heat parameters of air and charcoal is solved in both one and three dimensions. Principal consideration is given very low flow rates and times soon after accident onset, the conditions which pose the greatest threat to the charcoal.
- 818 CONTEMPT4/MOD2** - CONTEMPT4/MOD2 describes the long-term behavior of multicompartiment pressurized water reactor (PWR) containment systems and experimental containment systems subjected to postulated loss-of-coolant accident (LOCA) conditions. The program calculates the time variation of compartment pressures, temperatures, mass and energy inventories, heat structure temperature distributions, and intercompartment mass and energy exchange

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based on user-supplied values for compartment descriptions, time-step and edit controls, and selected problem features. Analytical models available to describe containment systems include models for containment fans and pumps, cooling sprays, fan coolers, heat conducting structures, sump drain, and PWR ice condensers. Optional automatic time-step control allows the code to determine time-step sizes within limits dictated by the user.

- 198 HEATING2** - HEATING2 is a generalized heat transfer code capable of solving transient and/or steady-state coordinate systems. The simplified input makes it a very useful code for those problems having geometrical configurations which can be described by parallel and perpendicular lines or planes, or concentric circles. These figures can be broken up into a maximum of 100 one-material regions with position and time-dependent volumetric heat generation rates. Up to 40 materials with constant properties can be described, and the initial temperatures of these regions are position-dependent. The boundaries of these regions can be contact, insulated, time-dependent temperature controlled, or forced convection with a time-dependent sink temperature. Also a radiation boundary with a time-dependent sink temperature is included.
- 246 FLOW-MODEL** - FLOW-MODEL is a multi-channel, two-dimensional, two-phase flow model designed to compute the axial and radial coolant density and quality profiles, the axial pressure profile and the weight flow distribution for an open matrix flow, boiling water reactor.
- 256 MANTA** - MANTA is a program which provides a thermal-hydraulic nodal analysis in the steady state. It was designed to analyze fuel element configuration in the superheat development program. MANTA analyzes mixing between coolant channels, allows for temperature variant conductivity in admittance calculations, and multiple stacked segments through the fuel region for a 7-element cluster analysis over a length of up to 8 feet. MANTA is designed for single-pass steam flow. The flow direction in the coolant channels may be either up or down, thereby permitting the analysis of two-pass as well as single-pass fuel elements. MANTA accounts for the heat transfer and pressure drop that may occur between coolant channels due to mixing as well as to the conventional heat transfer and pressure drop relationships due to friction, discontinuities, acceleration, convection, conduction, and radiation. MANTA allows for the calculation at each node of the material properties viscosity, specific heat, conductivity, and specific volume to correspond to the actual node temperature being solved for. The CDC6600 version uses sodium for the working fluid rather than steam.
- 267 WATER** - WATER is a subroutine used to extract thermodynamic and transport properties of liquid, vapor, and supercritical water by tabular interpolation over the range of states: 14.5 to 14,500 psia and 32 to 1472 degrees F. These properties are specific volume, specific enthalpy, dynamic viscosity, and thermal conductivity, tabulated for pressure and temperature conditions.
- 272 FIGRO** - FIGRO calculates the one-dimensional steady-state temperature distribution and total fuel swelling for metal-clad, axisymmetric, bulk-oxide cylindrical fuel elements. The fuel pellet may be solid, annular, or contain two radial zones. Oxide fuel thermal conductivity is a function of temperature, depletion, and porosity. Fuel swelling is a function of temperature, depletion, internal hydrostatic pressure, and fissioning rate. Fuel-clad gap conductance is a function of gas composition, temperature, and gap thickness at operating conditions. Either the clad surface flux or the temperature at the inside radius of the fuel may be specified as a boundary condition for the heat conduction equation. Thermal expansion of the fuel and cladding is accounted for. Transient temperature calculations can then be performed starting from the steady-state solution with user-specified heat generation and water temperature tables.
- 286 HOT2** - HOT2 is a digital computer program to solve two-dimensional plane and axially symmetric steady-state and transient heat conduction problems with diagonal boundaries and interfaces. Mesh spacing (at most 5000 points) is completely variable. As many as 99 regions are permitted in order to describe spatial variations in material properties, heat generation rates, and boundary conditions. The heat generation rate and boundary conditions may vary with time.
- 294 M0899/HOH** - By making calls on a subroutine called HOH, M0899 edits thermodynamic and transport properties of water over the range 14.5 to 2538 psia and up to 608 degrees Fahrenheit below saturation and 932 degrees Fahrenheit above saturation.
- 299 LION4** - LION4 is a computer program for calculating one-, two-, or three-dimensional transient and steady-state temperature distributions in reactor and reactor plant

components. It is used primarily for thermal-structural analyses. It utilizes finite difference techniques with first-order forward difference integration and is capable of handling a wide variety of bounding conditions.

Heat transfer situations accommodated include forced and free convection in both reduced and fully-automated temperature dependent forms, coolant flow effects, a limited thermal radiation capability, a stationary or stagnant fluid gap, a dual dependency (temperature difference and temperature level) heat transfer, an alternative heat transfer mode comparison and selection facility combined with heat flux direction sensor, and any form of time-dependent boundary temperatures. The program, which handles time and space dependent internal heat generation, can also provide temperature dependent material properties with limited non-isotropic properties. User-oriented capabilities available include temperature means with various weightings and a complete heat flow rate surveillance system.

- 331 M0219(FLOT1)** - FLOT1 will predict the steady-state flow and the flow transient due to the subsequent loss of power to all pumps and terminate the transient at a specified time or it will predict the flow transient in which only some of the pumps are lost. This latter transient may be terminated by a maximum transient time or by check valve closures in all loops in which pumping power is lost. In the latter event, the program will predict the subsequent steady-state flow distribution.
- 348 TOPS** - The TOPS program is a digital simulation of pressurizer dynamics based on a rigorous application of the first law of thermodynamics and phenomenological heat and mass transfer laws with empirically determined coefficients. The program is useful in studying the thermodynamic paths of pressurizer transients and is convenient to use as a design tool.
- 382 RAPP** - RAPP computes the relationship among mass flow, pressure, and piping resistance (k-factor) for high velocity flow of a two-phase mixture of steam and water. The source fluid may be subcooled or saturated water, saturated steam, or a mixture of steam and water. The downstream pressure must be below the saturation pressure of the source fluid. Specific applications include pressurizer surge line pressure drop and pressure distribution downstream of a relief valve.
- 395 FLAC** - The flow analysis code FLAC calculates the steady-state flow and pressure distribution in an arbitrary network. The program includes the possibility of heat addition and mass addition in any portion of the network.
- 396 WASP2** - WASP2 is a FORTRAN IV computer program which performs a spline function fit to data obtained from the WASP subprogram (see reference 1) for thermodynamic and transport properties of water and steam. The properties calculated by WASP2 are: pressure and temperature as functions of specific volume and specific internal energy; specific volume as a function of pressure and enthalpy; and viscosity, thermal conductivity, and specific heat as functions of pressure and temperature.
- 408 TAC2D** - TAC2D is designed to treat transient, two-dimensional heat transfer problems. Steady-state problems are treated by considering the problem to be a transient, starting with an assumed temperature distribution and running until equilibrium conditions are established. Geometrically, rectangular (x-y), cylindrical (r,z), or circular (r,theta) coordinates may be used.
- 414 TAC3D** - TAC3D is designed to treat transient, three-dimensional heat transfer problems. Steady-state problems are treated by considering the problem to be a transient, starting with an assumed temperature distribution and running until equilibrium conditions are established. Geometrically, the problem may be defined by either rectangular (x,y,z) or cylindrical (r,z,theta) coordinates.
- 424 GLUB1** - GLUB1 solves the waterlogging transient caused by the existence of a fuel element cladding defect during an increase in power. The power is either - case 1, put in as an arbitrary function of time, or case 2, assumed to be a series of linear ramps to a new steady-state with steeper and steeper slopes. All the geometry and metal properties are input quantities. Water properties are obtained from internal tables. Clad and fuel

thermal, stress, and strain computations are performed. The output consists of internal pressure and defect flow. For case 1, the clad stress versus time is printed, and for case 2 the steady-state power value which causes clad failure is printed.

- 432 COBRA4I** - COBRA4I performs steady-state and transient thermal-hydraulic analysis of rod bundle nuclear fuel elements and cores via the subchannel analysis method.
- 440 DYNAM** - DYNAM performs a dynamic analysis of once-through boiling flow oscillations with steam superheat. The model describing the superheat regime (single-phase, variable density fluid) for subcritical pressure operation is also applicable to the study of once-through operation using supercritical pressure water.
- 458 VELVET2** - VELVET2 solves the coupled, heat-transfer equations in the fuel, gap, cladding, and coolant for a triangular-spaced, close-packed, fuel rod bundle with liquid metal coolant. The model includes temperature-dependent material properties, turbulent velocity distribution in the coolant, and contributions to coolant heat transfer by turbulent mixing.
- 473 CHIC-KIN** - CHIC-KIN treats fast and intermediate reactivity transients in a water-cooled heterogeneous nuclear reactor. The program calculates the power, temperatures, and internal pressure surges when control rod motion, inlet temperature, inlet flow, and system pressure are known functions of time. The reactor model considered is a single-pass, water-cooled core represented by a single, fuel-element-coolant-passage system with reactivity feedback to the kinetics equations.
- 483 REPP** - The REPP computer code provides a method for (1) evaluating fuel temperatures and critical heat flux margins for a fixed reactor core and fuel design, (2) determining the number of fuel pins required to maintain specified heat flux margins from burnout at a given reactor power level, (3) determining the diameter of a fuel pin to design within fuel centerline temperature limits at a specified reactor power level, (4) evaluating the sintering effect on fuel temperature, (5) calculating pressure drop and coolant properties for single-phase and two-phase flow for fuel operating at average reactor conditions and a theoretical hot-pin hot-channel condition, and (6) calculating pressure drop across several types of fuel pin spacers.
- 487 STEAM-67** - STEAM-67 is a set of routines for calculating the properties of steam and water according to the ASME Steam Tables, 1967, which have been modified in accordance with the ASME paper (reference 3). Modifications were made to improve program running time as well as to correct some existing program errors. Corrections were also made to routines for the liquid region to improve accuracy on the IBM360 computer.
- 517 HEATING5** - HEATING5 is designed to solve steady-state and/or transient heat conduction problems in one-, two-, or three-dimensional Cartesian or cylindrical coordinates or one-dimensional spherical coordinates. The thermal conductivity, density, and specific heat may be both spatially and temperature-dependent. The thermal conductivity can be anisotropic. Materials may undergo a change of phase. Heat generation rates may be dependent on time, temperature and position, and boundary temperatures can be time-dependent. The boundary conditions, either surface-to-boundary or surface-to-surface, may be fixed temperatures or any combination of prescribed heat flux, forced convection, natural convection, and radiation. The boundary condition parameters are permitted to be time- and/or temperature-dependent. The mesh spacing can be variable along each axis.
- 525 ORTHIS/ORTHAT** - ORTHIS and ORTHAT are designed to solve steady-state and transient heat conduction problems, respectively, in two-dimensional geometries. Either Cartesian (x-y) or cylindrical (r-z, r-theta) coordinate systems may be used. Thermal properties, heat generation rates, and boundary conditions may be functions of position, time, or temperature.
- 545 BETTY** - BETTY describes spatial and temporal concentration behavior of a suspension in a pipe, as a result of deposition and erosion of the particles.

- 551 MOXY/MOD032** - MOXY is used for the thermal analysis of a planar section of a boiling water reactor (BWR) fuel element during a loss-of-coolant accident (LOCA). The code employs models that describe heat transfer by conduction, convection, and thermal radiation, and heat generation by metal-water reaction and fission product decay. Models are included for considering fuel-rod swelling and rupture, energy transport across the fuel-cladding gap, and the thermal response of the canister. MOXY requires that time-dependent data for the power, normalized to the steady-state power, for the heat-transfer coefficient, and for the fluid temperature be provided as input during the blowdown process. Internal models provide these parameters during the heatup and emergency cooling phases.
- 552 PWR-PPM** - PWR-PPM generates boration-dilution tables used by the reactor operator of a PWR. The computer printed tables plot initial and final reactor coolant system boron concentration in units of ppm boron against the gallons of makeup water and boric acid solution required to obtain the desired ppm change. These tables replace nomographs normally required for boration and dilution operations.
- 560 HYMAS** - HYMAS generates the hydrodynamic mass matrix per unit depth associated with a multi-mass system immersed in a liquid environment. It is assumed that the liquid environment may be represented by a series of flow-channels and nodes. Flow-channels are introduced in the region between surfaces of neighboring solids, and nodes are used to connect two or more flow-channels. Also, it is assumed that the solid bodies undergo unidirectional motion, that potential flow theory is applicable, that the width of a flow-channel is small compared with the length so there is no pressure drop across the flow-channel, and that nodal volume is small compared with flow-channel volume.
- 580 ASTEM** - ASTEM is a modular set of FORTRAN IV subroutines to evaluate the Gibbs, Helmholtz, and saturation line functions as published by the American Society of Mechanical Engineers (1967). Any thermodynamic quantity including derivative properties can be obtained from these routines by a user-supplied main program. PROPS is an auxiliary routine available for the IBM360 version which makes it easier to apply the ASTEM routines to power station models.
- 586 PLENUM** - Bulk flow distribution in a cylindrical reactor coolant inlet plenum is calculated using potential flow theory.
- 616 HAFMAT** - HAFMAT was developed for the calculation of the steady-state distribution of flow to all paths of any given flow system when the flow geometry and heat addition are specified for every flow path and the system boundary conditions are defined. The system is considered as a network of flow paths or pipes.
- 629 ORRIBLE** - ORRIBLE is a group of programs used to predict flow and temperature distribution for steady single-phase flow through bundles of heated rods separated by helical wire-wrap spacers. Any combination of flow subchannels can be blocked at the inlet. Turbulent interaction, sweeping cross flow due to the wire wrap, and transverse thermal conduction are considered. The eleven ORRIBLE programs in the package are for three duct configurations of 19-rod bundles, and for 37-, 91-, and 217-rod bundles in hexagonal ducts. In three versions, periodic channel area variations due to the wire wraps moving through channels and the possibility of the rod bundle forming a helix in the duct are considered.
- 636 6KILER** - 6KILER was developed for predictive and post-test analyses of core heat transfer during a loss-of-coolant accident for a General Electric BWR/6 type nuclear reactor plant.
- 651 SOLA/SOLA-SURF** - SOLA and SOLA-SURF are numerical solution algorithms for transient fluid flows. SOLA is for incompressible fluid flows without free surfaces. SOLA-SURF, an extension of the SOLA code, permits a free surface or curved rigid boundary (free-slip) to be located across the top or bottom of the fluid region.
- 659 COBRA3M** - COBRA3M calculates the steady state and transient flow, coolant temperature and pressure drop in the subchannels of nuclear fuel pin bundles. In addition, it calculates temperatures of fuel, cladding, and duct wall.

- 664 FLOW3** - FLOW3 was developed for the steady-state thermal and hydraulic analysis of two-phase flow in three-dimensional geometries. The program was developed with particular application to the analysis of flow on the primary and secondary sides of a steam generator and may be applied to a variety of fluid flow problems of a general nature. The program employs a network representation of the flow field and predicts local fluid conditions based on a boundary value solution method. The FLOW3 program user specifies a flow region of interest as a network of nodes with interconnecting links. Flow may enter or leave the network at designated boundary nodes (where the pressure is fixed) or at designated source nodes (where the flow is fixed). The conservation equations for mass, energy, and momentum are solved for the steady-state enthalpy and pressure at each node and the flow in each link. Heat may be added to any links, and two-phase flow is allowed.
- 673 SIEX** - SIEX is a steady-state heat transfer code for the calculation of mixed-oxide fuel pin thermal performance and dimension change (swelling and thermal expansion) in a fast neutron environment. Fuel restructuring, fuel and cladding displacements due to swelling and thermal expansion, fuel-to-cladding gap heat transfer, and fission gas release are included to provide an assessment of fuel, cladding, and coolant temperatures.
- 677 MARGE/SLUMP** - The MARGE/SLUMP code performs a series of one-dimensional (radial) calculations at fixed intervals along the axial length of a LMFBR fuel element to determine sodium temperature, clad temperature, fuel temperature, central void diameter, and amount of fuel addition or removal necessary to maintain the inner surface of the central void at the melting temperature of mixed oxide fuel.
- 694 FRAP-S1/FRAP-S3** - THE FRAP-S program predicts the thermal, mechanical, internal gas pressure, and material properties response of a water-cooled oxide fuel rod during steady-state reactor operation. The code considers the coupled effects of the response parameters by iterating to convergence at each power-time step. Fission gas generation and release are calculated as a function of burnup. Multi-axial elasto-plastic analysis included in the FRAP-S3 cladding deformation model and creep is taken into account. Also included in FRAP-S3 is a fuel rod failure subcode which checks for various modes of failure based on operating conditions.
- 696 ENERGY** - This package consists of four independent programs, ENERGY1, ENERGY2, ENERGY3, and SUPERENERGY developed for predicting coolant temperature distributions in wire wrapped fuel and blanket assemblies of a liquid-metal-cooled, fast breeder reactor.
- 702 COMPARE** - COMPARE performs transient calculation of the thermodynamic conditions in volumes connected by flowing junctions with provision for mass and energy addition. Volume thermodynamics and junction flows are for homogeneous mixtures of: steam, two-phase water, any three perfect gases, or combinations of the above. Critical vent flow is based on the Moody equation. Subcritical flow is based on compressible orifice flow of an ideal gas-like mixture with inlet and exit losses resulting in a polytropic flow process. Flow with inertia is calculated on the basis of an incompressible subelement relationship. The program was written to perform transient subcompartment analysis of nuclear power plants.
- 703 ORCENT** - ORCENT performs full-load design point heat and mass balance calculations for steam turbine cycles supplied with throttle steam, characteristic of light water reactor plants. The program handles both condensing and back-pressure turbine exhaust arrangements. Turbine performance calculations are based on the General Electric Company method for large steam turbine-generators operating with saturated and low superheat throttle steam. Output includes all information normally shown on a turbine cycle heat balance diagram.
- 706 TH13D** - TH13D is a computer program for steady-state, single-phase, thermal-hydraulic multichannel analysis. The model accounts for conservation of mass, energy, and momentum (both axial and transverse) subject to pressure-drop boundary conditions and leads to a nonlinear, multipoint boundary-value problem. Turbulent interchange, radial thermal conduction, and forced flow due to the wire wrap or grid between channels are explicitly taken into account. Temperature distributions in the coolant, cladding, fuel, and duct wall, and the size of the central void of the oxide fuel after thermal restructuring are

computed. Three different thermal-hydraulic channel arrangements (square, hexagonal, and triangular) can be treated. Multipin analysis with transverse interactions, or multiassembly calculations without transverse interactions between the channels, can be performed. Problems of partial flow blockage (porous blockage) can be analyzed, and the effect on the redistribution of the inlet mass velocity can be taken into account.

723 SOLA-ICE - SOLA-ICE is a numerical solution algorithm for transient, arbitrarily compressible fluid flows.

727 K-FIX - The transient dynamics of two-dimensional, two-phase flow with interfacial exchange are calculated at all flow speeds. Each phase is described in terms of its own density, velocity, and temperature. Separate sets of field equations govern the gas and liquid phase dynamics. The six field equations for the two phases couple through mass, momentum, and energy exchange.

730 HETRAP - HETRAP is a heat transfer analysis program developed for use in the evaluation of LOCA experiments. Its major application is calculation of heat flux and heat transfer coefficients at the surface of an electrically-heated rod during a fast transient, using measured temperatures in the rod. In addition, the code can be used to calculate the steady-state and transient temperature fields in fuel rods and electrically-heated rods for given heat transfer coefficients.

732 LOCK - LOCK was developed to study the problem of local blockage of coolant flow in a few channels in a fast breeder reactor. The program is designed to perform thermal calculations in the steady state and to calculate the transient behavior in temperature of the coolant and cladding. The heat transfer which is taken into account includes heat transmission mixing, thermal conduction, and cross flow.

737 DIFFUSER - The DIFFUSER program uses a turbulent-flow model to calculate the performance of two-dimensional subsonic diffusers and of three-dimensional diffusers under the assumption of similarity of the top, bottom, and side wall boundary layers.

755 VARR2 - VARR2 is a two-dimensional transient slightly-compressible fluid dynamics program. It solves the complete unsteady Navier-Stokes equation, the energy equation, and the continuity equation in either Cartesian or axisymmetric cylindrical geometry. Slight density variations are accounted for by use of the Boussinesq approximation, which couples the energy and momentum equations. At a cell face, the normal velocity component may be inward, outward, or zero; the tangential velocity component may specify free slip, no slip, or no slip with a turbulent velocity profile. For heat transfer problems, adiabatic or constant heat flux boundary conditions can be specified. By specifying the totality of cell-face boundary conditions in a self-consistent manner, the user can specify a wide spectrum of overall boundary conditions; for example, those called rigid, continuative, periodic, inflow/outflow, or derived.

763 REFLUX - REFLUX calculates the temperature-time history of a representative fuel rod during the reflood stage of a hypothetical loss-of-coolant accident (LOCA). The logic used for selection of the appropriate flow regime for analysis of the cladding temperature transient is based on the axial position with regard to the continuous liquid level (based on a mass balance), a liquid carry-over criterion (derived from a force balance on a drop suspended in a vapor stream), and the local cladding surface temperature. A generalized boiling curve is constructed, and the local flow and clad conditions determine the applicable heat transfer coefficient.

768 BEHAVE-SST - BEHAVE-SST calculates the steady-state and overpower transient behavior of cladding, fuel, and voidage in oxide LMFBR fuel rods prior to cladding failure. Cylindrical symmetry is assumed throughout the program. The BEHAVE-SST program calculates the stress, strain, displacement, and temperature fields in the fuel and cladding. Processes simulated include: cracking of fuel, dilation of fuel and cladding due to irradiation effects and thermal expansion, fuel densification by both stress and diffusion-controlled processes, axial slippage or locking at the fuel-cladding interface, axial flow of fuel, and gas pressurization of the central molten fuel region. Cladding failure is predicted utilizing a life-fraction cumulative damage technique.

- 771 TRUMP** - TRUMP solves a general nonlinear parabolic partial differential equation describing flow in various kinds of potential fields, such as fields of temperature, pressure, or electricity and magnetism; simultaneously, it will solve two additional equations representing, in thermal problems, heat production by decomposition of two reactants having rate constants with a general Arrhenius temperature dependence. Steady-state and transient flow in one, two, or three dimensions are considered in geometrical configurations having simple or complex shapes and structures. Problem parameters may vary with spatial positions, time, or primary dependent variables--temperature, pressure, or field strength. Initial conditions may vary with spatial position; and among the criteria that may be specified for ending a problem are upper and lower limits on the size of the primary dependent variable, upper limits on the problem time or on the number of time-steps or on the computer time, and attainment of steady state.
- 776 COMPARE-MOD1** - COMPARE-MOD1 performs transient calculation of the thermodynamic conditions in zero velocity or stagnant volumes connected by flowing junctions with provision for mass and energy addition. Volume thermodynamics and junction flows are for homogeneous mixtures of: steam, two-phase water to its triple point, any three perfect gases, or combinations of the above. Critical vent flow can be arbitrarily based on either the Moody, homogeneous equilibrium model (HEM) or polytropic orifice relationship. Subcritical flow can be arbitrarily based on either the polytropic orifice or the one-dimensional, constant area, constant density momentum equation with inertia. A compressible density accounting is used in the one-dimensional momentum equation. The program was written to perform transient subcompartment analysis of nuclear power plants, including those with ice condensers.
- 783 SLGTR** - The program simulates the condition of a partly liquid slag film flowing on a cooled vertical or horizontal wall of a large duct, through which pass slag-laden combustion gases. It computes the axial variations of gas temperature, radiative and convective heat fluxes from the hot combustion gas to the cooled wall, and thickness, temperature, and velocity distributions of the slag film. The program is useful in performing design calculations for a radiant-heater concept in the downstream system of an MHD power plant.
- 792 EVITS** - EVITS was developed for estimating steady-state, incompressible, isothermal flow fields in complex two-dimensional geometries. A velocity-stream function formulation is used along with a model to resolve viscous effects at solid boundaries. A number of geometry and ten boundary type options are included to permit specification of a variety of flow situations.
- 796 PACT2** - PACT2 computes the probability distribution of the coolant and cladding outside (film) temperatures for an LMFBF wire-wrap fuel assembly at the start of life under a steady-state operating condition. It uses a mathematical model that considers both thermal-hydraulics in coolant subchannels and Monte Carlo sampling of the thermal-hydraulic calculation. The coolant temperature is defined as a function of enthalpy, flowrate, crossflow between adjacent subchannels, heat flux, and position.
- 802 SCHAFF** - The SCHAFF (Slightly Compressible Heat and Fluid Flow) program was developed for numerical modeling of liquid geothermal systems involving natural convection and hot spring discharge. For one-, two-, or three-dimensional porous media, the single-phase fluid and heat transfer equations are solved interlaced in time, using an integrated finite difference method. The mathematical model describing the physical behavior of hot-water geothermal systems is used to analyze natural or cellular convection in permeable layers heated from below.
- 809 TVENT** - TVENT predicts flows and pressures in ventilation systems caused by pressure transients such as a tornado. A ventilation system model includes system elements (components such as filters, dampers, ducts, blowers) connected at nodal points to form networks. The program solves one-dimensional lumped parameter, incompressible flow equations augmented by fluid storage. The user can identify points of excessive depressurization and areas of high flow.

I. DEFORMATION AND STRESS DISTRIBUTION COMPUTATIONS, STRUCTURAL ANALYSIS, AND ENGINEERING DESIGN STUDIES

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- 80 SOR3** - SOR3 is used for the analysis of symmetrically loaded shells of revolution. The program computes stresses, strains, forces and deflections produced by thermal and mechanical loads. Normal and transverse shear stresses and wall thickness changes are taken into account. The program is based on constitutive equations which retain terms through the second order in the ratio of the thickness to the local radii of curvature. These features make the program applicable to shell structures with moderately large thickness to radius ratios.
- 252 SAFE-PLANE** - SAFE-PLANE is applied to two-dimensional structures of arbitrary geometry under in-plane loads. Either plane stress or plane strain conditions may be imposed. Mechanical and thermal loads are permitted.
- 253 SAFE-SHELL** - SAFE-SHELL is used to design and analyze axisymmetric thin-shell structures of arbitrary generatrices under axisymmetric mechanical and/or thermal loading conditions. The intersection of two or more shells can be treated.
- 266 CYGRO2** - CYGRO2 is used to determine stresses and strains during steady-state and transient power operation of an oxide-fueled, metal-clad rod-type fuel element in a pressurized environment. Major loading conditions include fuel swelling, fission gas and coolant pressure, clad growth and differential thermal expansion. The application for which the program has been developed is zircaloy tubes containing bulk oxide fuel. Axial and azimuthal symmetry of temperature and stresses is assumed.
- 282 SEALSHL2(M0110)** - The SEALSHL2 program determines stresses, strains, deflections, and reactions in a thick shell of revolution with axisymmetric loading. The loading consists of a temperature distribution, inside and outside pressure distributions, and circumferential forces and moments applied to the middle surface. The shell is linear-elastic with tensile, bending, and shear strains.
- 283 M0552** - M0552 solves the transient response problem of linear elastic, lumped-mass systems subjected to a unidirectional foundation transient that can be either a velocity or acceleration transient. Normal mode theory is used and the input to the program consists of the mode shapes, frequencies, and foundation transient. Element effects are also evaluated as a function of time. Modal damping coefficients may be specified.
- 300 SAFE-CREEP** - SAFE-CREEP performs a viscoelastic analysis of plane or axisymmetric composite concrete structures with age- and temperature-dependent creep data.
- 329 M0457(PIPE)** - PIPE performs an elastic stress analysis of a 3-dimensional piping structure with thermal stresses, redundant loops, and concentrated loads.
- 332 SAFE-3D** - SAFE-3D is a finite-element program for the three-dimensional elastic analysis of heterogeneous composite structures. The program uses the following types of finite elements - (1) tetrahedral elements to represent the continuum, (2) triangular plane stress membrane elements to represent inner liner or outer case, and (3) uniaxial tension-compression elements to represent internal reinforcement. The structure can be of arbitrary geometry and have any distribution of material properties, temperatures, surface loadings, and boundary conditions.
- 337 STEM** - STEM calculates and punches out partially-coupled mass, stiffness, and internal load function matrices for a structural system of beams having prismatic segments. Shear deformation and rotational inertia are included in the calculations.
- 344 GEM** - GEM is intended primarily to perform vibration studies with the capability of generating input for the VEP (vibration eigenvalue problem) routine and performing additional operations on the output from the SHO (shock) segment. Given a system of masses and springs, the VEP routine computes the natural frequencies of the vibrating system as well as the mode shapes for each frequency. Given the mode shapes, frequencies, and masses of a vibrating system, the SHO routine will compute the deflections and forces at the mass points.

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- 378 TUBE** - TUBE solves for the stresses due to pressure and temperature in a U-tube type heat exchanger. Specifically, it handles a configuration consisting of a spherical head, primary transition cylinder, and secondary cylinder. The transition cylinders may be conical and tapered in thickness, but the remaining shells are of uniform thickness. The spherical head and the transition cylinders may be omitted from a problem.
- 379 SAFE-2D** - SAFE-2D performs the elastic stress analysis of general axisymmetric, plane, and combined axisymmetric and plane composite structures.
- 383 M0266** - M0266 computes the dynamic shock forces and modal frequencies acting on a lumped mass, linear elastic model of a structure subjected to shock spectrum inputs. The model employed is a collection of lumped masses connected by weightless flexible elements. If the original structure is not statically determinate, redundant forces must be introduced to ensure a primary structure that is.
- 391 SORSDB** - SORSDB was written to calculate the stress intensities and fatigue usage factors for pressure vessels (structural members) in accordance with the ASME Code, Nuclear Vessels, Section 3. The input requires the basic membrane and bending stresses generated by the SOR2 code (NESC Abstract 80) or any adaptable shell program. The output includes stress differences, stress intensities, and fatigue usage factors.
- 397 GAPL3** - GAPL3 determines the inelastic, large-deflection behavior of thin plates or axially symmetric shells with pressure loading and deflection restraints.
- 402 SABOR4** - SABOR4 is a discrete element displacement program for the linear-elastic, static, load-deflection analysis of meridionally-curved, variable-thickness, branched, thin shells of revolution which may be subjected to concentrated or distributed external loading and to isothermal or nonuniform temperature conditions. The program consists of five primary subprograms - HAL4, MELT4, LANCE4, MAINS4, and SUMPLOT4. Three of these (HAL4, MELT4, and LANCE4) process external-mechanical-load or thermal-load data to determine the generalized nodal forces for each discrete element. MAINS4 computes the discrete-element stiffness and mass matrices and forms these matrices for the assembled structure. SUMPLOT4 calculates the other quantities of interest, sums contributions from various loading harmonics, and prepares results for CalComp plotting.
- 404 FINEL** - FINEL is a collection of 3 programs for the calculation of the elastic and plastic behavior of structures. The structures are built up from plates and bars, which can be arranged in either 2-dimensional or 3-dimensional assemblies. The plates can be in plane stress or plane strain. FINEL2 handles 2-D structures only. FINEL3 can handle both 2- and 3-D structures, but is slower.
- 412 MANE1** - The MANE1 program finds the magnetic flux in each branch of a magnetic network consisting of a number of branches of iron and air. The problem is one step in the design of slow speed reluctance motors in which the magnetic flux is determined in all component parts for a position of the rotor with respect to the stator.
- 449 CYGRO3** - CYGRO3 is an extensive modification of CYGRO1 and CYGRO2 (NESC Abstract 266). Basically the program calculates temperatures, deformation, and stresses in clad fuel rods as a function of a history of power and coolant conditions. Axial and circumferential uniformity are assumed. Bubble growth and migration are included. The main changes from CYGRO1 and CYGRO2 are in the area of void migration, fuel cracking, clad collapse, representation of in-pile creep and clad anisotropy.
- 451 SAFE-CRACK** - SAFE-CRACK performs a visco-elastic analysis of plane and axisymmetric composite concrete structures subjected to transient temperature and mechanical loadings. The specific creep of concrete as an age and temperature-dependent function, and concrete failure under combined stresses are considered. Particular emphasis is placed on the cracking analysis in concrete structures and the nonlinear dependence of creep property on transient temperature.

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- 452 SHELL5** - SHELL5 performs an elastic stress analysis of smoothly curved, arbitrarily shaped, three-dimensional thin shells with any desired distributions of material properties, boundary constraints, and mechanical, thermal, and displacement loading conditions.
- 460 LIFE3** - The LIFE3 computer code was developed to calculate the thermal and mechanical response of mixed-oxide fuel elements in a fast-reactor environment. It incorporates a one-dimensional, steady-state heat-transfer analysis and a finite-strain-theory structural analysis based on generalized plane strain and the method of successive elastic solutions. An incremental approach is used so that temperatures, stresses, and strains can be calculated during any specified history of reactor power cycling. Fuel-cladding and sodium-cladding chemical attack is treated by a cladding wastage model. Up to six axial sections are allowed to account for axial variations in power and coolant temperature. Fuel restructuring; migration of fabricated and swelling porosities; fuel and cladding thermal expansion, elasticity, swelling, and creep; fission-gas release; and fuel cracking, crack healing, and hot pressing are included in the analysis. LIFE3 is the reference ERDA code for calculating the performance of fast breeder reactor fuel elements under normal operating conditions, including power cycling.
- 468 BUBL1** - BUBL1 predicts fuel swelling and fission gas release from nuclear fuels, based on movement of fission gas bubbles in solids by a surface diffusion mechanism under the action of a thermal gradient (see reference 3). Interactions of the bubbles with dislocations and grain boundaries provide temporary trapping sites, prior to release.
- 481 BUSHL** - BUSHL determines the load at which a finite-length shell of revolution will buckle when subjected to hydrostatic pressure, axial compression, or a combination of the two. Elastic-plastic material properties are used with deformation theory and thin-shell theory to analyze the shell. BUSHL was developed primarily for the buckling collapse analysis of zircaloy-clad oxide fuel rods.
- 503 DUZ2** - DUZ2 performs two-dimensional elastic-plastic stress calculations. The program treats axially symmetric bodies or plane regions (plane stress or plane strain) assuming deformation theory. Loading conditions may be a non-uniform temperature distribution, body forces, and boundary displacements or stresses.
- 537 MO678(FUGIT1)** - FUGIT1 performs a transient step analysis of an elastic structure mounted on a rigid base which has a given shock history of motion. The structure may have nonlinear constraints and damping.
- 539 STRAP** - The code STRAP (STRUCTURAL Analysis Package) was developed to analyze the response of structural systems to static and dynamic loading conditions. STRAP-S solves for the displacements and member forces of structural systems under static loads and temperature gradients. STRAP-D will solve numerically a given structural dynamics problem.
- 542 PSA2** - PSA2 computes the reactions and stresses caused by thermal expansion and loads in a multi-anchor piping system which may contain loops and may be partially restrained at any point in any direction.
- 568 BEHAVE2** - BEHAVE2 calculates the position in space of cladding, fuel, and voidage in an operating oxide fuel pin with unfailed cladding. Axial symmetry is assumed throughout the program. Also calculated are stress, strain, displacement, and temperature fields. Influential processes simulated include cracking of fuel, dilatation of fuel and cladding due to irradiation effects and thermal expansion, fuel densification by both stress- and diffusion-controlled processes, axial slippage or locking at the fuel-cladding interface and axial flow of fuel.
- 570 STRIPE(MO850)** - STRIPE examines the deformations imposed on the cladding of cylindrical fuel elements due to differential thermal expansions during abrupt power increases. The title is taken from stresses and cracking in pellets. The calculational model includes effects of pellet cracking, the constraint of system pressure and cladding, compressive plastic flow in the fuel and the temperature dependence of material properties.

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- 581 SLADE-D** - SLADE-D analyzes the transient dynamic response of elastic shells.
- 597 MATUS** - MATUS performs small-strain elastic analysis of three-dimensional solids.
- 598 PELEN** - PELEN solves a two-dimensional, axisymmetrical model of a fuel pellet and clad element for the temperature, stress, and deformation throughout a time history. In a general time increment, the computational sequence is - (1) a heat conduction analysis of both fuel and clad to determine the current temperature field which is dependent on the power rate, the material properties, and the geometrical configuration, (2) an incremental stress analysis of both fuel and clad to determine the current stress and deformation fields which are dependent on the inelastic strain increments (temperature, creep, volume expansion, etc.), the material properties, and the geometrical configuration, and (3) a contact analysis of both fuel and clad to determine the corrected current stress and deformation fields which are dependent on the extent of contact between adjacent fuel pellets and/or the fuel and clad.
- 604 TCB01** - A tube under external pressure, at elevated temperature, and initially out-of-round will creep, becoming more out-of-round and eventually will collapse. TCB01 attempts to predict the time of collapse.
- 611 CHILES** - CHILES is a finite element computer program that calculates the strength of singularities in linear elastic bodies. Plane stress, plane strain, and axisymmetric conditions are treated. Crack tip singularity problems are solved by this version of the code, but any type of integrable singularity may be properly modeled by modifying selected subroutines in the program.
- 618 GAPCON-THERMAL2** - GAPCON-THERMAL2 was developed as a tool for estimating fuel-cladding gap conductances and fuel stored energy. GAPCON-THERMAL2 makes nuclear fuel pin steady-state thermal performance predictions, using models which include power history, fission gas generation and release, fuel relocation and densification, and fuel cladding gap conductance. The gas release and relocation models can be used to make either best estimate or conservative predictions.
- 627 TOODY2** - TOODY2 is used to compute wave propagation in two dimensions in rectangular or cylindrical coordinates.
- 641 SAP4** - SAP4 is a structural analysis program for determining the static and dynamic response of linear systems. The structural systems to be analyzed may be composed of combinations of a number of different structural elements. Presently, the program contains the following element types -
- (a) three-dimensional truss element,
 - (b) three-dimensional beam element,
 - (c) plane stress and plane strain element,
 - (d) two-dimensional axisymmetric solid,
 - (e) three-dimensional solid,
 - (f) variable-number nodes thick shell and three-dimensional element,
 - (g) thin-plate or thin-shell element,
 - (h) boundary element, and
 - (i) pipe element (tangent and bend).
- 643 NUBOW** - NUBOW performs a two-dimensional elastic analysis of reactor core systems subjected to thermal and/or mechanical bowing. Reactor assemblies are considered to be elastic beam members which may have variable geometry. Equilibrium forces and positions are calculated along with the shapes of individual rows. Clearance and local flexibility are allowed at all contacts.
- 648 LUGS** - LUGS calculates stresses, stress indices, and flexibility factors for a rectangular attachment on a cylindrical shell.

I. DEFORMATION AND STRESS DISTRIBUTION COMPUTATIONS, STRUCTURAL ANALYSIS, AND ENGINEERING DESIGN STUDIES

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- 650 ELBOW-ORNL** - ELBOW-ORNL calculates the stresses, stress indices, and flexibility factors for in-plane and out-of-plane bending of elbows and curved pipe subjected to internal pressure. Comparison with experiments indicates that the results accurately represent the maximum stresses which occur at the center of the bend.
- 657 LINDA** - LINDA implements a diagnostic procedure which depends upon the hypothesis that strain measurements obtained from a linear elastic structural test should be proportional to the applied loads. Nonlinearities in the data from such a test are expected to arise from errors in measuring or recording either the strains or the loads. The diagnostic procedure provides a means to identify and distinguish between the two types of errors.
- 667 BUCKLE** - BUCKLE is a one-dimensional computer code compiled to calculate the change in ovality, of an initially oval, closed-end finite length tube, as a function of time, temperature, neutron flux and uniform external pressure. The basic concept employed in BUCKLE is that a tube, which is slightly out-of-round, tends to become more out-of-round with time when subjected to net uniform external pressure. The timewise change in ovality occurs as a consequence of creep deformations arising from tangential compressive and tangential bending stresses produced by uniform external pressures acting on an initially oval tube.
- 672 HONDO** - HONDO is used to compute the time-dependent displacements, velocities, accelerations, and stresses within elastic or inelastic, two-dimensional or axisymmetric bodies of arbitrary shapes and materials.
- 682 GNATS/MESH2/GPRINT** - GNATS is a finite element computer program designed for nonlinear analysis of axisymmetric and two-dimensional static structures.
- 689 FLANGE-ORNL** - FLANGE-ORNL calculates appropriate loads, stresses, and displacements for the flanges, bolts, and gaskets that comprise a flanged piping joint for internal pressure or moment loading on the pipe, temperature difference between the flange hub and ring, and variations in bolt load that result from pressure, hub-ring temperature gradient and/or bolt-ring temperature differences. Flanges considered may be tapered-hub, straight or blind.
- 701 BEAMCRP** - BEAMCRP is a finite-element computer program which solves for stresses and total strains (elastic plus creep) in beams. The beams may have variable cross sections along the length (x-direction). However, the cross sections must be symmetrical about the y-axis. Besides prescribed displacements and tractions, the boundary conditions may also include limited free travel and elastic spring supports. Time-dependent variations in applied loads, thermal gradients and material swelling can also be analyzed. Arbitrary creep and material swelling laws can be used.
- 707 CREEP-PLAST** - CREEP-PLAST is a two-dimensional finite-element program for creep and plasticity analysis of metal structures operating at high temperature. The technique employed considers instantaneous time-independent elastic-plastic and time-dependent creep simultaneously in an incremental procedure which requires the user to select his own discrete time and/or load increments. The method of calculation is based on the assumption that the total strain at any instant consists of elastic, plastic, and creep parts with essentially no interdependence between the plastic and creep components. CREEP-PLAST is capable of predicting deformations, stresses, and total accumulated strains as functions of time and/or load for user-specified thermal and mechanical loadings which can be varied independently. The program can be used to analyze plane or axisymmetric structures.
- Two postprocessor graphics programs use plot output files from CREEP-PLAST to display the time and/or mechanical load histories of nodal displacement, stress, strain, and temperature (HISTORY-PLOT) or contour lines of whole field deformations and stress, strain, or temperature (CONTOUR-PLOT).
- 715 IMPAC2** - IMPAC2 solves the equations of motion for a one-dimensional, lumped-mass, nonlinear spring mathematical container model. The program was designed to analyze the dynamic response of metallic shipping containers impacting an unyielding surface. The container may consist of several hollow concentric cylinders, each of a different material and length.

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- 735 PIRAX2** - PIRAX2 estimates displacements, stresses, and strains for spatially three-dimensional piping systems subjected to elastic-plastic-creep behavior.
- 740 PLACRE** - PLACRE is a two-dimensional (plane stress or axisymmetric) elastic-plastic-creep finite element structural analysis program. It has been adapted to analyze one-dimensional pipe-wall problems in which the stress, strain, and temperature depend only on radius. In addition to structural analysis capabilities, PLACRE has facilities for carrying out simultaneous transient thermal analysis for pipe-wall problems.
- 750 CURT2** - CURT2 is a computer code that calculates stresses and displacements in a shell structure made up of curved or straight cylindrical segments such as those in a piping system. Loadings considered are internal pressure and/or arbitrary end loadings that may be distributed symmetrically or nonsymmetrically around the circumference.
- 759 CORTES** - CORTES is a package consisting of five finite element programs developed for the stress analysis of ANSI B16.9 tee joints. The five programs are:
SA, the stress analysis program which analyzes pipe joints for the effects of internal pressure and arbitrary combinations of bending moment, torsional moment, axial force, and shear force on the ends of the branch and run pipes. A limited temperature stress analysis capability is provided.
EP, the elasto-plastic stress analysis program which analyzes pipe joints for the effects of internal pressure and arbitrary combinations of forces (including moments) and/or displacements (including rotations) imposed on the ends of the run and branch pipes.
THFA, the transient heat flow analysis program which determines the time history of temperature variations in the pipe joints. The joint is assumed initially to be at a uniform temperature. Temperature changes are then specified at the inner surface, and a heat flow analysis is performed assuming a perfectly insulated outer surface.
SHFA, the steady-state heat flow analysis program which determines the steady-state temperature distribution in pipe joints. Temperatures are specified on given cross-sections of the branch and run portions of the tee joint, and the temperature distribution throughout the remainder of the joint is calculated assuming the inner and outer surfaces are perfectly insulated.
TSA, accepts as input, the output data from THFA or SHFA and performs the thermal stress analysis on the pipe joints.
- 770 GAPCON-THERMAL3** - GAPCON-THERMAL3 calculates the thermal and mechanical behavior of the fuel and cladding in a nuclear fuel rod during normal operation for both steady-state and operational transients.
- 785 AXICRP** - AXICRP is a finite-element computer code for creep analysis of plane stress, plane strain, and axisymmetric bodies of revolution. Principal application has been to obtain the creep solution for a Fast Flux Test Facility (FFTF) hexagonal flow duct. Other applications to a thick-walled cylinder and a rectangular beam demonstrate the variety of structural geometries which can be analyzed.
- 790 NUBOW-2D Inelastic** - This program solves the two-dimensional mechanical equilibrium configuration of a core restraint system, which is subjected to radial temperature and flux gradients, on a time increment basis. At each time increment, the code calculates the irradiation creep and swelling strains for each duct from user-specified creep and swelling correlations. Using the calculated thermal bowing, inelastic bowing and the duct dilation, the corresponding equilibrium forces, beam deflections, total beam displacements, and structural reactivity changes are calculated.
- 795 SHOCK** - SHOCK calculates the dynamic response of a structure modeled as a spring-mass system having one or two degrees of freedom for each mass when subjected to specified environments. The code determines the behavior of each lumped mass (displacement, velocity, and acceleration for each degree of freedom) and the behavior of each spring or coupling (force, shear, moment, and displacement) as a function of time. Two types of models, axial, having one degree of freedom, and lateral, having two degrees of freedom at each mass can be processed. Damping can be included in all models and shock spectrums of responses can be obtained.

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810 CREEP-PLAST2 - CREEP-PLAST2 is a special-purpose two-dimensional inelastic structural analysis program based on an incremental finite-element method. It is applicable to static and quasi-static loadings of plane structures (in-plane loadings, plane-stress conditions) and axisymmetric structures (axisymmetric loadings). The loadings can consist of combinations of applied forces, pressures, displacements, and/or temperatures. Cyclic as well as monotonic loadings can be treated, and loadings can be proportional or nonproportional. The structure can be composed of up to three different materials; each should be adequately represented by the thermoelastic-plastic-creep constitutive equation forms recommended for austenitic stainless steel in U.S. DOE RDT Standard F9-5T, (September 1974).

Two postprocessor graphics programs use plot output files from CREEP-PLAST2 to display the time and/or mechanical load histories of nodal displacement, stress, strain, and temperature (HISTORY-PLOT) and contour lines of whole field deformations and stress, strain or temperature (CONTOUR-PLOT).

817 COVE1 - COVE1 is a time-dependent incremental creep collapse code that estimates the change in ovality of a fuel pin cladding tube. Application is intended primarily for tubes manufactured from zircaloy. Therefore, provision is made for the effects of anisotropy in the Prandtl-Reuss flow equations for inelastic incremental deformations by using the P and R strain ratio coefficients. The creep deformation is computed in terms of the length of the collapse zone and includes the effects of changes in temperatures, system pressure, fill gas pressure, and neutron flux levels.

- 259 MUSCAT** - MUSCAT computes the incident scattered neutron currents as a function of position within (1) the cavity formed by two truncated concentric spheres, (2) the cavity between two concentric circular cylinders, or (3) a cylindrical cavity.
- 343 M0756(LETO)** - LETO will solve the gamma ray transport and energy deposition problem in one-dimensional laminar slab geometry. The energy group scheme is employed to account for photon energy degradation. An arbitrary external spatial isotropic source may be specified with an arbitrary energy spectrum. The boundary conditions may be (a) free boundaries with arbitrary incident, (b) symmetry on the left arbitrary incident on the right, and (c) symmetry on both ends.
- 429 ASPIS** - ASPIS computes the energy, dose and energy deposition buildup factors for monoenergetic gamma rays for a plane isotropic, plane monodirectional, or plane slant source, in an arbitrary laminar array.
- 462 SPAN4** - SPAN4 calculates the fast neutron dose rate, thermal neutron flux, gamma-ray flux, dose rate, and energy-absorption rate in rectangular, cylindrical, and spherical geometries by integrating appropriate exponential kernels over a source distribution. The shield configuration is flexible—a first-level shield mesh, using any one of the three geometries, is specified. Regions of this same geometry or of other geometries, having their own (finer) meshes, may then be embedded between the first-level mesh lines, defining second-level shield meshes. This process is telescopic—third-level shield meshes may be embedded between second-level meshlines in turn. All meshes may have variable spacing. Sources and detectors may be located arbitrarily with respect to any shield mesh. The source is defined by the function:
- $$s=s_0+s_1(a)\cdot s_2(b)\cdot s_3(c)+s_4(a,b)\cdot s_3(c)+s_5(a,c)\cdot s_2(b)+s_6(b,c)\cdot s_1(a)+s_7(a,b,c)$$
- where a, b, and c represent coordinates. If any factor is missing, the corresponding terms are zero. Cross sections, buildup factors, standard compositions, energy structures, dose-conversion factors, infinite line and infinite plane source kernels, and quadratures are contained in a library of approximately 10,000 items.
- 569 VIEWPIN** - The program calculates view factors for cylindrical pins whenever the problem can be represented two-dimensionally.
- 754 DEMONR** - DEMONR treats the behavior of neutrons in a slab shield. It is frequently used as a teaching tool.

273 THREDES - THREDES is a scientific applications programming system. Incorporated in this system are the necessary modules to perform parametric design studies of thermal reactors including the thermal cell homogenization (BAM), the fast spectrum calculation (FORM - NESC Abstract 51), reactor diffusion theory (FOG - NESC Abstract 28), and zero-dimensional burnup (KINDLE) calculations. These modules can be used in conjunction with one another or individually.

387 CITATION - CITATION is designed to solve problems involving the finite-difference representation of diffusion theory treating up to three space dimensions with arbitrary group-to-group scattering. X-y-z, theta-r-z, hexagonal-z, and triangular-z geometries may be treated. Depletion problems may be solved and fuel managed for multi-cycle analysis. Extensive first-order perturbation results may be obtained, given microscopic data and nuclide concentrations. Statics problems may be solved and perturbation results obtained with microscopic data.

676 DEMO4 - DEMO4 is a simulation model used to generate thermal-hydraulic transients for the Clinch River LMFBR demonstration plant. The three heat transport loops of the plant are simulated by a two-loop model. One loop, the L-loop, represents two of the actual plant loops, and the second loop, the S-loop, represents a single plant loop.

Thermal power is generated by point neutron kinetics and decay heat tables. The vessel internals are represented by a lower plenum, lower axial blanket, active core, upper axial blanket, radial blanket, bypass channel and an upper plenum with a variable sodium level and a cover gas. Plenum stratification on reduced flow can be modelled. The heated sodium leaves the vessel upper plenum to the primary heat transport system and returns to the vessel lower plenum. The overflow nozzle of the sodium purification system effects the vessel upper plenum level, as well as a user-input return flow from this system.

Each primary heat transport system is represented by piping, valves, the primary pump tank with a free surface and cover gas, and the shell side of the IHX. Each intermediate heat transport system is represented by piping, the tube side of the IHX, the shell side of the superheater and evaporator, and the intermediate pump.

Each water-steam system is represented by piping, recirculation pumps, the tube side of the superheater and evaporator, and a steam drum. The steam leaving all superheaters enters a common steam header, flows through piping to the turbine throttle valve and a steam dump valve. Limited modelling is provided for the feedwater system.

743 PARK1 - PARK1 is a computational tool for the analysis of the interrelated thermal, hydraulic, and nuclear characteristics of a pressurized water nuclear reactor plant under a variety of steady-state and transient conditions. The program will simulate the overall plant dynamic response to changes in plant conditions such as turbine load, motion of control rods, and main coolant pump switching. Specific transients might include plant maneuvers, loss of load, complete or sequential loss of primary coolant flow, cold water accidents, and startup or power range rod withdrawal accidents. Under more general classes of plant transients, PARK1 can simulate reactor protection performance or anticipated transients without scram (ATWS). PARK1 also provides forcing functions for more detailed studies of isolated system components such as hot channels, steam generators, and pressurizers. The features of PARK1 include a steady-state (initial condition) calculation, flexible reactor core configuration to permit 1, 1-1/2, or 2 pass cores with multiple channel regions per pass, separable space-time reactor kinetics including the effects of decay heat, coolant within-core leakage, up to four primary coolant loops, response of reactor plant control systems such as reactor protection and steam generator feedwater control, and graphical display of transient plant variables.

784 DSNP - DSNP (Dynamic Simulator for Nuclear Power-Plants) is a system of programs and data files by which a nuclear power plant, or part thereof, can be simulated. The acronym DSNP is used interchangeably for the DSNP language, the DSNP libraries, the DSNP precompiler, and the DSNP document generator.

The DSNP language is a special-purpose, block-oriented digital-simulation language developed to facilitate the preparation of dynamic simulations of a large variety of nuclear power plants. It is a user-oriented language that permits the user to prepare simulation programs directly from power plant block diagrams and flow charts by recognizing the symbolic DSNP statements for the appropriate physical components and listing these

statements in a logical sequence according to the flow of physical properties in the simulated power plant.

Physical components of nuclear power plants are represented by functional blocks, or modules. Many of the more complex components are represented by several modules. The nuclear reactor, for example, has a kinetic module, a power distribution module, a feedback module, a thermodynamic module, a hydraulic module, and a radioactive heat decay module. These modules are stored in DSNP libraries in the form of a DSNP subroutine or function, a block of statements, a macro, or a combination of the above. Basic functional blocks such as integrators, pipes, function generators, connectors, and many auxiliary functions representing properties of materials used in nuclear power plants are also available.

The DSNP precompiler analyzes the DSNP simulation program, performs the appropriate translations, inserts the requested modules from the library, links these modules together, searches necessary data files, and produces a simulation program in FORTRAN. FORTRAN is considered to be a subset of DSNP and can be inserted anywhere in the simulation program without restriction. I/O statements can be located anywhere in the program in arbitrary sequence. No formatting is required and the listed variables are printed at user-defined intervals in an easy-to-read tabular form.

L. DATA PREPARATION

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- 296 GRDWRK** - GRDWRK generates as punched output the basic finite element reference grid work for the SAFE codes. This generated grid consists of triangular elements and nodes, uniaxial elements, such as reinforcement bars, tendons, and anchors, and biaxial membranes, such as any thin shell or liner. The punched output serves as direct input data to the SAFE codes.
- 345 GAND** - GAND prepares the cross sections needed for detailed computations of neutron energy spectra in fast reactors from a file of basic nuclear data in the ENDF/B format.
- 373 BL47** - BL47 is a plotting routine designed for plane structures that are to undergo stress analysis. Points and lines are input in various parametric forms, and curved segments are drawn between given points along the given lines. The program may be used as a drafting tool to construct engineering drawings. BL47 uses three points on a straight line segment to obtain dimensions for SEALSHELL2 (NESC Abstract 282) input data.
- 406 DATATRAN2 RAD1 Geometry Modules** - This series of DATATRAN modules is designed to provide the computerized two-dimensional geometry descriptions required for engineering and nuclear design computations. The modules communicate via DATATRAN N-dot datasets, and the user must link the appropriate modules to perform a specific task. Modules are designed to accept as input data transcribed from engineering drawings, to plot, check, and edit the generated geometric data, and to calculate moments of inertia and area intersections.
- 530 GENRD** - GENRD will read and process free-format numeric and Hollerith input data from cards.
- 533 ARC-NUI002 BCD Input Processor** - The module ARC(NUI002) processes general neutronics input data sets for subsequent use by the neutronics-computational modules of the Argonne Reactor Computation (ARC) System.
- 594 ARC-XSEC1** - ARC-XSEC1 provides the capability of manipulating multigroup microscopic cross section data in the XS.ISO format to affect modifications of the isotopic cross section components, to collapse the energy group structure to fewer groups, and to homogenize mixtures into material and composition level data for use by the neutronics modules of the Argonne Reactor Computation (ARC) System.
- 612 QMESH/RENUM** - QMESH generates meshes having quadrilateral elements on arbitrarily shaped two-dimensional (planar or axisymmetric) bodies. The main intended application is in finite element analysis. A flexible hierarchical input scheme is used to describe bodies to QMESH as collections of regions. A mesh for each region is developed independently, with the final assembly and bandwidth minimization performed by the separate program, RENUM.
- 746 EURCYL1** - EURCYL1 produces a finite-element model of a cylinder-cylinder intersection for any of a number of general-purpose, thermal-structural computer programs including ANSYS, MARC, MATUS (NESC Abstract 597), and WECAN. The mesh is created using three-dimensional solid elements. Node and element descriptions are generated in punched card or data file format.

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- 271 CLIP** - CLIP is the cross section library preparation and maintenance program for FORM and THREDES.
- 375 SCORE3** - SCORE3 is an interactive neutron cross section evaluation system.
- 384 CHECKER/CRECT/DAMMET/PLOTFB/** - This package of five programs is designed for processing ENDF/B (Evaluated Nuclear Data File Version B) Version I tapes.
CHECKER checks that the ENDF/B tapes are in proper format and all fields are within specified limits, rather than the physics of the data library. Angular distributions reconstructed from Legendre coefficients are everywhere positive.
CRECT, which can process ENDF/B Version III data as well as earlier versions, provides a means of correcting assembled data on a tape by insertion and deletion of data.
DAMMET selectively merges data from one or two ENDF/B library tapes onto a final tape. The mode (BCD or binary) and arrangement (standard or alternate) may be changed during this process.
PLOTFB processes ENDF/B library tapes which contain data embedded within a necessary library structure in order to produce comprehensive listings and/or plots. The listings and/or plots contain an extensive amount of information related to the data, such as temperature dependence, physical units of the data, interpolation laws for the data, cryptic titles defining the reaction type, etc.
SLAVE3 provides modular subroutines which can be assembled to retrieve and process ENDF/B data for a specific problem.
- 386 DATATRAN2** - DATATRAN2 is a data base management system for a scientific and engineering modular program environment. DATATRAN consists of a set of extensions to the FORTRAN language designed to simplify the development, interconnection and use of large computer programs in a scientific and engineering environment. It allows users to easily connect a series of functional program units (modules) to perform a specific task.
- 403 TIGIR2** - TIGIR2 is a modular program designed to generate and maintain libraries of document information (abstracts, bibliographic information, index terms, and other significant information), to retrieve the information selectively, to print the retrieved information in various output formats, and to generate statistics of the information files.
- 475 CRECT/CHECKER/RIGEL/PLOTFB/** - This package of eight programs is designed for processing ENDF/B II (Evaluated Nuclear Data File Version B Format II) tapes.
CRECT, which processes Version III ENDF/B data as well as earlier versions, provides a means of correcting assembled data on a tape by insertion and deletion of data.
CHECKER checks that the ENDF/B BCD card image format tapes are in proper format and all fields are within specified limits, rather than the physics of the data library. Angular distributions reconstructed from Legendre coefficients are checked to ensure they are everywhere positive.
RIGEL will perform any or all of the following operations - selectively retrieve ENDF/B data on from 1 to 9 ENDF/B tapes, merge retrieved ENDF/B data onto from 1 to 8 ENDF/B result tapes, change tape arrangement (from standard to alternate or vice versa) and change tape mode.
LISTFC, which processes Version III ENDF/B data as well as earlier versions, produces interpreted listings of information from BCD standard arrangement ENDF/B tapes.
DICTION constructs a new section dictionary (file 1, section 451) for an entire ENDF/B tape. If a section dictionary is already present it is replaced.
PLOTFB processes ENDF/B library tapes which contain data embedded within a necessary library structure in order to produce comprehensive listings and/or plots. The listings and/or plots contain an extensive amount of information related to the data, such as temperature dependence, physical units of the data, interpolation laws for the data, cryptic titles defining the reaction type, etc.
SLAVE3 provides modular subroutines which can be assembled to retrieve and process ENDF/B data for a specific problem.
DAMMET selectively merges data from one or two ENDF/B library tapes onto a final tape. The mode (BCD or binary) and arrangement (standard or alternate) may be changed during this process.

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- 493 TROUT** - TROUT is a file maintenance program which allows the user to alter, merge, delete, overlay or create multigroup cross section files in MUG format.
- 502 EDITOR** - EDITOR produces readable listings of the contents of ENDF/B nuclear data cross section tapes. It also allows copying, altering mode, merging and punching of the data on one or more ENDF/B tapes.
- 522 ARC-SYSTEM** - ARC-SYSTEM is the collection of systems subprograms and modules which provide the software environment necessary to execute the modular computational capabilities of the Argonne Reactor Computation (ARC) System on IBM360 systems.
- 557 SHLOG** - SHLOG provides general-purpose data manipulation functions for data analysis. These functions include creating, maintaining, and storing files, displaying the contents of a file via either the line printer or an on-line plotter, searching for data points by comparing values with specified criteria, and performing certain statistical operations on the data points.
- 571 CHECK3/RIGEL3** - These programs are used to process ENDF/B Version III data. In addition, the CDC6600 programs will process ENDF/B Version IV data. CHECK3 checks that the ENDF/B tapes are in proper format and all fields are within specified limits, rather than the physics of the data library. Angular distributions reconstructed from Legendre coefficients are everywhere positive. RIGEL3 will perform any or all of the following operations - selectively retrieve ENDF/B data on from 1 to 9 ENDF/B tapes, merge retrieved ENDF/B data onto from 1 to 8 ENDF/B result tapes, change tape arrangement (from standard to alternate or vice-versa) and change tape mode.
- 587 AEC-ALO FAU** - The AEC-ALO Radio Frequency Assignments and Uses program (FAU) provides for maintaining radio frequency assignment and transaction records. It lists all radio frequency assignments and uses from initial application (AEC-310) through authorizations (IRAC docket). The program allows for sorting by office, system number, location, frequency, expiration date, ALO or AEC serial number, and IRAC docket number.
- 589 BECOM** - AEC regulations require that a purchase vs. lease analysis be made on each piece of data processing equipment as part of the study preceding the lease or purchase of such equipment. In addition, it is required that a purchase vs. lease analysis be prepared annually for each item of data processing equipment leased with AEC funds. BECOM was developed to facilitate the rapid and accurate preparation of an AEC purchase vs. lease schedule for an item of data processing equipment.
- 595 MAPPER** - MAPPER is a computer program for predicting equipment requirements. It was designed as an aid to management and can interpret component production requirements backward from shipping schedules to the process of interest, calculate equipment capacity, display six months prior equipment utilization and process yield data.
- 603 RALCRTPH** - RALCRTPH is a resource allocation system used to provide the project planner with a tool to help him schedule resources involved in a project. Information on which jobs are critical and the resources available is necessary for project scheduling. This system is oriented toward the user who is planning a plant shutdown. However, it also has applications in other areas.
- 607 SPIRAL** - The general ability of SPIRAL is building, perhaps gradually, a machine-readable encyclopedia of information items that are or may become important to a particular project, and then later, recalling bits of information as required. The information content of a collection can range from cryptic comments (as occur in some test and inspection records) to more lengthy entries (such as technical abstracts and management briefs) as well as full text of documents.
- 638 RIGEL4/CHECK4/SUMUP4/LISTF4** - These programs are updated versions of ENDF/B checking, retrieval, and display codes capable of processing the Version-IV data files. RIGEL4 retrieves ENDF/B data and changes mode (BCD-BIN) or arrangement. Updated version processes decay data (mf=1, mt=457) and error files.

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CHECK4 checks the structure, consistency, and formats of ENDF data files. Updated version recognizes newly defined mt and mf numbers, checks mt=457 and the formats of the error files, contains RSIC photon file changes.

SUMUP4 checks whether partial cross sections add up to the total. Updated version flags grid points present in the partial cross section, absent in the total.

LISTF4 produces interpreted listings of ENDF/B data. Updated version lists mt=457, skips over error files, contains minor corrections.

PLOTF4 produces plots of ENDF/B data. Updated version plots mt=457, skips over error files, contains minor corrections.

RESEND processes ENDF materials with resonance parameters into a pointwise form. Capability of processing Adler-Adler parameters added.

CRECT corrects ENDF/B data files.

DICT4 generates a section table of contents (dictionary) for ENDF/B materials.

CAREN4 tests for discontinuities across the limits of resonance ranges of an ENDF/B material. Updated version contains minor corrections.

660 JOURNAL CONTROL SYSTEM - The JOURNAL CONTROL SYSTEM is a series of programs designed to handle all journal ordering for the three Union Carbide installations in Oak Ridge - ORNL, Y-12, and ORG-DP. This series of programs provides:

- (1) management information in the form of cost, subscriber, and title statistics,
- (2) seven-copy purchase requisitions, and
- (3) claim letters to vendors relating to missing issues.

In addition, computer check-in, notification of binding, and recording of journal arrival is supplied for the ORNL library operation.

679 RANDOM SAMPLING TABLE(RND424RQ) - This program is designed to generate a uniformly random sequence of numbers for ordering laboratory test samples to eliminate any bias from the testing.

691 LASIP3 - LASIP3 processes Version III standard interface data files specified by the Reactor Physics Committee on Computer Code Coordination (CCCC). This processor performs two distinct tasks: namely, transforming free-field format, BCD data, into well-defined binary files and providing for printing and punching data in the binary files.

695 NMMSS - Three basic programs in the Nuclear Materials Management and Safeguards System (NMMSS) for processing incoming transaction data and maintaining the current transaction data file are: TJEDIT, TJUPDT, and COMPAT. TJEDIT prepares, verifies, and maintains the integrity of data as it is introduced into the data base. TJUPDT maintains the current transaction data file on a daily basis. COMPAT maintains consistency between related data sets on the transaction data master file.

801 SKILLS INVENTORY - The personnel SKILLS INVENTORY system consists of the three programs SKILLS, SKLFORM, and SEARCH. Each program is run independently of the others. SKILLS is designed to add, change, and delete personal data; build, search and/or print one master record for each employee entered into the system, whether active or terminated; delete an employee's entire master record; insert indicative comments when required; and perform a general check against an employee personnel card deck to ensure compatibility of data. Using skills search parameter cards, SEARCH can perform a complex variety and combination of searches, including a reverse search, and print various listings on a selective basis. Listing information includes educational degrees, professional licenses, professional society memberships, education, and employment status. SKLFORM converts employees' coded data into readable English language and prints their entire record.

813 GLOVE CHANGE ANALYSIS SYSTEM - The system uses the Glovebox Glove Data Base for analysis of the frequency, nature, and probable cause of glovebox glove failures, and for tracking and scheduling routine preventive-maintenance changes. The system provides edits of weekly data input, monthly summary of change activity and gloves scheduled to be changed, plus a maintenance-type program to annually remove old data from the active files. File retrieval language is then used to perform non-routine statistical analyses on any combination of data elements.

N. SUBSIDIARY CALCULATIONS

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- 409 **LARCA** - Multigroup cross sections are weighted by the flux in the appropriate groups and regions, and cross sections for the assembly are computed and punched in DTF4 format. The program also computes the infinite medium flux, reaction rates, and the infinite multiplication factor and material buckling.
- 434 **HEATMESH** - HEATMESH is used to generate geometrical data required for studies of heat transfer in axisymmetric structures represented as surfaces of revolution. The program consists of two distinct phases. The first subdivides the given parts into a nodal network and evaluates the geometrical properties of the nodes. The second determines adjacent nodes and edits geometrical data for the thermal model.
- 455 **DAC1** - DAC1 uses angular fluxes from the DTF4 SN code to calculate reactivity perturbations, effective delayed neutron fractions, and generation times in reactors. The reference reactor specifications are input to DAC1 by a direct reading of the DTF4 input deck. Consequently, the only additional input needed are the perturbation specifications.
- 471 **GAPER2D** - GAPER2D is a two-dimensional transport perturbation theory program using the real and adjoint fluxes and currents from 2DF (NESC Abstract 173) problem results to compute reactivity changes due to small perturbations in reflected multiregion systems.
- 544 **PLOT-3D** - PLOT-3D is a package of subprograms designed to draw three-dimensional surfaces from arrays of points (x,y,z). The surfaces can be drawn after arbitrary rotations about the three coordinate axes.
- 760 **GRFPAK** - GRFPAK is a graphics package written for the CORTES finite-element programs. It includes three plotting routines to assist in analyzing, interpreting, and presenting CORTES results. One plotting routine displays stresses or stress indices by means of contour curves drawn within either the outside or inside surface outline of a quarter section of the tee-joint. Using this routine, one can also obtain plots of the finite-element mesh as viewed from any point in space. A second plotting routine gives a stress versus distance plot along any specified line of nodes. A third routine displays cross-sectional views of the finite-element mesh for both the undeformed (original) and deformed configuration. The deformed configurations are drawn using an exaggerated scale specified by the user.
- 765 **ZONE** - The ZONE program is a finite element mesh generator which produces the nodes and element description of any two-dimensional geometry. The geometry is divided into a mesh of quadrilateral and triangular zones defined by node points taken in a counter-clockwise sequence. The zones are arranged sequentially in an ordered march through the geometry. The order can be chosen so that the minimum bandwidth is obtained. The mesh that is generated can be used as input to any two-dimensional as well as any axisymmetrical structure program.
- 773 **PRPLOT** - PRPLOT is a line printer graphics subroutine package that maintains compatibility with the CalComp incremental pen plotter software. Calls to PLOT, PLOTS, FACTOR, WHERE, SYMBOL, NUMBER, SCALE, LINE, and AXIS are supported and a dummy NEWPEN subroutine is included. When a large plot size is selected, the plot is generated in page-wide strips to be separated and assembled as the complete plot.

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- 258 EXPN** - EXPN analyzes pulsed neutron data using the Garelis-Russel technique (reference 1). Basically the code computes the prompt decay constant, alpha, and the parameter $(k\text{-beta}/l)$ from experimental data, which is directly extracted from a time analyzer storage memory and read onto a punched paper tape. The alpha-determination part of the code was originally obtained under the name EXPLICIT from Knolls Atomic Power Laboratory but has since been modified. The code provides options for a pre-burst or a post-burst background analysis. That is, the parameters alpha and $(k\text{-beta}/l)$ are obtained using a background measured prior to the burst or measured after the burst.
- 311 BURNUP** - BURNUP correlates heavy element isotopic analysis with fission product neodymium, uranium, and plutonium concentrations in an irradiated uranium fuel for calculation of burnup (atom per cent fission and MWD/MT). Reactor parameters, including effective neutron absorption cross sections for all uranium and plutonium isotopes, capture-to-fission ratios for U235, Pu239, and Pu241, a two-group description of the neutron spectrum, the average neutron temperature, the reactor fast fission factor, and the distribution of the sources of fission among the fissionable nuclides are computed from the experimental data obtained from the mass spectrometric analysis of uranium, plutonium, and neodymium.
- 333 TOAD** - TOAD is used to process and analyze gamma ray spectra.
- 390 CORGAM** - A correlation algorithm is coded to allow the unfolding of complex gamma-ray spectra typically collected in a neutron activation analysis procedure. CORGAM (1) will compensate for electronic shifts in the data, (2) will correct for background, (3) will normalize the data to a fixed neutron flux level, (4) allows a choice of weighting factors, and (5) allows a choice of methods for calculation of standard deviations. The code requires a matrix of reference gamma-ray spectra. These spectra can be in raw-data form. All of the modifications available to the complex gamma-ray spectra are available to the reference gamma-ray spectra. In addition, a decay correction is available for the reference gamma-ray spectra. Only the reference gamma-ray spectra that have intensity coefficients which are significant at a prescribed level of significance are retained in the final solution. The intermediate solutions, i.e., those solutions that contain reference gamma-ray spectra which have nonsignificant intensity coefficients at the prescribed level, are printed out. Therefore, several solutions are imbedded in the final solution.
- 394 JITER** - JITER computes the following quantities measured in reactor fluctuation experiments - the dispersion parameter γ , the modified coefficient of correlation MCC, the frequency dependent part of the power spectral density PSD, and the cross power spectral density CPSD.
- 413 ALPHA-M** - ALPHA-M is used for determining radioisotopes by least-squares resolution of the gamma ray spectra. It can handle a very large library of gamma ray spectra and takes into account corrections such as background subtraction, counting time, decay time, dead time, automatic compensation for gain and threshold shifts, size of the aliquot, volume reduction prior to counting, and so on.
- 421 MICHRD** - The Vickers pyramid number and the microhardness increment fraction are computed from filar micrometer eyepiece readings. These readings are made on indents, which have been made by an indenter, in the material being tested.
- 425 REDUX** - REDUX is used for the reduction of data from reactor fluctuation experiments. From input count samples recorded by one or two counting channels, the program computes unbiased sample estimates of moments and functions of moments of the count distributions, including the dispersion parameter γ and the modified coefficient of correlation MCC. Standard error estimates are computed for γ and MCC.
- 457 GSSLN1B** - GSSLN1B is utilized for evaluations and statistical determination of photopeaks in photon spectra. The code performs evaluations of photopeak spectra using as input the digitized, pulse-height distribution which is output from a large multichannel analyzer. Photopeaks are located, functions fit to each real peak, and the relative intensity of each fitted peak above the background continuum is calculated. The code is

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easily adaptable for analysis of any spectra which can be adequately defined by peaks represented in analytic form.

- 464 **DYN01** - DYN01 calculates the distribution of electrons that are emitted from a photomultiplier composed of a series of dynodes.
- 469 **PMS1** - PMS1 corrects experimental fast neutron polarization data for finite geometry and multiple scattering effects, when liquid helium is the polarizer analyzer.
- 476 **CAGE/BIRD/SPEC** - CAGE/BIRD/SPEC is a package of three independent codes designed for the reduction and processing of neutron time-of-flight spectra in pulsed multiplying or non-multiplying assemblies.
- 485 **GASSPAN** - GASSPAN analyzes output pulses from a lithium-drifted germanium semiconductor detector to define complex gamma-ray spectra of routine crud and filtrate samples.

- 43 **CURFIT** - CURFIT is a composite program for fitting experimental data points with different types of common analytic curves. There are at present five fits available:
- (1) polynomial $y = \text{summation over } i \text{ of } a(i) \cdot (x^{**}(i))$
 - (2) exponential $y = a \cdot \exp(bx)$
 - (3) cosine $y = a \cdot \cos(b(x+c))$
 - (4) series of cubics $y = a(j) + b(j) \cdot x + c(j) \cdot (x^{**}2) + d(j) \cdot (x^{**}3)$
 - (5) Fourier series
- 321 **EXPALS** - This program fits by least squares a function which is a linear combination of real exponential decay functions. The function is
- $$y(k) = \text{summation over } j \text{ of } a(j) \cdot \exp(-\text{lambda}(j) \cdot k).$$
- Values of the independent variable (k) and the dependent variable y(k) are specified as input data. Weights may be specified as input information or set by the program ($w(k) = 1/y(k)$).
- 324 **FRANTIC** - FRANTIC is designed to process raw counting data and to fit in the least squares sense these data to the multiple exponential growth and decay equations. The program can be used for sums of exponentials with positive, negative, or zero exponents and positive or negative coefficients.
- 327 **DAFT1** - DAFT1 is a program for weighted least squares fitting of 0.0253 eV neutron data for fissile nuclides. The program also carries out computations relevant to discerning overall goodness of fit, particularly deviant data, and data whose improvement would lead to large reductions in error of each fitted parameter.
- 364 **SNEQ** - SNEQ consists of the two codes, SNAP and EQPLT, which have been merged due to their common use of the SLIP compiler. SNAP interprets and solves pseudo-FORTRAN input equations representing nonlinear algebraic systems. EQPLT interprets pseudo-FORTRAN input equations and calculates and plots multiple curves on a single graph. EQPLT is useful for parameter studies.
- 407 **DATATRAN2 Utility Plotting** - This series of DATATRAN modules is designed to provide basic plotting capability in an easy-to-use package. Functions of one or two variables can be accommodated. The modules may be used to plot results of calculations performed by other modules or to display data read from cards or tapes.
- 411 **M0661/M0657/M0626** - M0661, M0657, and M0626 perform statistical analyses of data based on a least squares polynomial fit.
- 428 **DOGGY** - DOGGY can perform most routine form sheet calculations. The program can handle common arithmetic manipulations on columns of input such as addition, subtraction, multiplication, and division. It also has provisions for the use of special functions such as logarithmic, trigonometric, arc trigonometric, hyperbolic, exponential, square root, maxima, minima, and raising a number to any power. DOGGY also calculates water properties such as thermal conductivity, viscosity, and Prandtl Number over a wide range of temperature and pressure.
- 442 **SIMPLE1** - SIMPLE1 compiles and executes multistatement calculations typed in a familiar algebraic notation at a time-shared terminal, immediately returning requested results to the terminal and permitting ad lib continuation of a calculation. The user may use the system as an extended and powerful electronic calculator, or as a calculator of small load-and-go runs. Errors are detected and corrected on an as-you-go basis. Calculations may include interactive input/output, functions, and loops.
- 444 **ROPE** - ROPE is used to calculate roots of polynomials.
- 445 **LIZARD4** - LIZARD4 is used to solve nonlinear, ordinary differential equations as a one-shot effort. It was written to solve initial value equations, that is, the values of the dependent variables must be specified at some initial value of the independent variable. One-dimensional steady-state boundary value problems can be solved with LIZARD4, providing an iterative method is employed by the user where one of the boundary conditions is specified and integration proceeds until the alternate boundary condition is met.

- 446 **MOST** - MOST is designed to vary a set of coordinates ($x_1, x_2, \dots, x_n$) representing the vector x in such a way that a specified function $y(x)$, $y(x)$ greater than or equal to 0, is minimized.
- 478 **BETTIS ENVIRONMENTAL ROUTINES**, - The BETTIS ENVIRONMENTAL ROUTINES extend the FORTRAN language by modifying some of the standard CDC6600 library routines and by adding routines to the library to facilitate decimal input and output, file maintenance, scratch I/O, storage allocation, utility functions, operating system interfacing, and operator communication.
 MODEL (MODified Environmental Library) differs from the original Bettis version in that it allows the operating system, rather than the environmental package, to control the operating environment.
- 484 **FIGS** - FIGS is a FORTRAN-callable subroutine package for the support of interactive computing programs utilizing an IBM System/360 computer and an IBM2250 display unit.
- 496 **KAPLPLOT** - KAPLPLOT is the set of standard CalComp subroutines written at Knolls Atomic Power Laboratory to provide graphic output.
 GRLIN is used to draw an axis system, establish scaling factors, and enable the user to draw linear graphs.
 GRLOG is used to draw an axis system, establish scaling factors, and permit users to draw full logarithmic graphs.
 LINLG provides the capability of drawing semi-logarithmic graphs with linearly-scaled abscissas while LOGLN provides the same capability with linearly-scaled ordinates.
 PENSET initializes the plotting subroutines and draws the job identification, time, date, and charge number.
 PENEND moves the pen off a completed plot and prevents subsequent plots from overwriting the completed plots.
 IPLOT moves the plotter pen from its current position to a new position.
 IDPLOT moves the pen a specified incremental distance in inches from its present position.
 PSCALE establishes the value of factors to be used by the SPLOT subroutine in scaling user data to fit on plotter coordinates.
 SPLOT causes the pen to move to coordinates which are obtained by applying PSCALE scale factors to user data.
 XCPLLOT and YCPLLOT cause alphabetic information to be written parallel to the direction of the abscissa axis, XCPLLOT, or the ordinate axis, YCPLLOT.
 PMARK causes a distinctive symbol to be plotted at the current position of the pen.
 PLTSIZE conveys to the plotting system information which will enable the plotting system to place the maximum number of plots in a minimum length of paper.
- 497 **RELO1** - RELO1 computes the failure probability for a single failure mode. Two options are available: option 1 calculates the interaction of two normally-distributed variates and option 2 calculates the interaction of two truncated normally-distributed variates.
- 514 **FORSIM** - FORSIM is a FORTRAN oriented simulation program which automates the continuous transient solution of systems of ordinary and/or partial differential equations. The user writes his equations in a FORTRAN subroutine, following prescribed rules, and loads this routine along with the executive routines. The executive routines then read in initial data supplied by the user and proceed with the integration.
- 515 **GENED ENVIRONMENTAL ROUTINES** - The GENED ENVIRONMENTAL ROUTINES consists of a set of standard routines written at the General Electric Nuclear Energy Division and a set of standard GE635 system routines. The first set includes the following -
 BITA moves bits from one word to another without altering those bits outside the range of the call.
 CASE positions an input file so that the input data following a case card can be read.
 CASERR assumes that an error was detected in the last data case and forces the CASE subroutine to advance the data input file to the next independent case card or to the end of the input data, whichever occurs first.

DRAW is a general-purpose plotting routine used to (a) draw a grid network, (b) label the grid network, (c) draw curves within the grid network, (d) allow two different y-axis values, and (e) produce a bar or histogram plot.

ERRSYS is a general error indicating routine that sets up diagnostic information for use in error recovery within program systems.

F4TRBK provides a trace of calling programs from level to level up to the original calling level. F4TRAC prints out a trace and then returns to the statement after the call to F4TRAC. F4TRID provides the name of the program which called ERRSYS.

FLEXO writes a message on the on-line typewriter during program execution to serve as a guide to the operator or user.

FLTBCD converts a FORTRAN floating-point number to a BCD number in either F or E format.

FSNOW is a special subroutine to save a file code in the cell .SPFC.

FSUP permits the user to suppress a floating-point number or binary configuration when printing or punching with FORTRAN I/O.

FSUPC is called to disable the suppress function performed by FSUP and return to normal FORTRAN I/O processing.

HELP is used to supply a user with the type of device (tape/ disk/drum) and the number of links used if the device is a disk or drum unit.

IDFTAP creates a logical unit designator (referred to as a LUD), from the information given to the IDFTAP function by the user, and returns the LUD to the user.

ISERVE is a function with various options to pick up and/or convert one of the following - date, clock time, case number, user identification, and computer processor time.

ISUP permits the user to suppress a fixed-point number or binary configuration when printing or punching with FORTRAN I/O.

ISUPC is called to disable the suppress function performed by ISUP and return to normal FORTRAN I/O processing.

LIMRTN permits the user to regain control after an I8 abort (running time exceeded) occurs, allowing the program an additional 5 minutes of processor time.

LISTFORM consists of two subprograms, JGEGEN and JGEOUT, and enables the FORTRAN user to write output tapes (for printing or punching) in a more efficient and faster manner than is possible with a FORTRAN WRITE (I,N) LIST statement, which must scan the FORMAT statement each time output is initiated.

LOCF4 is a function used to convert the address of a variable or an array into a FORTRAN integer.

NBCDFX converts a BCD number, including the sign, to a FORTRAN integer.

NFXBCD converts a FORTRAN integer to a BCD number.

NIPS interprets an array of BCD characters in integer, real, or Hollerith format.

NPOST is a multiple entry subroutine incorporating the functions of VTAB, REWIND, POSWDS, POSLIN, POSTMW, POSASN, POSPOS, PRID, PWID, POSTSF, POSTSB, POSTRB, and POSTWB. It serves as a driver to RWSBT for groups of data which are uniquely defined on a physical device called a line (a disk, drum, or tape file).

NSORT provides a flexible ascending-order sorting capability to a FORTRAN program that requires a tape or disk sort.

PLOTRC provides a series of CalComp plotter routines. These include PENSET, PSCALE, SPLOT, IPLOT, IDPLOT, XCPLLOT, YCPLLOT, PMARK, and PENEND.

PRNTHD causes a printer output heading to be written at the top of a new page.

REREAD allows the user to re-read (re-format) the last BCD record read in, under a different format control. CONVRT permits character manipulation and conversion of any datum/data in memory.

RWSBT manipulates information in binary form on tape, disk, or drum physical devices. It includes BLKSIZ, RDBT, WTBT, SBTF, SBTB, RWD, RWDLO, and MOVEBT.

VAMP1R provides the complete setup of linear graphs to be produced on a digital plotter. ZERO causes division by zero to yield a fixed or floating-point zero as the dividend instead of the machine's maximum. It also suppresses the associated divide check and error messages.

The set of standard GE635 system routines include -

DUMP which dumps the indicated limits of core storage and terminates execution by returning control to the operating system.

PDUMP which dumps the indicated limits of core storage and then continues execution.

LINK which enables the programmer to call program overlays and LLINK which loads a link and then returns to the next sequential statement of the calling routine.

FLGEOF which is used to process end-of-file conditions.

516 PTAC11 - PTAC11 allows a programmer to assemble binary code for the Digital Equipment Corporation PDP-11 computer on the IBM360/75, taking advantage of the facilities and speed of the larger machine.

518 ERREST - ERREST sorts the rod bundle library of critical heat flux data and performs error calculations on sorted subsets.

519 NRTS OS/360 Remote Job Entry - NRTS allows users at remote locations to submit jobs over slow or high speed communication lines to an IBM system 360/75 using the operating system that provides multiprogramming with a variable number of tasks. This program is an extension of the standard RJE program. Once a job has been entered execution proceeds under OS job management routines.

534 EISPACK Release 2 - EISPACK is a collection of FORTRAN subroutines to solve the standard eigenproblem for any one of the following classes of matrices - real general, certain real tridiagonal, real symmetric, real symmetric band, real symmetric tridiagonal, complex general and complex Hermitian; to solve the generalized eigenproblem for real symmetric positive-definite and real general matrix systems; and to perform the singular value decomposition of a real rectangular matrix and solve an associated least squares problem. The individual subroutines are -

IDENTIFICATION	DESCRIPTION
BAKVEC F281	Back transform vectors of matrix formed by FIG1
BALANC F269	Balance a real general matrix
BALBAK F270	Back transform vectors of matrix formed by BALANC
BANDR F226	Reduce sym. band matrix to sym. tridiag. matrix
BANDV F227	Find some vectors of sym. band matrix
BISECT F294	Find some values of sym. tridiag. matrix
BQR F236	Find some values of sym. band matrix
CBABK2 F272	Back transform vectors of matrix formed by CBAL
CBAL F271	Balance a complex general matrix
CG F301	Driver subroutine for a complex general matrix
CH F302	Driver subroutine for a complex Hermitian matrix
CINVIT F297	Find some vectors of complex Hess. matrix
COMBAK F283	Back transform vectors of matrix formed by COMHES
COMHES F282	Reduce complex matrix to complex Hess. (elementary)
COMLR F295	Find all values of complex Hess. matrix (LR)
COMLR2 F296	Find all values/vectors of cmplx Hess. matrix (LR)
COMQR F245	Find all values of complex Hess. matrix (QR)
COMQR2 F246	Find all values/vectors of cmplx Hess. matrix (QR)
CORTB F247	Back transform vectors of matrix formed by CORTH
CORTH F244	Reduce complex matrix to complex Hess. (unitary)
EISPAK F299	Control program for EISPACK (IBM version only)
ELMBAK F274	Back transform vectors of matrix formed by ELMHES
ELMHES F273	Reduce real matrix to real Hess. (elementary)
ELTRAN F220	Accumulate transformations from ELMHES (for HQR2)
FIG1 F280	Reduce nonsym. tridiag. matrix to sym. tridiag.
FIG12 F222	Reduce nonsym. tridiag. matrix to sym. tridiag.
HQR F286	Find all values of real Hess. matrix
HQR2 F287	Find all values/vectors of real Hess. matrix
HTR1BK F285	Back transform vectors of matrix formed by HTR1D1
HTR1B3 F243	Back transform vectors of matrix formed by HTR1D3
HTR1D1 F284	Reduce Hermitian matrix to sym. tridiag.
HTR1D3 F242	Reduce Hermitian packed matrix to sym. tridiag.
INTQLV F234	Find all values of sym. tridiag. matrix
INTQL1 F291	Find all values of sym. tridiag. matrix
INTQL2 F292	Find all values/vectors of sym. tridiag. matrix
INVIT F288	Find some vectors of real Hess. matrix
MINFIT F233	Singular value decomposition & least squares soln.
ORTBAK F276	Back transform vectors of matrix formed by ORTHES
ORTHES F275	Reduce real matrix to real Hess. (orthogonal)
ORTRAN F221	Accumulate transformations from ORTHES (for HQR2)
QZHES F238	Reduce real generalized matrix system

QZIT	F239	Further reduce real generalized matrix system
QZVAL	F240	Find all values of reduced real generalized system
QZVEC	F241	Find all vectors of real generalized matrix system
RATQR	F298	Find extreme values of sym. tridiag. matrix
REBAK	F225	Back transform vectors of matrix formed by REDUC
REBAKB	F231	Back transform vectors of matrix formed by REDUC2
REDUC	F224	Reduce sym. generalized matrix system to standard
REDUC2	F230	Reduce sym. generalized matrix system to standard
RG	F303	Driver subroutine for a real general matrix
RGG	F312	Driver subroutine for a real generalized system
RS	F304	Driver subroutine for a real sym. matrix
RSB	F308	Driver subroutine for a real sym. band matrix
RSB	F309	Driver subroutine for real sym. generalized system
RSGAB	F310	Driver subroutine for real sym. generalized system
RSGBA	F311	Driver subroutine for real sym. generalized system
RSP	F307	Driver subroutine for a real sym. packed matrix
RST	F305	Driver subroutine for a real sym. tridiag. matrix
RT	F306	Driver subroutine for a nonsym. tridiag. matrix
SVD	F222	Singular value decomposition of rectangular matrix
TINVIT	F223	Find some vectors of sym. tridiag. matrix
QLRAT	F235	Find all values of sym. tridiag. matrix
QL1	F289	Find all values of sym. tridiag. matrix
QL2	F290	Find all values/vectors of sym. tridiag. matrix
TRBAK1	F279	Back transform vectors of matrix formed by TRED1
TRBAK3	F229	Back transform vectors of matrix formed by TRED3
TRED1	F277	Reduce sym. matrix to sym. tridiag. matrix
TRED2	F278	Reduce sym. matrix to sym. tridiag. matrix
TRED3	F228	Reduce sym. packed matrix to sym. tridiag. matrix
TRID1B	F237	Find some values of sym. tridiag. matrix
TSTURM	F293	Find some values/vectors of sym. tridiag. matrix

541 WSP-HASP/DOS - The WSP (Work Station Package) is a modification of the standard HASP/RMT360 package supplied by IBM and runs on a multiprogrammed DOS System/360/30 using multi-leaving and binary synchronous communications to communicate with a System/360/195/ASP central CPU.

556 KEELE - KEELE is a linearly constrained nonlinear programming algorithm for locating a local minimum of a function of n variables with the variables subject to linear equality and/or inequality constraints.

562 AMDLIBAE - AMDLIBAE is a subset of the IBM 360 Subroutine Library at the Applied Mathematics Division at Argonne National Laboratory. This subset includes library categories A-E:

IDENTIFICATION	DESCRIPTION
A152S A MPA	Mult. prec. floating point arith. package
B156S A ARSIN	Arcsine, arccosine
B158S A DSIN/DCOS	DP sine, cosine
B159S A DTAN/DCOT	DP tangent, cotangent
B252S A SINH/COSH	Hyperbolic sine, cosine
B353S A ALOG	SP logarithm
B354S A DEXP	DP exponential
B355S A DLOG	DP logarithm
B456S A DCUBRT	DP cube root
B457S A ARGPOWER	X**Y
B458S A ARGFOXP	DP X**Y
C150S F DQD	Q. D. algorithm applied to a power series
C151S F DCONF1	Eval. cont. fract. Q. D. of power series
C250S F CUBIC	Roots of cubic polynomial equation
C251S F QUARTIC	Roots of quartic polynomial equation
C252S F RSSR	All roots of poly eqs. with real coef.
C253S F POLDRV	Driver for C254S
C254S F CPOLY	Roots arb. poly. Jenkins-Traub algorithm

C353S F1	CLEBSH	Ang. mom. coef. - Clebsch, Racah, Wigner
C365S A	ALGAMA	Logarithm of the gamma function
C366S A	DGAMMA/DLGAMA	DP gamma and log(gamma) functions
C368S F	EONE	Exponential integral E1
C370S F	BESJY	Bessel functions J and Y
C371S F	BESIK	Bessel functions I and K
C372S F	CHIPRB	Chi-square integral
C380S F	DRZETA	Long precision zeta, zeta-1 functions
C382S F	DCGAM	Long precision complex gamma
C383S A	DERF/DERFC	DP error function
C384S F	BFJ1	Bessel function J1
C385S F	COULMB	Regular Coulomb wave functions
C386S F1	DSGMAL	Coulomb phase shift
C387S F	BFJYR	Bessel functions J0,J1,Y0,Y1
C388S F	IRCOUL	LP irregular Coulomb wave functions
C389S F	GAMIN	Incomplete gamma function
C390S F	LQ	Assoc. Legendre functions of 2nd. kind
C392S A	DAERF	Inverse error function
C393S F	CDEONE	Modified complex exponential integral
D153S F	DROMB	Two-dimensional Romberg quadrature
D153S P	DROMBP	Two-dimensional Romberg quadrature
D158S F	ANC4	Adap. quad. using 4-th order Newton-Cotes
D158S P	ANC4P	Adap. quad. using 4-th order Newton-Cotes
D161S F	GAUSS	Arbitrary Gaussian weights and nodes
D162S F	SQUANK	Simpson's quad. used adaptively
D252S F	DDFSUB	DP Neville or Stoer sol. lin. dif. eqns.
D253S F	DDFSYS	Driver for D252S
D255S F	DFBND	Stoer sol. dif. eqs. with error bounds
D256S F	DFBDRV	Driver for D255S
D257S F	GEARDV	Gear's sol. of init. value problem
D452S F	ENDACE	Numerical derivatives real analytic fn.
E206S F	LSQPOL	Least squares weighted polynomial fit
E208S F1		Arbitrary function fit, least squares
E209S F	CALLSQ	Driver for E206S
E212S F		General least squares fit + fnction eval.
E250S F	VA02A	Least squares funct. min. w/o derivatives
E252S F	MINMAX	Chebyshev line fit
E253S F		Arbitrary functional fit II
E256S F	BGPOL	Least squares fit with polynomials
E257S F	BGLSSQ	Least squares fit with arbitrary function
E350S F	SMOOTH	Smoothing by cubic splines

563 AMDLIBF - AMDLIBF is a subset of the IBM 360 Subroutine Library at the Applied Mathematics Division at Argonne. This subset includes library category F:

IDENTIFICATION	DESCRIPTION
F152S F SYMINV	Invert sym. matrices, solve lin. systems
F154S A DOTP	Double plus precision accum. inner prod.
F156S F RAYCOR	Rayleigh corrections for eigenvalues
F161S F XTRADP	A fast extended precision inner product
F162S A XTRADP	Inner product of two DP real vectors
F202S F1 EIGEN	Eigensystem for real symmetric matrix
F203S F	Driver for F202S
F248S F RITZIT	Largest eigenval. & vec. real sym. matrix
F261S F EIGINV	Inverse eigenvalue problem
F313S F CQZHES	Reduce cmplx matrices to upper Hess & tri
F314S F CQZVAL	Reduce complex matrix to upper Hess. form
F315S F CQZVEC	Eigenvectors of cmplx upper triang. syst.
F316S F CGG	Driver for complex general eigenproblem
F402S F MATINV	Matrix inversion and sol. of linear eqns.
F403S F	Driver for F402S
F452S F CHOLLU,CHOLEQ	Sym. decomp. of pos. def. band matrices
F453S F MATINC	Inversion of complex matrices

F454S F CROUT	Solution of simultaneous linear equations
F455S F CROUTC	Sol. of simultaneous complex linear eqns.
F456S F1 DIAG	Integer preserving Gaussian elimination

564 **AMDLIBGZ** - AMDLIBGZ is a subset of the IBM 360 Subroutine Library at the Applied Mathematics Division at Argonne National Laboratory. This subset includes library categories G-Z:

IDENTIFICATION	DESCRIPTION
G552S F RANF	Random number generator
J952S F YOLYPLOT	CalComp plots
J955S P GRAF	Prints a graph of points on line printer
K250S A1	Core to core conversion
K251S A HEXINP	Hexadecimal input for PL/I programs
K252S A HEXOUT	Hexadecimal output conv. PL/I programs
M101S F SORT	Algebraic sort
M150S F CSORT	Algebraic sort
M151S P2 ANLKWIC	KWIC sort
M250S A SMALLIST	Squeezes assembler listing to 8 x 11
N251S A ABEND	Calls ABEND dump
Q052S A CLOCK	Time
Q053S A COPYAGO	Copy load module from tape to disk
Q054S A DATE	Current date in form MM/DD/YY
Q055S A TIME	Time (24 hour clock) in EBCDIC HH.MM.SS
Z013S F	Variable metric minimization
Z057S A LOCF	Locate machine addresses of variables
Z071S A ALLOC	Allocate LCS for FORTRAN programs
Z074S A ANLMNP	Exponent & mantissa manipulative functs.

578 **PLOTR** - PLOTR and the auxiliary routine XYGRD contour a function defined over a two-dimensional grid and compute the area within the contours.

592 **GEAR** - GEAR is a package of subroutines for the numerical solution of systems of ordinary differential equations, given the initial values. It is particularly well-suited for stiff systems, but can be used generally.

593 **SPEAKEASY MU+ Level** - SPEAKEASY is a user-oriented language. It is intended to provide its users with the means of quickly formulating problems for computer processing and for obtaining answers to those problems in a minimum of time.

601 **ERF/ERFC** - ERF and ERFC are used to compute values of the error function and complementary error function for any real number. They may be used to compute other related functions such as the normal probability integrals.

602 **LENSEDES** - LENSEDES analyzes the performance of optical lenses by computing the image errors found when bundles of skew rays are traced from object points to the image surface. Lens performance is optimized by varying selected lens parameters under direction of the nonlinear least squares program, OPTIMIZ.

610 **FUNPACK Release 2** - FUNPACK is a collection of FORTRAN subroutines to evaluate certain special functions. The individual subroutines are -

IDENTIFICATION	DESCRIPTION
NATS10 F210	Bessel function I-sub-0
NATS11 F211	Bessel function I-sub-1
NATSJ0 F2J0	Bessel function J-sub-0
NATSJ1 F2J1	Bessel function J-sub-1
NATSK0 F2K0	Bessel function K-sub-0
NATSK1 F2K1	Bessel function K-sub-1
NATSBESY F2BY	Bessel function Y-sub-nu
DAW F1DW	Dawson's integral
DELIPK F1EK	Complete elliptic integral of the first kind
DELIPE F1EE	Complete elliptic integral of the second kind
DEI F1EI	Exponential integrals

NATSPSI F2PS Psi (logarithmic derivative of gamma function)
 MONERR F1MO Error monitoring package.

613 NRTS ENVIRONMENTAL SUBROUTINES - The NRTS ENVIRONMENTAL SUBROUTINES are a collection of routines designed to aid the programmer by providing extensions to the FORTRAN language, data management services, and programming aids.

ASTEM evaluates the 1967 ASME equations of state for water/steam and derivatives of these equations.

DOUT extracts decks from a file and writes each deck as a separate file so that they can be processed by the assembler which can handle only one deck per step.

UMRG is used to merge parts of update tapes.

UPD is used to update source decks.

STHG generates water thermodynamic property tables.

AND, IAND, DAND, OR, IOR, and DOR give the logical product (and) and logical sum (or) for 4 and 8-byte words.

CVI converts EBCDIC information to binary information.

COMPAR compares a character string beginning at location a(i) with another character string beginning at location b(j). The comparison is made one character at a time and terminated after all requested characters are tested or after the first inequality is found.

DATE converts the Julian date maintained by the OS operating system into the form mm/dd/yy where mm is the month, dd the day, and yy the year.

FABEND causes an abnormal termination of the job step, and a core dump is printed if a SYSUDUMP or SYSABEND DD card is included in the job step JCL.

The FETCH function returns the value of the variable whose address is specified as the argument.

The extended IBCOM# routine provides automatic page control, and optionally, permits from one to three lines to be inserted as page headings in the output to a specified sysout unit.

The INP set of subroutines, a data input package for use with FORTRAN programs, is a conversion of the INPF FORTRAN package written by Bettis for the CDC6600 and can be used in the conversion of Bettis programs that use INPF.

INFILQ is an incore read and write subroutine that modifies IBCOM# in such a way that the next read or write request causes information in the user's list to be placed in a core buffer.

JBIDZZ returns the name of the job entered on the name field of the job card.

JULIAN returns a 5-byte numeric Julian date in EBCDIC characters from the OS operating system.

LOCFCN returns the absolute core address of the variable specified as the argument.

MAINS and MAIND are matrix inversion subroutines in single- and double-precision, respectively.

MOVE transfers data assumed to be in character, full-word, or double-word form from one array to a second array.

RUNOUT can be used to obtain a second copy of the printed output.

ISL, ISR, ISRL, SL, SR, SRL, DSL, DSR, and DSRL are arithmetic and logical shift functions for 4 and 8-byte words.

The interval TIME routine provides the user with the means of determining the elapsed time of his task.

TYME will return the time of day as the second argument.

VOLSER provides the volume serial number(s), data set name, and creation date of data sets residing on peripheral devices (disk or tape units).

ZEROUT sets to zero an arbitrary length of sequential 8-byte words beginning on a double-word boundary.

The FTB package is a set of subroutines for controlling dynamic storage allocation in fast core, bulk core, four disk data sets, and one drum data set and performing the I/O operations to disk and drum storage.

Subroutine FLINK allows access to the LINK macro.

The FIOSET routine is used to override the FORTRAN convention for naming DD cards.

RENTYM gives the user access to his unused CPU time.

The standard CalComp plotter subroutines are also part of the package.

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The Integrated Graphics System (IGS) used at the Rand Corporation to support an SC4060 stored-program recording system is also included.

614 HISTOGRAMS - HISTOGRAMS provides graphical representation of lot sample characteristics in the form of histogram bars. On large lot samples, if a histogram bar should exceed fifty units, the entire histogram plot is automatically scaled by the smallest integer that will cause the largest frequency to fall within the maximum plot of fifty units. The number of cells in the histogram can vary from 3 to 22. The equal intervals are determined by the difference of the upper and lower boundaries divided by the number of cells less two. In addition to the plot, the program provides statistical characteristics in the form of: the mean, standard deviation, skewness, kurtosis, range, number of standard deviations between the mean and the two specification limits, and up to nineteen values falling outside the boundary limits.

621 BH99 - BH99 is used for the statistical analysis of data based on the extreme value distribution.

623 SETS - SETS is used to achieve the symbolic manipulation of set (or Boolean) equations, particularly the reduction of set equations by the application of set identities.

624 GRAPH - This program calculates and graphs statistical results of experimental data. It calculates the linear regression, correlation coefficients, the confidence intervals for 90-95-99 percent confidence that the next sample will be within the printed interval, the 90 percent confidence interval that 95 percent of the remaining population will be within, and the mean and standard deviation of each parameter. The program graphs these confidence intervals, the regression line and the experimental data to obtain a visual indication of correlation. Input data is printed in tabular form and all dependent data are displayed against all independent data, one parameter at a time.

630 LATIN SQ - LATIN SQ is used for the statistical analysis of data generated from an N x N Latin Square experimental design. The program output includes an analysis of variance table for testing the significance of the row, column and treatment main effects. The analysis of variance table also includes information for testing the linear and higher-order curvilinear components for each main effect. A subroutine is provided for performing Duncan's new multiple range test for making all pair-wise comparisons among the factor level mean values.

633 LOS ALAMOS SUBROUTINE LIBRARY - LOS ALAMOS SUBROUTINE LIBRARY is a subset of the CDC6600 subroutine library of Los Alamos Scientific Laboratory. This subset includes library categories A-W:

IDENTIFICATION		DESCRIPTION
A101A COM	UNPAK	Unpack a floating-point number
A102A COM	IUNPK	Unpack a floating-point number
A202A F4	DCABS	Absolute value of d.p. complex number
A203A COM	CABS	Magnitude of a complex number
B104A COM	ATAN	Arctangent of x or of y/x
B106A COM	SINCOS	Sine or cosine for arg. in rad. & deg.
B107A F4	TAN	Fl.-pt. tangent or cotangent routine
B108A COM	ASIN	Arcsine or arccosine
B109A COM	CSIN	Sine or cosine of a complex number
B203A COM	SINH	Hyperbolic sine & cosine
B204A COM	TANH	Hyperbolic tangent
B306A COM	EXP	Exponential function e ^{••x}
B307A COM	CLOG	Complex natural log
B310A COM	CEXP	Natural exponential of a complex number
B313A COM	DBA1EX	Eval. dx ^{••n} where dx is d.p. & n is int.
B407A COM	CUBRT	Cube root FORTRAN IV single-precision
B408A COM	SQRT	Square root
B409A COM	CSQRT	Complex square root of a complex number
C302A F4	GAMMA	Incomplete gamma function
C304A F4	ELLI	Complete & incomplete elliptic integrals
C309A F4	E1	Exponential integral E1(x)

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C310A F4	ERF	Error function
C325A F4	GAM1	Gamma function
C326A F4	LNGAM	Cmplx nat. log of gamma fn. with cmplx arg
C327A F4	BASF	Bessel functions for large real arguments
C328A F4	BJY1K	Bessel fns. for real order & argument
D301A F4	TBPSDN	Truncated Buneman Poisson solver
E102A F4	SPL1D1	Spline interpolation-coefficient eval.
E103A F4	SPL1D2	Spline interpolation-function evaluation
E104A F4	SPL2D1	2-D bi-cubic spline interp.-coeff. calc.
E105A F4	SPL2D2	2-D bi-cubic spline interp.-funct. eval.
E106A F4	AKNINT	Interpolation by Aitken's repeated process
E107A F4	SPL2D3	Spline interp. fn. to be used with E105A
E203A F4	SMOOTH	Least-square spline approximation
E208A F4	PFTS	Orthogonal polynomial least squares
F115A F4	MAXV	Vector max., min., max. abs. or min. abs.
F116A F4	MAXM	Matrix max., min., max. abs., min. abs.
F119A F4	MATTRS	Matrix transpose in place
F120A F4	MATMOV	Matrix move
F121A F4	MATTRA	Matrix move & transpose
F122A F4	MATMPY	Matrix multiply routine
F123A F4	MTMPY	Matrix transpose multiply routine
F124A COM	DOTPRO	Inner product of two vectors (dot product)
F128A F4	MGS	Modified Gram-Schmidt orthogonalization
F132A F4	MATINV	Matrix inverse
F133A COM	VECSUM	Vector addition
F134A F4	ECMATPY	ECS matrix multiply
F135A F4	ECMTRPY	ECS matrix transpose multiply
F136A F4	COTPRO	Inner product of two complex vectors
F137A F4	CATINV	Complex matrix inversion
F139A COM	ADDVEC	Vector addition
F222A F4	SMEVAL	Eigenvalue routine--real symmetric matrix
F223A F4	SMHSTR	Tridiagonalize real symmetric matrix
F224A F4	SMEVEV	Eigenval/eigenvec rout. for real sym. mtrx
F225A F4	PRODHH	Cpute transform to tridiag. a symm. matrix
F226A F4	HMEVAL	Eigenvalue routine--cmplx Hermitian mtrx
F227A F4	HMHSTR	Tridiagonalize complex Hermitian matrix
F228A F4	HMEVEV	Eigenval/eigenvec rout. for Hermitian mtrx
F229A F4	PROHHH	Cpute transform to tridiag. Hermitian mtrx
F230A F4	BISECT	Cpute subset of eigenvals of tridiag. mtrx
F404A F4	LSS	Linear system solver
F405A F4	GLSS	General linear system solver
F409A F4	MATFAC	Lin. syst. solver & mtrx factorization(LU)
F410A F4	LSSIT	Iterative solution of linear systems
F411A F4	BANMAT	Band mtrx factorization & lin. syst solver
F413A COM	ABTDSS	Symm. constant tridiag. linear syst solver
F414A F4	SPERLSS	Symmetric periodic linear system solver
F415A F4	ECSGLSS	ECS general linear system solver
F416A F4	CATFAC	Complex linear system solver
F417A F4	CLSIT	Soln of cmplx lin. syst by iterative rfnmt
F418A COM	FACTTD	LU decomp. of diag. dom. tridiag. matrix
F419A COM	SOLTDM	Solve diag. dominant tridiag. linear syst.
G601A F4	SPCTRL	Spectral analysis of time series
G602A F4	ACFCN	Autocovariance/autocorrelation function
G603A F4	WINDOW	Lag-window generator
G604A F4	PWRSPCT	Power spectrum computation
I401A F4	LOAD	Load FORTRAN IV format free input
J506A COM	ADV	Advance film
J510A F4	ASCL	Automatic graph scaling
J516A COM	PLT	Plot a point
J517A COM	DRV	Draw vector
J518A COM	GXA	Generate x or y axis
J520A COM	TSP	Type specific point

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J521A COM	TCP	Type current point
J522A COM	TSPV	Type specified point vertically
J523A COM	FRAME	Draw frame
J524A COM	STB	Store word in buffer
J526A F4	CONVRT	Convert to 4020 coordinate
J527A F4	TCR	Test coordinate for range
J528A COM	DGA	Define graph area
J529A F4	DLNLN	Draw linear-linear grid
J530A F4	DLNLG	Draw combination of linear & log grids
J533A F4	SLLIN	Scale left side linearly
J535A F4	SBLIN	Scale top or bottom of graph linearly
J540A F4	SBLOG	Scale a boundary of graph logarithmically
J541A F4	PLOT	Plot n points
J542A COM	WLCH	Write large characters horizont. or vert.
J562A F4	PLOJB	Standardized plot on film
J565A COM	BS4020	Double buffer film output
J567A F4	DLCH	Draw large characters
J569A F4	COLOR	Color
J592A F4,COM	PICTURE	Pict-perspec plots, hidn lines out, color
K203A COM	ECR	ECR reads one word from ECS
K204A COM	ECW	ECW writes one word to ECS
M101A F4	SORT1	Extended sort routine
M117A F4	SORT2	Two level extended sort routine
M118A F4	SEARCH	Rapid search of a floating-point table
M119A F4,COM	ESEARCH	Binary search through ECS
M401A COM	SHIFT	Shift word w/o zero end around or sign ext
M403A COM	PUTFTCH	Puts & fetches characters
N103A F4	LABRT	Los Alamos aborter & message printer
Q408A COM	RWPRU	Read/write binary PRU (physical record)
Q409A F4	ECSBUFO	Data transfer ECS to file & file to ECS
W113A COM	OPEN	Open & close files

635 SLACMON, SLACMON/370 - SLACMON and SLACMON/370 operating as systems' tasks or jobs under OS/VS2, are designed to monitor hardware and software performance over a given period of time. Input specified in the parameter field on the execute card coupled with the corresponding operand in the operator's start command allows selected functions to be performed. Five data sets optionally provide names of queues, I/O devices, or modules that the programs monitor. Output consists of a number of reports followed by a summary page; certain summary data may appear on the console device. The output is most useful for identifying bottlenecks and interactions, tuning a system for peak performance and for indicating desirable hardware and software reconfiguration.

640 DE/STEP,INTRP; DEROOT/STEP,INTRP - DE/STEP,INTRP performs the solution of an initial-value problem for a system of first-order ordinary differential equations to a fixed endpoint. With the companion program, DEROOT/STEP,INTRP, the endpoint may be specified implicitly as the root of a nonlinear function of the independent variable, the solution, and its first derivative. Each of these programs is supplied in both a basic and in a more versatile extended version.

642 PROGLOOK - PROGLOOK makes it possible to monitor the execution of virtually any OS/MVT or OS/VS2 Release 1.6 load module. The main reason for using PROGLOOK is to find out which portions of a code use most of the CPU time so that those parts of the program can be rewritten to reduce CPU time. For large production programs, users have typically found it possible to reduce CPU time by 10 to 30 percent without changing the program's function.

644 GETCOR/FRECOR - GETCOR and FRECOR are assembly language subroutines which may be called from FORTRAN subroutines during execution to allocate and release core storage. Those variables for which core storage is to be allocated must be passed as arguments of the FORTRAN subroutines. These programs allow variable dimensioning in subroutines without a previous specification of the maximum allowable dimensions.

646 COPYCAT - COPYCAT is an OS utility program designed to produce an efficient system-wide catalog which may reside on many volumes. Substantial improvement in performance may also be obtained on a system with only a single catalog. First, catalog entries from many different catalogs may be redistributed to equalize the load on each catalog. Second, each individual catalog is restructured in a way designed to minimize the I/O time required for searching and updating. Redistribution and restructuring parameters are under user control. Model DSCB's for generation data groups and alias entries are also processed. Catalogs on all direct access devices, including data cells, are supported. Backup copies may also be made.

647 SLOP/CROSS - The package contains two PL/I codes, SLOP (Structural Layout Of Programs) and CROSS, designed to check IBM FORTRAN H source programs. SLOP examines the SYSPRINT file produced by a FORTRAN H compilation for local errors and sends its observations to CROSS which detects potential global errors. SLOP summarizes variables, labels, common blocks, and other items in a subroutine, showing which symbols are being improperly used. Optionally, the SLOP program can list the output from the original FORTRAN subroutine compilation, can list and/or save a 'corrected' and resequenced FORTRAN file, and save and/or list the information intended for the CROSS routine.

For each subroutine CROSS tabulates:

- the subroutine name and size,
- entry points,
- listed but unused symbols,
- uninitialized variables,
- unreferenced statement numbers,
- internal statement numbers of input-output statements,
- symbols which appear in input-output statements,
- called subroutines, and
- the active variables in common and/or equivalence blocks,

together with block names and addresses.

CROSS lists common and/or equivalenced variables in alphabetic order with addresses and corresponding block names, along with the names of routines in which these variables are actively used. Any suspicious-looking or inconsistent items are flagged. The same information will also be sequenced and listed according to block names and addresses within each block. CROSS also produces a table designed to show instantly which routines need attention because SLOP found errors in them, which are missing or defined more than once, and which routine is calling (and how many times it is being called by) another. Finally, if any cycles of subroutine calls are detected, then a second table indicating these recursive calls will be produced.

The test case supplied with this package is designed to be self-explanatory, removing the need for reference documents.

649 COMQC - COMQC is a quality control data analysis statistical program that calculates mean, standard deviation, range, skewness and kurtosis. Tolerance limits, confidence limits on the percent defective, and a one-way analysis of variance are also provided.

652 STFODE/COLODE - COLODE is a subroutine intended primarily for solving first-order systems of stiff differential equations by collocation methods. STFODE is a driver routine written to simplify the use of COLODE.

654 MATHLIB - MATHLIB contains routines for linear algebraic equations, eigenvalues and eigenvectors, numerical quadrature, ordinary differential equations, data fitting, Fourier transforms, zeros and optimization of functions, zeros of polynomials, special functions, and numerical sorting.

656 BESSEL FUNCTION PACKAGE - Subroutines for evaluating

Bessel functions:

$J_0(x)$, $J_1(x)$, $I_0(x)$, $I_1(x)$ for x between + and - infinity;

$Y_0(x)$, $Y_1(x)$, $K_0(x)$, $K_1(x)$ for x greater than zero;

$J_{nu}(x)$, $I_{nu}(x)$ for x greater than or equal to 0 and nu greater than or equal to 0;

$Y_n(x)$, $K_n(x)$ for x greater than 0 and $n=0,1,2,\dots$;

Airy functions:

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$Ai(x)$, $Ai'(x)$, $Bi(x)$, $Bi'(x)$ for x between $+$ and $-$ infinity;
and the log gamma function:
 $LNGAMMA(x)$ for x greater than 0.

- 651 **GEARB** - GEARB is a package of seven subroutines for the numerical solution of the initial-value problem for systems of first-order ordinary differential equations for which the Jacobian matrix is banded. The package is suitable for either stiff or non-stiff systems. It can also be used if the Jacobian matrix can be approximated by a banded matrix.
- 665 **BETTIS ENVIRONMENTAL LIBRARY** - The BETTIS ENVIRONMENTAL LIBRARY consists of a large number of subroutines and functions which are available for use in application programs. These routines effectively extend the FORTRAN language in such areas as system communication, decimal input, file management, scratch I/O, storage allocation, and plotting.
- 668 **METRICATION** - METRICATION deals with the U.S. customary units of measure and the International System of Units (SI). The program provides for: (1) a means of converting units of one system of measurement to another, (2) standard methods of converting and rounding values, (3) standard output formats for converted and rounded values, (4) conversion of any units provided the conversion can be expressed linearly or as a table of function values, and (5) as much flexibility for the user as possible consistent with simplicity of use.
- 675 **EPISODE** - EPISODE is a package of eight subroutines for the numerical solution of the initial-value problem for systems of first-order ordinary differential equations. The package can be used for either stiff or non-stiff systems. It is especially suited to problems with intermittent high-speed transients.
- 678 **MORTRAN2** - MORTRAN2 is a FORTRAN language extension that permits a relatively easy transition from FORTRAN to a more convenient and structured language. Its features include free-field format; alphanumeric statement labels; flexible comment convention; nested block structure; for-by-to, do, while, until, loop, if-then-elseif-else, exit, and next statements; multiple assignment statements; conditional compilation; and automatic listing indentation. The language is implemented by a macro-based pre-processor and is further extensible by user-defined macros.
- 698 **DUMP** - DUMP is a user-oriented program dumping routine which provides diagnostics in English. It can be used to print a job's exchange package (operating registers) and part or all of its memory. It will print messages telling where the program was executing when it quit, why DUMP thinks it quit, and what routines have been called.
- 705 **EPISODEB** - EPISODEB is a package of eight subroutines for the numerical solution of the initial value problem for systems of first order ordinary differential equations whose Jacobian matrices are banded or can be approximated by band matrices. The package can be used for either stiff or non-stiff systems whose Jacobians can be approximated by band matrices. It is especially suited to problems with intermittent high-speed transients or waves.
- 709 **NIXLIN** - NIXLIN performs a function minimization by a direct search iterative process that has the advantage of requiring no derivative evaluations. This particular version is well-suited to fitting nonlinear models to experimental data and to the solution of systems of nonlinear simultaneous equations.
- 725 **JCLCROSS** - The JCLCROSS program scans PROCLIBs and produces a cross-reference listing of DSNAMES, PROGRAMS, STEP NAMES, DISPS, UNITS, and PGM parameters. The list may be sorted as desired and passed to the JCLCROSS program for printing with page headings.
- 728 **SLIDES** - The SLIDES program takes text and commands as input and prepares lettered slides and posters, utilizing the DISPLA graphics subroutines to generate its output. The program automatically selects the character-size so that the text fills the designated area. The ANL-AMD plotter subroutines permit the output to be displayed on an interactive graphics terminal or alternatively directed to any AMD plotter.

- 729 DYNDSK** - DYNDSK optimizes the placement of data sets on an IBM 3330/2314 disk pack to reduce seek time (arm travel) and forecast improvement expected after reorganization. Data sets are theoretically reordered based on size and number of references. With known percentages of seeks between data sets the program computes the average number of cylinders traveled per seek. Input data consists of addresses captured by a DYNAPROBE 8000 hardware monitor and specification of the present location of the data sets.
- 731 SUPORT** - SUPORT solves a system of linear two-point boundary-value problems subject to general separated boundary conditions.
- 738 ARSTEC** - The ARSTEC program was written to solve nonlinear, mixed integer, optimization problems. An example of such a problem in the nuclear industry is the allocation of redundant parts in the design of a nuclear power plant to minimize plant unavailability.
- 748 DRAFTMAN** - DRAFTMAN is a FORTRAN DISSPLA-based program that allows the user to obtain drawings of simple graphs. Figures are developed interactively on a graphics terminal, with the terminal user prompted for responses describing the figure being developed. When user/terminal interaction is completed the figure is drawn on the screen for review. The user can then submit a batch job directing the output to a plotting device for a high-quality drawing of the figure. The program can be utilized completely in a batch mode, if desired.
- 753 OCOPTR, DRVOCR** - OCOPTR and DRVOCR are computer programs designed to find minima of non-linear differentiable functions $f: R^n \rightarrow R$ with n dimensional domains. OCOPTR requires that the user only provide function values (i.e. it is a derivative-free routine). DRVOCR requires the user to supply both function and gradient information.
- 764 SOERP** - SOERP computes second-order error propagation equations for the first four moments of a function of independently distributed random variables. SOERP was written for a rigorous second-order error propagation of any function which may be expanded in a multivariable Taylor series, the input variables being independently distributed. The required input consists of numbers directly related to the partial derivatives of the function, evaluated at the nominal values of the input variables and the central moments of the input variables from the second through the eighth.
- 769 PCTEST** - PCTEST performs principal component analysis on multivariate data with emphasis on methods which can be used to detect outlier data.
- 772 FORTIO** - FORTIO is a set of Assembly language subroutines which allow FORTRAN IV programs to use several OS/360-370 data management and supervisor macro instructions. In particular, the FORTRAN programmer has available BSAM, QSAM, and BPAM access methods; can open, close and position files; position at or point to a block within a file; create and modify DCB's; dynamically LOAD, LINK, CALL, or DELETE other modules; and dynamically obtain and free storage (GETMAIN, FREEMAIN, GETPOOL, FREEPOL, etc.).
- 777 PDEONE** - PDEONE was developed as an interface to allow the software developed in the field of ordinary differential equations (ODEs) to be applied directly to the solution of partial differential equation problems. The original intent was to use PDEONE for solving coupled systems of nonlinear parabolic PDEs and this is reflected in the equations and conditions. However, the solution of other problems such as hyperbolic and elliptic PDEs may also be attempted. The equations are sufficiently general to include PDEs for which solutions may neither exist nor be unique. It is the user's responsibility to define a meaningful problem.
- 781 SPEKEN** - SPEKEN computes Pearson, Spearman, and Kendall correlation coefficients and associated significance levels for multivariate data. Special features of the program include exclusion of pairs of data values where one value is missing, and adjustment for tied rankings. The hypothesis of independence between each pair of variables can be tested using the obtained significance level for each correlation.

800 LINPACK - LINPACK is a collection of FORTRAN subroutines which analyze and solve various classes of systems of simultaneous linear algebraic equations. The collection deals with general, banded, symmetric indefinite, symmetric positive definite, triangular, and tridiagonal square matrices, as well as with least squares problems and the QR and singular value decompositions of rectangular matrices.

A subroutine-naming convention is employed in which each subroutine name consists of five letters which represent a coded specification (TXXYY) of the computation done by that subroutine. The first letter, T, indicates the matrix data type. Standard FORTRAN allows the use of three such types: S REAL, D DOUBLE PRECISION, and C COMPLEX. In addition, some FORTRAN systems allow a double-precision complex type: Z COMPLEX*16. The second and third letters of the subroutine name, XX, indicate the form of the matrix or its decomposition:

GE General
GB General band
PO Positive definite
PP Positive definite packed
PB Positive definite band
SI Symmetric indefinite
SP Symmetric indefinite packed
HI Hermitian indefinite
HP Hermitian indefinite packed
TR Triangular
GT General tridiagonal
PT Positive definite tridiagonal
CH Cholesky decomposition
QR Orthogonal-triangular decomposition
SV Singular value decomposition

The final two letters, YY, indicate the computation done by the particular subroutine:

FA Factor
CO Factor and estimate condition
SL Solve
DI Determinant and/or inverse and/or inertia
DC Decompose
UD Update
DD Downdate
EX Exchange

The following chart shows all the LINPACK subroutines. The initial 'S' in the names may be replaced by D, C or Z and the initial 'C' in the complex-only names may be replaced by a Z.

	FA	CO	SL	DI	DC	UD	DD	EX
SGE	x	x	x	x				
SGB	x	x	x	x				
SPO	x	x	x	x				
SPP	x	x	x	x				
SPB	x	x	x	x				
SSI	x	x	x	x				
SSP	x	x	x	x				
CHI	x	x	x	x				
CHP	x	x	x	x				
STR		x	x					
SGT			x					
SPT			x					
SCH					x	x	x	x
SQR			x		x			
SSV					x			

The LINPACK package also includes a set of routines to perform basic vector operations called the Basic Linear Algebra Subprograms (BLAS).

803 BASIC2 INTERPRETER - The BASIC2 INTERPRETER was developed to provide a high-level easy-to-use language for performing both control and computational functions in the MCS-80. The numerical operations are done using Advanced Micro Device's Am9511 arithmetic processor chip, or alternatively, by using a software simulation of that chip. To minimize system

size and cost, the interpreter was constrained to fit in 8K bytes, requiring implementation of a customized subset of BASIC. The package is supplied as two alternative implementations, hardware and software. The "software" implementation provides the following capabilities: entry and editing of BASIC programs, device-independent I/O, special functions to allow access from BASIC to any I/O port, formatted printing, special INPUT/OUTPUT-and-proceed statements to allow I/O without interrupting BASIC program execution, full arithmetic expressions, limited string manipulation (10 or fewer characters), shorthand forms for common BASIC keywords, immediate mode BASIC statement execution, and capability of running a BASIC program that is stored in PROM. The allowed arithmetic operations are addition, subtraction, multiplication, division, and raising a number to a positive integral power. Numbers in BASIC2 may be considered to be stored in floating-point notation with seven-digit accuracy. The smallest and largest normalized numbers are $2.710505 \text{ E}-20$ and $9.223372 \text{ E}+18$. The BASIC statements allowed are: DIM (to declare one-dimensional arrays), LET, GO TO, GO SUB, and RETURN, IF-THEN, FOR-TO-STEP-NEXT, REM, END, STOP, INPUT, PRINT, GET, PUT, and CALL (to call a user-written assembly language subroutine). The built-in functions are ABS (for absolute value) and INT (for least integer part). Interpreter commands include FREE, RUN, LIST, PLIST (to LIST to a peripheral device), PTAPE (to input a program from a peripheral device), and SCR (to clear user memory). In the second, or "hardware", implementation of BASIC2 requiring an Am9511 Arithmetic Processing Unit (APU) interfaced to the 8080 microprocessor, arithmetic operations are performed by the APU. The following additional built-in functions are available in this implementation: square root, sine, cosine, tangent, arcsine, arccosine, arctangent, exponential, logarithm base e, and logarithm base 10. For this implementation, in raising to a power only non-negative bases are allowed, but they may be raised to any power as long as the result is within the valid number range.

806 2DEPEP - 2DEPEP solves the partial differential equation system:

$$C1(X,Y,U,V,T) \cdot DU/DT = D(OXX)/DX + D(OXY)/DY + F1(X,Y,U,V,T)$$

$$C2(X,Y,U,V,T) \cdot DV/DT = D(OYX)/DX + D(OYY)/DY + F2(X,Y,U,V,T)$$

in a general two-dimensional region, R, with

$$U = FB1(S)$$

$$V = FB2(S) \text{ for } S \text{ on } BR1, \text{ and}$$

$$OXX \cdot NX + OXY \cdot NY = GB1(S,U,V,T)$$

$OYX \cdot NX + OYY \cdot NY = GB2(S,U,V,T)$ for S on BR2, where BR1 and BR2 are distinct parts of the boundary. (NX,NY) = unit outward normal.

$$U = U0(X,Y)$$

$$V = V0(X,Y) \text{ for } T = T0, \text{ and}$$

$$OXX = OXX(X,Y,DU/DX,DU/DY,DV/DX,DV/DY,T)$$

$$OXY = OXY(X,Y,DU/DX,DU/DY,DV/DX,DV/DY,T)$$

$$OYX = OYX(X,Y,DU/DX,DU/DY,DV/DX,DV/DY,T)$$

$$OYY = OYY(X,Y,DU/DX,DU/DY,DV/DX,DV/DY,T).$$

The Jacobian matrices of derivatives of OXX,OXY,OYX,OYY with respect to DU/DX,DU/DY,DV/DX,DV/DY and of F1,F2 with respect to U,V and of GB1,GB2 with respect to U,V must be symmetric.

The related elliptic and eigenvalue problems are also solved by 2DEPEP and single equations can be handled efficiently. Examples of applications of the program are elasticity, one- or two-component diffusion, heat conduction, minimal surface, potential problems and the time-independent and time-dependent Schrodinger equations.

812 MTRC0001 - MTRC0001 was developed to convert SI metric units of measurement from engineering drawings to U.S. customary dimensions based on the rounding rules specified in the Mound Laboratory Design/Drafting Standard DWG No. SPA760290.

816 DPOLE - DPOLE solves the Dirichlet problem for the Helmholtz equation over a general bounded three-dimensional region imbedded in a unit cube $-W(XX)-W(YY)-W(ZZ)+CC \cdot W=G1$ in the region $W=F$ on the boundary where F and G1 are given functions of X, Y, and Z, and CC is a real constant. The boundary is arbitrary.

819 ANOVA - ANOVA provides the analysis of variance techniques necessary to analyze experimental data. Four models can be used to analyze one, two, or three factor experiments, with the factors being either fixed or random. These models are: fully

P. GENERAL MATHEMATICAL AND COMPUTING SYSTEM ROUTINES

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crossed, fully nested, factors A and C crossed with B nested in A, and factors A and B crossed with C nested in AB.

Q. MATERIALS

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- 586 RESPOND** - RESPOND calculates the relative energy absorption of a small region of one material in a large body of another material exposed to gamma- or x-radiation.
- 609 INDX** - INDX provides a means for rapidly defining and testing trial unit cells as an aid to indexing powder patterns of crystal structures of unknown symmetry.
- 619 ISOTAB** - Given measured calorimeter measurement dates and the isotopic composition for a plutonium sample, ISOTAB computes for a sample of mixed isotopes (Pu238, Pu239, Pu240, Pu241, Pu242, and Am241) a table between two specified dates. The table contains: a) the power output (in watts), b) the specific power (in milliwatts/gram), c) the total plutonium mass (in grams), and d) the estimated error (in grams) for each date in the table. If you do not desire all the table values printed between the table start date and the table end date, a table interval greater than one day may be specified.
- 620 GROUP2** - This program calculates the symmetry properties of lattice vibrations either for atomic crystals or for external modes of molecular crystals and generates the irreducible multiplier representations (IMR's) including the effects of time reversal invariance (TRI) on the symmetry coordinates.
- 655 XDTRAP** - XDTRAP calculates gas diffusion with trapping. The effect of trapping on hydrogen permeation and evolution was explored for a range of parameter values from computer-generated tables of concentrations of diffusing and trapped hydrogen.
- 680 MARLOWE** - MARLOWE generates atomic displacement cascades in crystalline solids and analyzes many of their properties. Analyses available include primary recoil range distributions, replacement sequence directions and length distributions, distributions of pair separations, and various detailed cascade reports.
- 758 COREL/RASE4/DAMG2** - COREL calculates the final average projected range, standard deviation in projected range, standard deviation in locations transverse to projected range, and average range along path for energetic atomic projectiles incident on amorphous targets or crystalline targets oriented such that the projectiles are not incident along low index crystallographic axes or planes.
- RASE4 calculates the instantaneous average projected range, standard deviation in projected range, standard deviation in locations transverse to projected range, and average range along path for energetic atomic projectiles incident on amorphous targets or crystalline targets oriented such that the projectiles are not incident along low index crystallographic axes or planes. RASE4 also calculates the instantaneous rate at which the projectile is depositing energy into atomic processes (damage) and into electronic processes (electronic excitation), the average range of target atom recoils projected onto the direction of motion of the projectiles, and the standard deviation in the recoil projected range.
- DAMG2 calculates the distribution in depth of the energy deposited into atomic processes (damage), electronic processes (electronic excitation), or other energy-dependent quality produced by energetic atomic projectiles incident on amorphous targets or crystalline targets oriented such that the projectiles are not incident along low index crystallographic axes or planes.

- 527 HERMES** - The HERMES model calculates the regional radionuclide releases and radiation dose to the populace in a given year arising from the operation of nuclear facilities to meet electrical generation demands within a given study region.
- 591 PLETHS** - PLETHS is a time-sharing isopleth-area program for determining ground-level areas of high pollutant concentration downwind of a single source of emission. These elliptical areas are enclosed by isopleths of constant concentration produced by continuous pollutant emissions from one smoke stack or ground source, or from a closely associated group of single sources. Stack height, weather conditions, and source emission rate are typed in and the program calculates and describes the high pollution areas enclosed by isopleths.
- 599 TOPLYR2** - TOPLYR2 applies the first law of thermodynamics to compute the temperature of a water mass flowing in an open channel. The program is designed to accommodate variable depth, velocity, and cross section. The source of energy (location of the discharge) is assumed to be sufficiently distant from the river segment under examination that the momentum associated with the discharge is insignificant. Velocity distribution at both the inlet and outlet of the reach as well as the temperature distribution at the inlet as a function of time and at the outlet initially are specified. Eddy diffusivities, ambient meteorological conditions, and geometry are also supplied to the code. Although the lateral eddy diffusivity is allowed to vary spatially, the effect of density disparity is not treated explicitly by the code. Temporal behavior induced by variations in the ambient meteorological and boundary conditions are computed.
- 687 SITE2** - SITE2 is designed to (1) screen candidate energy facility sites or areas within an electric utility region, based on the region's physical and socioeconomic attributes, the planned facility's characteristics, and impact assessments, and (2) evaluate the cumulative regional impacts associated with alternate energy supply options and interregional energy import/export practices, specifically, comparison of different energy technologies and their regional distribution in clustered or dispersed patterns.
- 692 SOLSYS** - SOLSYS simulates the transient response of solar energy systems. It can be used to predict performance characteristics of a system; parametric studies can be performed for optimization and to determine auxiliary fuel requirements.
The program consists of a component subroutine library, an information subroutine library, a control-component subroutine library, and an executive program.
- 724 MOBY** - MOBY calculates daily heating and cooling energy requirements for a mobile home, or other structure of light construction and box-like shape, using hourly weather data from tapes available from NOAA, the National Oceanographic and Atmospheric Administration.
- 774 POLUTE** - POLUTE is a computer model designed to estimate the uptake of air pollutants by forests. The model utilizes submodels to describe atmospheric diffusion immediately above and within the canopy, and into the sink areas within or on the trees. The program implementing the model is general and can be used, with only minor changes, for any gaseous pollutant. The model provides an estimate describing the response of the vegetation-atmosphere system to the environment as related to three types of processes: atmospheric diffusion, diffusion near and inside the absorbing plant, and the physical and chemical processes at the sink on or within the plant.
- 787 ATM** - ATM can be used to estimate the transport of a pollutant from an emitting source to some receptor point. It is based on a Gaussian plume model and is capable of calculating wet and dry deposition and air concentration of non-radioactive pollutants at various receptor points located within 50 kilometers of a source or sources. The model can treat point, area, and line sources, including wind blown sources. The use of either the Pasquill-Gifford or the Briggs-Smith dispersion parameters can be specified.
- 788 SULCAL** - SULCAL models the chemical reactions of sulfur species in the plume of a fossil fuel power plant, their transport through the atmosphere and deposition on the land surface. The model employs averaged concentrations based on the Gaussian plume and can calculate deposition rates for gaseous and particulate material as a function of such variables as distance from the source, wind speed, meteorological stability class,

temperature, relative humidity, and the ambient concentrations of OH radical, ozone, and ammonia.

- 789 ODMOD** - ODMOD is a transport model which predicts the coupled movement of both water and trace contaminants through a layered and unsaturated soil-moisture zone. In order to achieve computation speeds suitable for watershed implementations, moisture properties are approximated as exponential functions of pressure head, and lateral flows are treated as sinks in a basically vertical one-dimensional analysis. In addition, only advection by the Darcy-flow velocities and linear absorption by the soil-matrix are considered in depicting movement of the trace contaminant.
- 793 CHNSE** - CHNSE is an expanded model of hydrologic response of a watershed. It includes the simulation of trace contaminant transport through the watershed. Within the stream channel system trace contaminant is transported in dissolved and adsorbed form. CHNSE includes both SEDTRAN, a model of sediment transport through a rectangular stream channel system, and the Wisconsin Hydrologic Transport Model, WHTM (NESC Abstract 808), a processes model. Processes considered in CHNSE include particulate mobilization (sheet erosion and overland transport) and dissolved contaminant transport (associated with run off, interflow, and base flow inputs to the channel system). An ion exchange submodel simulates the soil-contaminant-water interaction at the land surface, and sediment transport and partitioning of trace contaminant between water and sediment in the channel system are also included. Following its entry into the channel system, dissolved contaminant transport is derived from flow routing algorithms of the WHTM. Routing of the adsorbed fraction is controlled by sediment transport dynamics, which are governed by bedload and suspended load sediment transport.
- 794 OPTRM** - OPTRM is utilized to determine an optimal set of model parameters for the Wisconsin Hydrologic Transport Model, WHTM (NESC Abstract 808). An optimal set of parameters is defined as that set which gives in a mathematical sense the best simulation; i.e., which provides the best match on either a monthly or daily basis between observed outflows and simulated outflows. The term outflow applies here to either water or trace contaminant values.
- 808 WHTM** - WHTM is the Wisconsin Hydrologic Transport Model which treats the movement of water and trace amounts of chemicals from the place and time of introduction onto the land area segments of a watershed, through these segment vertical profiles to the water table or laterally to streams, and through the stream channel network to the watershed outfall. Overland and stream flow are governed by the Chezy-Manning equation. Trace chemical transport is represented by an ion-exchange model which uses a single distribution coefficient $K(d)$ for each chemical species. Operation of the program requires historical hourly precipitation data and daily or monthly climatological data in addition to the parameters used to describe the watershed.
- 811 COMB** - COMB performs a steady-state one-dimensional analysis to predict overall behavior of a high-temperature coal combustor for use in open-cycle MHD power-generation systems. Following ignition a one-dimensional flow model with radiative heat loss is used to describe the subsequent vaporization of ash and devolatilization, combustion, and gasification of the coal. Combustion is considered to take place either at a flame sheet in the diffusion layer surrounding each particle or at the particle surface. Redistribution of combustion products in the main gas stream of the combustor is assumed to occur according to simplified chemical equilibrium criteria, and the various competing reactions within the coal particle are resolved by use of a simplified devolatilization rate formula.
- 814 TRITMOD** - TRITMOD is a steady-state advection model of tritium dispersion and cycling in underlying vegetation and soil from an atmospheric point source. Radial geometry is assumed. Tritium is in both gaseous and water vapor form.

577 FFEARS - FFEARS is generally applicable for the solution of boundary value problems involving the Laplace equation using difference equations in axisymmetric or rectangular coordinates. It will handle virtually any configuration of dielectrics and floating electrodes, producing both equipotential and equifield plots, if desired.

681 ACCEL MOD2 - ACCEL is a set of computer programs designed to aid in the construction of electronic printed circuit boards. The ACCEL system performs the following tasks -

- (1) edits the engineers' data, resolves the schematic into a node component-list, looks up physical and electrical data for the parts used in the circuit, and notes any errors in the data;
- (2) locates the components on the board by an iterative process;
- (3) lays out the interconnection pattern between components;
and
- (4) generates the output plots.

697 F0355 - Program F0355 produces a plot which shows the geometry of the cutter required to produce a given external circular spur gear or ratchet wheel. It is particularly applicable for non-involute tooth forms. In addition, the program can provide a comparator chart for inspecting cutters, indicate whether a given geometry can be shaped, and be used to determine the effects of changes in pitch diameter and related variables. The output of the program is a magnified drawing of the shaper cutter, the workpiece, and the paths of the cutter teeth. The program does not print a numerical description of the cutter profile.

721 WFLLL2B - WFLLL2B solves the problem of electromagnetic radiation from wire structures in free space or in the presence of a lossy half-space, including structures penetrating the interface. Antenna structures may be composed of many interconnected wires of differing radii, which may be impedance loaded. Electric space and surface wave fields may be evaluated.

782 DOE2.0 - DOE2.0 is a set of computer programs for the analysis of energy consumption in buildings. Programs are included to calculate the heating and cooling loads for each space (zone) in the building for each hour of a year (LOADS), to simulate the operation and response of the equipment and systems that control temperature and humidity and distribute heating and cooling to the space (SYSTEMS), to model primary energy conversion equipment that uses fuel (e.g. oil, gas, or sun) to provide the required heating, cooling, and electricity (PLANT), and to compute the life-cycle cost for building operation based on economic parameters (ECONOMICS). A problem-oriented building design language (BDL) facilitates the description of the building geometry, its central plant equipment, its HVAC systems, occupancy, equipment, and lighting schedules, and the selection of other problem parameters. In addition to the LSPE programs (LOADS, SYSTEMS, PLANT, and ECONOMICS), the system includes the BDL processor, two report generators, a weather data processor, and a stand-alone response factor generating program. Standard output reports are produced by the RPTGEN program. A weather data tape included with the system contains weather station data for 61 U.S. cities and 15 California climate zones.

799 TDIST2 - The TDIST2 program designs and performs an analysis of community size total energy systems supplying thermal and electrical energy to a multi-consumer-type metropolitan area. The program models the time-dependent energy requirements of building unit consumers, distributes these demands within a Thermal Utility System (TUS), simulates the TUS performance and determines the required behavior of the power station and thermal-energy storage reservoir. The energy requirements of the community fall into three categories: space conditioning demands (heating and cooling), electric non-space conditioning demands (load from use of lights, motors, etc.), and hot water demands.

- 605 GAUSS5** - GAUSS5 is used to determine gamma-ray energies and intensities from spectra obtained with a Ge(Li) detector and a multichannel pulse-height analysis system.
- 645 DYNAMIC ANALYSIS OF GASES** - The program processes mass spectral data to determine the rate at which gases evolve from a solid sample and the total quantity of gas evolved. Calibration data and mass-peak measurements are described as input data. Gas flow rate and gas quantity are described as output data. It is used for the dynamic analysis of gases by fast scanning mass spectrometry. Although written for data obtained from a Bendix model 12-107 time-of-flight (TOF) mass spectrometer, it may be applied to any type of mass spectrometer. The Bendix mass spectrometer is used to continually monitor gases evolved during vacuum bakeout of solid samples. The technique is used to determine surface contaminants, adsorbed and trapped gases and other volatile outgas products.
- 662 SOLVEX** - SOLVEX simulates the dynamic and steady-state behavior of solvent extraction banks composed of either mixer-settlers or centrifugal contactors. Two options permit terminating dynamic phases by time or by achieving steady-state, and a third option permits artificial rapid close to steady-state. Distribution data may be expressed in the form of tables or cubic polynomial equations.
- 690 SEPHIS/MOD4** - SEPHIS/MOD4 simulates the solvent extraction portions of either the Purex or the Thorex process. The program iteratively applies an unsteady state mass balance to a series of ideal mixer settler stages to follow the changes in solute concentrations. Reasonably good agreement has been found between the calculated and experimental concentrations. The components considered by SEPHIS/MOD4 are nitric acid, thorium, uranium, plutonium (IV), plutonium (III), a plutonium reductant, and inextractable nitrate salts.
- 720 RICE-LASL** - The fluid dynamics of chemically reactive mixtures are calculated at arbitrary flow speeds with the RICE-LASL program. Application is made to continuous wave HF chemical lasers to compute the supersonic mixing and chemical reactions that take place in the lasing cavity.
- 736 BIOSSIM** - BIOSSIM determines the time course of chemical reactions in chemical (or biochemical) systems. The user inputs a description of the chemical reactions of the system with initial chemical concentrations and reaction rate constants. The program calculates the concentrations of these chemicals as a function of time.
- While the simulation program is designed for chemical systems, it has features which facilitate the ability to work with distribution equations for enzyme forms. The simulation program may also be applied to other areas where appropriate. It has been applied to compartmental analysis of radioactive tracer data in physiological modeling and interacting animals in ecological systems. In general, this program can be used as a differential equation solver for any set of simultaneous linear or nonlinear differential equations of first and higher orders.

V. PARTICLE ACCELERATORS AND HIGH VOLTAGE MACHINES

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791 TRANSPORT - The first- and second-order optical properties of static-magnet charged particle beam transport systems are analyzed. The program can vary some of the physical parameters of the elements comprising the system and impose various constraints on the beam design.

807 SLACKLY - SLACKLY performs a one-dimensional analysis of a multicavity Klystron tube. Its formulation is based on the application of polarization variables to the physics of the propagation of a confined beam of electrons within a drift tube and the interaction of this beam with the cavities of the Klystron. By specifying the geometry of the Klystron and an appropriate set of initial conditions, a comprehensive analysis of the tube's characteristics will result. Space charge effects and higher-order harmonics are included in the simulation.

574 MACS LATTICE VIBRATION CODES - This package of seven related codes is basically aimed at giving maximum capability for calculating slow-neutron scattering by moderators.

MACS-C computes crystal vibrations when the potential energy is a sum of parts arising from short-range forces and long-range Coulomb interactions. It also obtains Jacobian matrices for determining adjustments in force constants and ionic charge which can lead to improved agreement with data. Structure factors for neutron inelastic scattering can also be calculated.

MACS-J computes the dynamical matrix for the harmonic oscillations of a crystal, its eigenvalues and eigenvectors, the corresponding structure factors for coherent single-phonon scattering of neutrons, and Jacobian matrices for use in adjusting force constants to fit calculated to observed dispersion curves.

REVISED-D calculates valance coordinates in terms of mass adjusted atom displacements, together with coordinates which define rigid group rotations.

REVISED-MVFC constructs force constant matrices for use in valance force potential functions which are used in other programs dealing with molecular and crystal vibrations.

ADJUSTER is a force adjuster program to obtain a least squares fit to observed frequencies of molecules and crystals.

DIPOLE-SUM calculates dipole sums for an arbitrary crystal.

MODEL-PI calculates crystal vibrations when the potential energy is a sum of short-range and long- or intermediate-range terms in the dipole coordinate approximation. It also obtains Jacobian matrices for use in adjusting input parameters.

575 MSCAT - In a thermal neutron scattering experiment, the measured cross section includes both single and multiple scattering events. In order to extract the single scattering cross section, the cross section for multiple scattering must be known. Since this contribution is generally a smoother function of angle and scattered energy than the single scattering, it is less sensitive to details of the single scattering cross section. It is therefore feasible to calculate the multiple scattering using an approximate scattering function, and to subtract it from the measurements in order to obtain the single scattering. MSCAT calculates the single and multiple scattering cross sections, for a specified experimental situation, given a single scattering function as input.

622 GAUSS6 - GAUSS6 is used for the production analysis of gamma-ray spectra obtained with a Ge(Li) detector and a multichannel pulse-height analyzer system. In addition to determining gamma-ray energies and intensities, it provides isotopic identification, decay corrections and correlation of data from different peaks and different spectra to obtain isotopic decay rates.

632 MMM3 - MMM3 computes the eigenvalues (frequencies) and eigenvectors (normal modes) for a semi-rigid molecule, and computes the transformation matrix for expressing the Cartesian displacements of the atoms in terms of the normal coordinates. Computation of the effective atomic masses and mean-squared amplitudes of vibration for use in slow neutron scattering calculations is included as well.

742 CASIM - CASIM is a Monte Carlo program to study the average development of high energy cascades in large targets (shields) of arbitrary geometry and composition. The program is best suited for incident energies in the range 20-1000 GeV.

786 CONDYN - The CONDYN program fits a Polya (negative binomial) frequency distribution to an observed secondary electron spectrum. Secondary-electron yields measured by a spectrometer are fit to the Polya statistical model by a nonlinear least squares technique. There are two basic assumptions in the Polya model: (1) the mean secondary-electron yield from each small, thin element of surface area of an ion-converter dynode follows a Poisson distribution, and (2) the frequency of these mean yields follows a gamma distribution.

X. MAGNETIC FUSION RESEARCH

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561 TOKMINA/TOKMINA2 - TOKMINA finds the minimum magnetic field, B_m , required at the toroidal coil of a Tokamak type fusion reactor when the input is β (ratio of plasma pressure to magnetic pressure), q (Kruskal-Shafranov plasma stability factor), and y (ratio of plasma radius to vacuum wall radius: r_p/r_w) and arrays of PT (total thermal power from both d-t and tritium breeding reactions), P_w (wall loading or power flux) and TB (thickness of blanket), following the method of Golovin, et al. TOKMINA2 finds the total power, PT , of such a fusion reactor, given a specified magnetic field, B_m , at the toroidal coil.

749 STEEP4 - STEEP4 calculates fusion reaction rates in terms of the specific reactivity ($\sigma-v$) which is the product of cross section and relative velocity averaged over the actual ion distributions of the interacting particles in the plasma. Maxwellian ion distributions are modified to include slowing-down contributions which are characterized in terms of plasma parameters. Rapid and accurate algorithms are used for integrating the specific reactivity from spectra and input cross sections. Options are also provided for rapid calculation of screening effects on specific reaction rates.

356 GAF/GAR Data Tapes used in GGA - A benchmark study of ZPR-III Assembly 48 using ENDF/B cross sections was undertaken to identify possible cross section discrepancies in the microscopic ENDF/B data. This work was done for the CSEWG testing subcommittee as part of their Phase I data testing. This package contains the cross section data generated for this study in the form of the ultra-fine group cross sections of the materials of ZPR-III Assembly 46 in the format of the GGA GAF/GAR program data tapes.

447 ETOG1 Data for MUFT and GAM - The data required for the creation of MUFT4, MUFT5, GAM1, and GAM2 libraries were generated from the Brookhaven National Nuclear Data Center ENDF/B tapes 114 through 117 by the ETOG1 program (NESC Abstract 437).

532 LASL GROUP-AVERAGED X-SECTIONS - Group constants and computed neutron cross sections are tabulated for a variety of materials including - Al, B, Be, C, Cd, Cl, D, Ga, F194, Fe, H, K, Li6, Mo, Na, Ni, O, Pu239, Pu240, Pu249, Th, U233, U235, U238, and Zr. These are presented as 18-, 24-, and 25-group calculations for reactors with neutron energies ranging from fast to thermal.

543 ENDF/B-THERMOS - These data are 30-group THERMOS thermal scattering kernels for P0 to P5 Legendre orders for every temperature of every material from s(alpha,beta) data stored in the ENDF/B library. These scattering kernels were generated using the FLANGE2 computer code (NESC Abstract 368). To test the kernels, the integral properties of each set of kernels were determined by a precision integration of the diffusion length equation and compared to experimental measurements of these properties. In general, the agreement was very good. Details of the methods used and results obtained are contained in the reference. The scattering kernels are organized into a two volume magnetic tape library from which they may be retrieved easily for use in any 30-group THERMOS library. The contents of the tapes are as follows -

VOLUME I

Material	ZA	Temperatures (degrees K)
Molecular H2O	100.0	296, 350, 400, 450, 500, 600, 800, 1000
Molecular D2O	101.0	296, 350, 400, 450, 500, 600, 800, 1000
Graphite	6000.0	296, 400, 500, 600, 700, 800, 1000, 1200, 1600, 2000
Polyethylene	205.0	296, 350
Benzene	106.0	296, 350, 400, 450, 500, 600, 800, 1000

VOLUME II

Material	ZA	Temperatures (degrees K)
Zr bound in ZrHx	203.0	296, 400, 500, 600, 700, 800, 1000, 1200
H bound in ZrHx	230.0	296, 400, 500, 600, 700, 800, 1000, 1200
Beryllium-9	4009.0	296, 400, 500, 600, 700, 800, 1000, 1200
Beryllium Oxide	200.0	296, 400, 500, 600, 700, 800, 1000, 1200
Uranium Dioxide	207.0	296, 400, 500, 600, 700, 800, 1000, 1200

637 GAMTAB - This package contains a two-part catalog of gamma rays emitted by nuclides in radioactive decay and a list of corresponding references. The first part lists the gamma rays in order of ascending energy. This listing consists of gamma-ray energy and uncertainty, abundance, half-life, production mode, and the energies of two of the more abundant associated gamma rays. The second part of the catalog lists up to 50 of the more abundant gamma rays for each nuclide. The listing for each nuclide includes half-life, production mode, possible genetic relationships, and references. This listing is followed by the energy, uncertainty in energy, and abundance of each gamma ray. References available through May 1973 corresponding to the reference keys listed for each nuclide in part 2 are listed as the third file.

Z. DATA

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693 SOLDATBQ62 - SOLDATBQ62 is a data collection consisting of readings of direct and total solar radiation intensities and related parameters for solar energy systems studies. The solar data measurements are for Albuquerque, New Mexico for the year 1962. The items presented are: hour, wind direction, wind speed, dry bulb temperature, wet bulb temperature, dew point, atmospheric pressure, sky cover, visibility, atmospheric precipitable water vapor content, hourly integral of direct-normal radiation, hourly integral of total-horizontal radiation, six readings of direct-normal intensity at 10-minute intervals, and six readings of total-horizontal radiation at 10-minute intervals. These data were compiled from strip-chart recordings of the National Climatic Center, Asheville, North Carolina.

APPENDIX B: KWIC INDEX

A&TS

ALGEBRAIC

A&TS	370	F4	RS P C H	\$FLAC, STEADY-STATE FLOW, PRESSURE DISTRIBUTION	395
A-E	ANL	360B	F+P+A RS	T P \$AMDLIBAE, ARGONNE SUBROUTINE LIBRARY CAT.	562
AAEC	360	F+BAL	RSBPLXCT G	\$NAIAD, COMPRESSIBLE 2-PHASE COOLANT BEHAVIOR	726
ABSORPTION REMOVAL X-SECS	BAPL	6600	F4 RS	B \$M0807, 2-D DIFFUSION	R280
ACCEL(MOD2), DESIGN OF PRINTED-CIRCUIT BOARDS	SLA	1108	F+BAL RSBP T T S		681
ACCEL(MOD2), DESIGN OF PRINTED-CIRCUIT BOARDS	SLA	6600	F+COM RS P T T S		681
ACCIDENT	BNL	7600	F+COM RS P T G	\$NALAP, LMFBR TRANSIENT RESPONSE TO	780
ACCIDENT ACTIVITY RELEASE	PGE	360	F4 RS P T G	\$SEMERALD REV. 1, PWR	546
ACCIDENT ANALYSIS	BAPL	6600	F4 RS P T G	\$FLASH3, LOSS-OF-COOLANT	R295
ACCIDENT ANALYSIS	HEDL	6600	F4 RS P T G	\$CACECO, LMFBR CONTAINMENT	R762
ACCIDENT ANALYSIS	NED	635	F4 RS P T G	\$FREADM1, FAST REACTOR CORE	479
ACCIDENT ANALYSIS	BAPL	6600	F4 RS P T G	\$M0555, ACT1, LOSS-OF-COOLANT	R284
ACCIDENT ANALYSIS DOSE CALC	GGA	1108	F4 RS	T G \$GADOSE, DOSET, HTGR	261
ACCIDENT CONSEQUENCES	NRC	370	F4 RS PLX T G	\$CRAC, CALC OF REACTOR	722
ACCIDENT CORE HEATUP & MELTDOWN	BCL	6400	F4 RS P	G \$BOIL1, BOILOFF	734
ACCIDENT RELEASED RADIOLOGICAL DOSE	AI	370	F4 RS P T G	\$COMRADEX4,	663
ACRC	370	F4	RS P CT N	\$PRPLOT, LINE PRINTER PLOT SUBROUTINE PACKAGE	773
ACTIVITY RELATION	GEC	635	F4 RSBP	D \$DOS, NEUTRON FLUX-DOSE-METER	423
ACTIVITY RELEASE	PGE	360	F4 RS P T G	\$SEMERALD REV. 1, PWR ACCIDENT	546
ACTIVITY RELEASE AND DOSE	PGE	360	F4 RS P T G	\$SEMERALD-NORMAL, PWR	685
ACT1, LOSS-OF-COOLANT ACCIDENT ANALYSIS	BAPL	6600	F4 RS P T G	\$M0555,	R284
ADEP, 1-D & 2-D FEW-GROUP SPACE-TIME KINETICS	BCL	6400	F4 RS P T F	\$	494
ADLER, ENDF/B RESONANCE XSECTION CODES	BNL	6600B	F4 RS P T A	\$RESEND,	465
ADSORBERS ORNL	360	F4	RS P T G	\$CHART, IODINE DECAY HEAT ON CHARCOAL	804
ADVECTION MODEL OF TRITIUM DISPERSION	DP	360	CSMP S	R \$TRITMOD,	814
AEB	360	F4	RS L T C	\$FIRE5, 1-D AGE-DIFFUSION SLAB CYLINDER SPHERE	9
AEB	360	F4	RS P	B \$WELWING, MATERIAL BUCKLING CYL FUEL ELEMENTS	362
AEB	360	F4	RS P	E \$AIRESK3, SPACE-INDEPENDENT KINETICS W/FEEDBACK	121
AEB	360	F4	RS P	E \$BLAST, REACTOR KINETICS TEMPERATURE DIST STUDY	363
AEC DP PURCHASE VERSUS LEASE ANALYSIS	SLA	360	COBOL RSBP CT M	\$BECOM,	R589
AEC DP PURCHASE VERSUS LEASE ANALYSIS	SLA	1108	COBOL RS P	M \$BECOM,	R589
AEC-ALO FAU, RADIO FREQUENCY MANAGEMENT SYSTEM	ALOO	360	COBOL RS P	M \$	587
AEROSOL BEHAVIOR LOG-NORMAL DIST MODEL	BCL	6400	F4 RS P T G	\$SHAARM3,	797
AEROSOL BEHAVIOR LOGNORMAL MODEL	AI	370	F RS P T G	\$SHAA3B,	443
AEROSOL PARTICLE TRANSPORT STUDY	ANL	370	F4 RS P	G \$DISPER1,	554
AFTER LOCA	BCL	6400	F4 RS P T G	\$CORRAL2, RADIONUCLIDE CONTAINMENT	745
AGE CALCULATION OF ENDF/B DATA	BAPL	6600	F4 RS P T B	\$EPOCH, NEUTRON	R461
AGE-DIFFUSION SLAB CYLINDER SPHERE	AEB	360	F4 RS L T C	\$FIRES, 1-D	9
AI	360	F+BAL	RS T P	\$FIGS, IBM360&2250 FORTRAN GRAPHICS SUBROUTINES	484
AI	360	F+BAL	RS P T A	\$CCMNUC, CASCADE, COMPOUND NUCLEUS REACTION	482
AI	360	F+BAL	RS P T E	\$AIROS2A, SIMULATION OF REACTOR DYNAMICS	326
AI	360	F+BAL	RS P CT A	\$U3R, UNRESOL RESONANCE XSEC PROBABILITY TABLES	553
AI	360	F+BAL	RS P X T B	\$HWOCR-SAFE, 2-D MONTE CARLO CELL CALCULATION	307
AI	360	F+BAL	RSB L CT M	\$SCORE3, SCISRS ENDF/B GRAPHIC X-SEC EVALUATION	375
AI	360	F4	RS P	G \$SOFIRE2, SODIUM POOL FIRE 1- & 2-CELL ANALYSIS	559
AI	360	F4	RS P	Q \$RESPOND, DISSIMILAR MEDIA TLD CORRECTION CALC	566
AI	360	F4	RS P T F	\$TSN, SPATIALLY-DEPENDENT REACTOR KINETICS	309
AI	360	F4	RS P T G	\$AISITE2, PARAMETRIC SITE REQUIREMENT STUDY	172
AI	360	F4	RS P C I	\$PSA2, STRESS ANALYSIS MULTIANCHOR PIPE SYSTEM	542
AI	360	F4	RS PLX T B	\$AILMOE, X-SECTION CALC ELASTIC SCAT RESONANCES	147
AI	360	F4	RSB L T M	\$CLIP, FORM OR THREDES LIBRARY UTILITY ROUTINE	271
AI	360	F4	RSBP T K	\$THREDES, 1-D FEW-GP DIFFUSION DESIGN SYSTEM	273
AI	360	F4	RSBP X T D	\$SIZZLE, 1-D MULTIGROUP DIFFUSION DEPLETION	58
AI	360	F4	RSBPLX T C	\$CAESAR4, LIBLST, 1-D MULTI-GP DIFFUSION & LIB.	270
AI	370	F	RS P T G	\$HAA3B, AEROSOL BEHAVIOR LOGNORMAL MODEL	443
AI	370	F4	RS P T G	\$COMRADEX4, ACCIDENT RELEASED RADIOLOGICAL DOSE	663
AI	370	F4	RS P T G	\$SOMIX1, SODIUM SPRAY FIRES IN CYLINDRICAL CELL	R751
AI	7600	F4	RS PLX T C	\$VIM1, MONTE CARLO CRITICAL ASSEMBLY ANALYSIS	510
AI-A	360	F4	RSBPLXCT C	\$VIM1X, MONTE CARLO CRITICAL ASSEMBLY ANALYSIS	510
AILMOE, X-SECTION CALC ELASTIC SCAT RESONANCES	AI	360	F4 RS PLX T B	\$	147
AIM AND FOG CODES	BHSC	360	F4 RS P	C \$PERT, 1-D PERTURBATION FOR	30
AIM6, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	OSUC	370	F4 RS PL CT C	\$	29
AIRS	7600	F4	RS P T C	\$FLARE, 3-D REACTIVITY AND POWER DISTRIBUTION	167
AIR POLLUTANT UPTAKE MODEL	DP	360	CSMP RS	R \$POLUTE, FOREST	774
AIREK3, SPACE-INDEPENDENT KINETICS W/FEEDBACK	AEB	360	F4 RS P	E \$	121
AIREOS2A, SIMULATION OF REACTOR DYNAMICS	AI	360	F+BAL RS P T E	\$	326
AIRY & LOG GAMMA SUBROUTINES	SLA	6600	F4 RS P T P	\$BESSEL FUNCTIONS,	656
AISITE2, PARAMETRIC SITE REQUIREMENT STUDY	AI	360	F4 RS P T G	\$	172
ALAMOS SUBROUTINE LIBRARY ROUTINES	LASL	6600C	F+COM RS	T P \$LASLIB, LOS	633
ALBUQUERQUE 1962 SOLAR DATA	SLA	6600	BCD R	L T Z \$SOLDATABQ62,	693
ALBUQUERQUE 1962 SOLAR DATA	SLA	6600B	BIN R	L T Z \$SOLDATABQ62,	693
ALGEBRAIC EQN SOLN CURVE PLOT	KAPL	6600	F+ASC RS P T P	\$SNEQ, NONLINEAR	R364

ALGEBRAIC

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ALGEBRAIC EQUATNS	ANL	370	F4	RS P X T P	SLINPACK, SIMULTANEOUS LINEAR	800
ALGORITHM	LASL	7600B	F	RS P	H SSOLA, SOLA-SURF, TRANSIENT FLUID FLOW	651
ALLOC	ORNL	360	BAL+F	RS P C P	\$GETCOR, FRECOR, FORTRAN DYNAMIC STORAGE	644
ALLOCATION PROJECT PLANNING	MLMO	360	F+C+R	RSBP T M	\$RALCRPH, RESOURCE	G603
ALOO	360	COBOL	RS P	M	\$AEC-ALO FAU, RADIO FREQUENCY MANAGEMENT SYSTEM	587
ALPHA-M, RESOLUTION OF GAMMA-RAY SPECTRA	ORNL	360	F4	RS P	O \$	413
ALVIN, DIFFERENTIAL-INTEGRAL DATA CONSISTENCY	LASL	7600	F4	RS P CT A	\$	815
AMDLIBAE, ARGONNE SUBROUTINE LIBRARY CAT. A-E	ANL	360B	F+P+A	RS	T P \$	562
AMDLIBF, ARGONNE SUBROUTINE LIBRARY CAT. F	ANL	360B	F+BAL	RS	T P \$	563
AMDLIBGZ, ARGONNE SUBROUTINE LIBRARY CAT. G-Z	ANL	360B	F+P+A	RS	T P \$	564
AN-T	360B	F4	RSBP CT I	\$CYGR03, OXIDE FUEL ROD STRESS & DEFORMATION		R449
ANALYSES SEMI-RIGID MOLECULES	EG&G	360	F4	RS P	W \$MM3, COORDINATE	632
ANALYZER GAMMA-RAY SPECTRA	GGA	1108	F+BAL	RS P T O	STOAD, PROCESSING OF	333
ANCON, SPACE-INDEPENDENT REACTOR KINETICS CODE	ANL	360	F4	RS P T E	\$	486
ANCON, SPACE-INDEPENDENT REACTOR KINETICS CODE	LASL	6600	F4	RS P T E	\$	486
ANGULAR DISTRIBUTION LEGENDRE FITTING	KAPL	6600	F4	RS P	A \$CLEM,	R531
ANISN X-SEC FORMAT	WAPD	6600	F4	RS PL T B	SETOG1, ENDF/B TO MUFT, GAM,	437
ANISN X-SEC FORMAT	WAPD	7600	F4	RS P T B	SETOG3, ENDF/B TO MUFT, GAM,	538
ANL	360	F	RSBP T P	\$STFODE, COLODE, COLLOCATION SOLN OF STIFF ODE'S		652
ANL	360	F+BAL	RS P T C	\$DTF4, 1-D MULTI-GP DISCRETE ORDINATE PROGRAM		209
ANL	360	F+BAL	RSBP CT M	\$ARC-SYSTEM, SYSTEM SUBPROGRAMS AND MODULES		522
ANL	360	F+BAL	RSBP X T P	\$SPEAKEASY MU+, LANGUAGE PROCESSOR TSO OR BATCH		593
ANL	360	F+BAL	RSBP XCT B	\$1DX, 1-D DIFFUSION FAST X-SECTION GENERATION		374
ANL	360	F4	RS	T M \$RIGEL, ENDF/B V3 DATA PROCESSING CODE		571
ANL	360	F4	RS P	D \$NPRFCCP, FUEL CYCLE COSTS PERFORMANCE DATA		146
ANL	360	F4	RS P	E \$R101, SPACE-INDEPENDENT KINETICS KEX OPTIONS		255
ANL	360	F4	RS P	E \$R102, SPACE-INDEPENDENT INVERSE KINETICS CALC		168
ANL	360	F4	RS P	G \$NAHAMMER, FLUID HAMMER ANALYSIS PIPING SYSTEM		717
ANL	360	F4	RS P	G \$NATTRANSIENT, FLUID HAMMER ANALYSIS 1-D PIPING		718
ANL	360	F4	RS P	G \$SOCOOL2, SODIUM-FUEL INTERACTION ANALYSIS		521
ANL	360	F4	RS P	H \$MARGE/SLUMP, MAXIMUM TEMPERATURE LMFBR FUEL PIN		677
ANL	360	F4	RS P	O \$DYNO1, PHOTOMULTIPLIER ELECTRON DISTRIBUTION		R464
ANL	360	F4	RS P	T \$F0355, SHAPER CUTTER CONTOUR GENERATOR		697
ANL	360	F4	RS P	X \$TOKMINA/TOKMINA2, TOKAMAK FUSION REACTOR STUDY		561
ANL	360	F4	RS P T B	\$CLUP77, SQUARE CELL COLLISION PROBABILITY CALC		526
ANL	360	F4	RS P T E	\$ANCON, SPACE-INDEPENDENT REACTOR KINETICS CODE		486
ANL	360	F4	RS P T F	\$SAS1A, FAST REACTOR POWER AND FLOW TRANSIENTS		400
ANL	360	F4	RS P T F	\$TWIGGLE, 2-D 2-GP SPACE-TIME DIFFUSION		R338
ANL	360	F4	RS P T G	\$NATRAN2, FLUID HAMMER ANALYSIS 1D & 2D SYSTEMS		719
ANL	360	F4	RS P T H	\$EVITS, STEADY STATE TWO-DIMENSIONAL FLUID FLOW		792
ANL	360	F4	RS P T M	\$RECT,CHECKER, ENDF/B V2 PROCESSING CODES		475
ANL	360	F4	RS P T N	\$PLOT-3D, 3-D PLOTS ON IBM2280 OR CALCOMP780		544
ANL	360	F4	RS P T P	\$OCOPTH, DRVOCR, UNCONSTRAINED OPTIMIZATION		753
ANL	360	F4	RS P T Q	\$GROUP2, GROUP THEORY OF LATTICE DYNAMICS		620
ANL	360	F4	RS P T R	\$SITE2, ENERGY FACILITY SITING ASSESSMENT		687
ANL	360	F4	RS P CT D	\$3DB, 3-D MULTIGROUP DIFFUSION BURNUP ANALYSIS		567
ANL	360	F4	RS P CT F	\$REXCO-H, 2-D HYDRODYNAM RESPONSE TO EXCURSION		550
ANL	360	F4	RS P CT F	\$REXCO-H2, 2-D HYDRODYNAM RESPONSE TO EXCURSION		R615
ANL	360	F4	RS P CT L	\$QMESH, RENUM, SELF-ORGANIZING MESH GENERATION		612
ANL	360	F4	RS P CT P	\$DRAFTMAN, DRAW FIGURES & GRAPHS WITH DISSPLA		748
ANL	360	F4	RS P CT T	\$FFEARS, LAPLACE EQUATION ISOTROPIC DIELECTRICS		577
ANL	360	F4	RS P CT W	\$MSCAT, SLOW NEUTRON MULTIPLE SCATTERING CALC		575
ANL	360	F4	RS P X T F	\$FORE2, FAST REACTOR EXCURSION CALCULATIONS		174
ANL	360	F4	RS P XCT F	\$VENUS, 2-D LMFBR POWER EXCURSION DISASSEMBLY		511
ANL	360	F4	RS PL CT F	\$QX1, QUASISTATIC SPATIAL REACTOR KINETICS CODE		474
ANL	360	F4	RSBP CT C	\$ARC-DIF1D, 1-D MULTI-GP DIFFUSION & INVENTORY		626
ANL	360	F4	RSBP CT L	\$ARC-NUI002, BCD INPUT DATA PROCESSING MODULE		533
ANL	360	F4	RSBP CT C	\$VARI-1D, 1-D VARIATIONAL SENSITIVITY		625
ANL	360	F4	RSBP CT L	\$ARC-XSEC1, MICROSCOPIC X-SECTION MANIPULATION		594
ANL	360B	F+ASM	RSBP CT P	\$WSP-HASP/DOS, DOS-MFT REMOTE WORKSTATION PKG		541
ANL	360B	F+BAL	RS	T P \$AMDLIBF, ARGONNE SUBROUTINE LIBRARY CAT. F		563
ANL	360B	F+BAL	RSBP CT D	\$REBUS2, FUEL CYCLE ANALYSIS FOR FAST REACTORS		634
ANL	360B	F+P+A	RS	T P \$AMDLIBAE, ARGONNE SUBROUTINE LIBRARY CAT. A-E		562
ANL	360B	F+P+A	RS	T P \$AMDLIBGZ, ARGONNE SUBROUTINE LIBRARY CAT. G-Z		564
ANL	360B	F4	RS P	I \$NUBOW, STRUCTURAL ANALYSIS BOWED REACTOR CORES		643
ANL	360B	F4	RSBP CT H	\$COBRA3M, FUEL PIN THERMAL-HYDRAULIC ANALYSIS		659
ANL	360B	F4	RSBP XCT P	\$EISPACK2, MATRIX EIGENVALUE/VECTOR PACKAGE		534
ANL	360B	PL1	S P CT P	\$SLOP, CROSS, IBM360 FORTRAN H PROGRAM CHECKER		647
ANL	360C	F4	RS P X	P \$GEAR, ORDINARY DIFFERENTIAL EQN SYSTEM SOLVER		592
ANL	360D	BAL	RS X T P	\$COPYCAT, IBM OS SYSTEM CATALOG UTILITY ROUTINE		646
ANL	370	BAL	RSBP CT P	\$FORTIO, FORTRAN INTERFACE TO IBM370 MACROS		772
ANL	370	F+BAL	RS P T G	\$PROSA1, PROBABILISTIC RESPONSE SURFACE CODE		R778

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ANL	370	F+BAL	RSBPL	CT	B	SMC**2-2, FAST NEUTRON SPECTRA & MULTIGP X-SECS	355							
ANL	370	F+CSM	RS	P	G	\$SPOOL-FIRE, SPRAY-POOL BURNING OF SODIUM	R714							
ANL	370	F4	RS	P	G	\$DISPER1, AEROSOL PARTICLE TRANSPORT STUDY	554							
ANL	370	F4	RS	P	H	\$DIFFUSER, 2D SUBSONIC MHD DIFFUSER PERFORMANCE	737							
ANL	370	F4	RS	P	H	\$SLGTR, SLAG TRANSPORT MODELS FOR DUCT SURFACES	783							
ANL	370	F4	RS	P	I	\$NUBOW2D-INELASTIC, BOWED REACTOR CORE ANALYSIS	790							
ANL	370	F4	RS	P	P	\$FRANTIC, LEAST SQUARES FIT SUM OF EXPONENTIALS	324							
ANL	370	F4	RS	P	T	\$IMPORTANCE, FTA BASIC EVENT & CUT SET RANKING	779							
ANL	370	F4	RS	P	T	\$PTA1, PIPE SYSTEM PRESSURE ANALYSIS	R761							
ANL	370	F4	RS	P	C	\$SLIDES, FOR DISSPLA-LETTERED SLIDES & POSTERS	728							
ANL	370	F4	RS	P	CT	\$THI3D, THERMAL-HYDRAULIC MULTICHANNEL ANALYSIS	706							
ANL	370	F4	RS	P	CT	\$LIFE3, MIXED-OXIDE FUEL ELEMENT PERFORMANCE	R460							
ANL	370	F4	RS	P	X	\$DSNP, DYNAMIC SIMULATION NUCLEAR POWER PLANTS	784							
ANL	370	F4	RS	P	X	\$LINPACK, SIMULTANEOUS LINEAR ALGEBRAIC EQUATNS	800							
ANL	370	F4	RS	PL	C	\$CURIE, FISSION PRODUCT INVENTORY DECAY HISTORY	196							
ANL	370	PL1	RS	P	T	\$COMB, 1D HIGH-TEMPERATURE COAL COMBUSTOR MODEL	811							
ANL	370B	F+BAL	RS	P	X	\$SYN3D, SINGLE-CHANNEL FLUX SYNTHESIS DIFFUSION	713							
ANL	370B	F4	S	P	X	\$FUNPACK2, SPECIAL FUNCTION ROUTINES	610							
ANL	370B	F4	RS	P	T	\$SUPPORT, SOLUTION OF BOUNDARY-VALUE PROBLEMS	731							
ANL	370D	F4	RS	P	CT	\$SAP4, STRUCTURAL ANALYSIS OF LINEAR SYSTEMS	641							
ANL	GETS	F	R			\$PLETHS, ISOPLETH-AREA CALC FROM SINGLE SOURCE	591							
ANL	PD10B	F4	RS	P	X	\$EISPACK2, MATRIX EIGENVALUE/VECTOR PACKAGE	534							
ANL	1108B	F5	S	P	X	\$FUNPACK2, SPECIAL FUNCTION ROUTINES	610							
ANL	1110B	F4	RS	P	X	\$EISPACK2, MATRIX EIGENVALUE/VECTOR PACKAGE	534							
ANL	6600	F4	RS	P	T	\$SAS1A, FAST REACTOR POWER AND FLOW TRANSIENTS	400							
ANL	6600B	F	S	P	X	\$FUNPACK2, SPECIAL FUNCTION ROUTINES	610							
ANL	6600B	F4	RS	P	X	\$EISPACK2, MATRIX EIGENVALUE/VECTOR PACKAGE	534							
ANL	6700B	F4	RS	P	X	\$EISPACK2, MATRIX EIGENVALUE/VECTOR PACKAGE	534							
ANL	7600	F+COM	RS	P	X	\$SYN3D, SINGLE-CHANNEL FLUX SYNTHESIS DIFFUSION	713							
ANL	7600	F+COM	RS	PL	X	SMC**2-2, FAST NEUTRON SPECTRA & MULTIGP X-SECS	355							
ANL	7600	F4	RS	P	G	\$NAHAMMER, FLUID HAMMER ANALYSIS PIPING SYSTEM	717							
ANL	7600	F4	RS	P	T	\$LIFE3, MIXED-OXIDE FUEL ELEMENT PERFORMANCE	R460							
ANL	7600B	F4	RS	P	T	\$WHAM6, LIQUID-FILLED PIPING SYSTEM ANALYSIS	278							
ANNULAR VOID X-SECTION CALCULATION					GEC	625	F4	RS	P	B	\$AVOID,	276		
ANOVA, THREE FACTOR ANALYSIS OF VARIANCE					BKC	6600	F4	RS	P	P	\$	819		
ANVENT, LOCA ANALYSIS DUKE POWER MCGUIRE UNITS					DUCC	635	F4	RS		G	\$	529		
APG 6600 F4 RS					B	\$APRFX1, 99-GP	DLC-2B	LIBRARY	GROUP-COLLAPSING			466		
APRFX1, 99-GP DLC-2B LIBRARY GROUP-COLLAPSING					APG	6600	F4	RS		B	\$	466		
ARC-DIF1D, 1-D MULTI-GP DIFFUSION & INVENTORY					ANL	360	F4	RSBP	CT	C	\$	626		
ARC-NU1002, BCD INPUT DATA PROCESSING MODULE					ANL	360	F4	RSBP	CT	L	\$	533		
ARC-SYSTEM, SYSTEM SUBPROGRAMS AND MODULES					ANL	360	F+BAL	RSBP	CT	M	\$	522		
ARC-XSEC1, MICROSCOPIC X-SECTION MANIPULATION					ANL	360	F4	RSBPL	CT	L	\$	594		
AREA CALCULATION					SLA	6600	F4	RS	P	P	\$PLOT, 2-D CONTOUR PLOTS &	R578		
ARGONNE SUBROUTINE LIBRARY CAT. A-E					ANL	360B	F+P+A	RS	T	P	\$AMDLIBAE,	562		
ARGONNE SUBROUTINE LIBRARY CAT. F					ANL	360B	F+BAL	RS	T	P	\$AMDLIBF,	563		
ARGONNE SUBROUTINE LIBRARY CAT. G-Z					ANL	360B	F+P+A	RS	T	P	\$AMDLIBGZ,	564		
ARHC 6600 F+COM RS P CT G					\$FTA, FAULT TREE ANALYSIS SYSTEM							666		
ARSTEC, NONLINEAR MIXED INTEGER OPTIMIZATION					EG&G	360	F4	RS	P	P	\$	738		
ASM RS P T P					\$BASIC2 INTERPRETER, MINIMAL BASIC LANGUAGE					LLL	8080	803		
ASME STEAM AND WATER PROPERTIES					BG&E	360C	F4	RS	T	H	\$STEAM-67, 1967	487		
ASPLS, GAMMA-RAY SOURCE BUILDUP FACTOR CALC					BAPL	6600	F+ASC	RS	P	T	J	\$	R429	
ASSEMBLER FOR THE PDP-11 ON 360 EG&G					360	PL1	RS	P	T	P	\$PTAC11, 2-PASS	516		
ASSEMBLY ANALYSIS AI 7600 F4					RS	PLX	T	C	\$VIM1, MONTE CARLO CRITICAL			510		
ASSEMBLY ANALYSIS AI-A 360 F4					RSBPLXCT	C	\$VIM1X, MONTE CARLO CRITICAL					510		
ASSEMBLY 48 GAFGAR ENDF/B DATA TAPES					GGA	1108	BIN	R	L	T	Z	\$ZPR-III	356	
ASSESSMENT ANL 360 F4					RS	P	T	R	\$SITE2, ENERGY FACILITY SITING			607		
ASTEM, THERMODYNAMIC PROPERTIES WATER & STEAM					BCAC	6600	F4	RS	P	T	H	\$	580	
ASTEM, THERMODYNAMIC PROPERTIES WATER & STEAM					EG-D	360B	F4	RS	P	X	T	H	\$	580
ATHENA4, INELASTIC SCATTERING FORM FACTORS					ORNL	360	F4	RS	P	T	A	\$	417	
ATM, ATMOSPHERIC TRANSPORT & DIFFUSION MODEL					ORNL	360	F+BAL	RS	P	T	R	\$	787	
ATMOSPHERIC TRANSPORT & DIFFUSION MODEL					ORNL	360	F+BAL	RS	P	T	R	\$	787	
ATOM SPECTRA ENDF/B DATA					ORNL	360	F4	RS	P	T	B	\$RICE, PRIMARY RECOIL	453	
ATTACHED PIPES ORNL 360 F+BAL RS P XCT I					\$CURT2, CURVED TUBES OR ELBOWS &							R750		
ATTACHMENTS TO PIPE ORNL 360 F4 RS P					I	\$LUGS, STRESS FOR INTEGRAL						648		
AUTO- AND CROSS-SPECTRAL DENSITIES					BNW	1108	F5	RS	P	X	T	F	\$NOISY1,	488
AVERAGE X-SEC CALC BNL 6600 F4 RS P					A	\$AVERAGE, UNRESOLVED REGION						376		
AVERAGE, UNRESOLVED REGION AVERAGE X-SEC CALC					BNL	6600	F4	RS	P	A	\$	376		
AVOID, ANNULAR VOID X-SECTION CALCULATION					GEC	625	F4	RS	P	B	\$	276		
AXICRP, FINITE ELEMENT CODE FOR CREEP ANALYSIS					HEDL	6600	F4	RS	P	CT	I	\$	785	
AXISYM LOAD BAPL 6600 F4 RS P T I					\$SEALSHL2, SHELL STRESS ANALYSIS							R282		
AXISYM LOAD SR 360 F4 RS P T I					\$SEALSHL2, SHELL STRESS ANALYSIS							R282		
AXISYM LOAD WTSC 7600 F4 RS P T I					\$SEALSHL2, SHELL STRESS ANALYSIS							R282		

AXISYMMETRIC

BAPL

AXISYMMETRIC & PLANE ELASTIC-PLASTIC	BAPL	6600	F+COM	RS P	T I	SDUZ2, 2-D	R503
AXISYMMETRIC STRESS ANALYSIS	GGA	1108	F4	RS P	T I	SSAFE-2D, PLANE &	379
B-W PARAMETERS	GGA	1108	F5	RS P	CT A	SFSDP3, POINTWISE XSECS. FROM	216
B-W X-SEC CALC	BNL	6600	F4	RS P	A	SSIGPLOT, RESOLVED MULTILEVEL	377
BAL RS CT P	SSLACMON	2.2,	OS360	MVT/MFT	PERFORMANCE MONITOR	SLAC	360
BAL RS X T P	SCOPYCAT,	IBM	OS	SYSTEM	CATALOG UTILITY ROUTINE	ANL	360D
BAL RSB T P	SNRTS-RJE,	OS/360	MVT	REMOTE	JOB ENTRY SYSTEM	EG&G	360
BAL RSB CT P	SSLACMON/370,	VERSION	4.0	VS	SOFTWARE MONITOR	SLAC	370
BAL RSBP CT P	SFORTIO,	FORTTRAN	INTERFACE	TO	IBM370 MACROS	ANL	370
BAL+F RS P C P	SGETCOR,FRECOR,	FORTTRAN	DYNAMIC	STORAGE	ALLOC	ORNL	360
BANDED JACOBIAN	LLL	360C	F4	RS P	X T P	SGEARB, SOLVE ODE SYSTEM WITH	661
BANDED JACOBIAN	LLL	6600C	F4	RS P	X T P	SGEARB, SOLVE ODE SYSTEM WITH	661
BANDED JACOBIAN	LLL	360	F4	RS P	X T P	SEPISODEB, SOLVE ODE SYST WITH	705
BAPL 6600	F+ASC	RS P	T	J	SASPIS, GAMMA-RAY SOURCE BUILDUP FACTOR CALC		R429
BAPL 6600	F+ASC	RS P	X T	B	SRESQ2,RESQO,DBF1, RESONANCE INTEGRAL HEX CELL		R285
BAPL 6600	F+COM	RS	T	P	SBETTIS PROGRAMMING ENVIRONMENT LIBRARY		R665
BAPL 6600	F+COM	RS P	H		SHYMAS, HYDRODYNAMIC MASS MATRIX GENERATION		R560
BAPL 6600	F+COM	RS P	T	B	SRECAP-0, RECAP-12 X-SECTION LIBRARY GENERATION		R671
BAPL 6600	F+COM	RS P	T	I	SDUZ2, 2-D AXISYMMETRIC & PLANE ELASTIC-PLASTIC		R503
BAPL 6600	F+COM	RS P	T	I	SGAPL3, INELASTIC LARGE DEFLECTION STRESS STUDY		R397
BAPL 6600	F+COM	RS P	X T	B	SPAX03, HARMONY-PDQ X-SECTION GENERATION CODE		R426
BAPL 6600	F+COM	RS P	X T	I	SMATUS, 3-D FINITE-ELEMENT ELASTIC ANALYSIS		R597
BAPL 6600	F4	RS	B		SM0807, 2-D DIFFUSION ABSORPTION REMOVAL X-SECS		R280
BAPL 6600	F4	RS	C		SM0648, 1-D SLAB TRANSPORT WITH SLOWING DOWN		R342
BAPL 6600	F4	RS	H		SWATER, STEAM TABLES 14.5-14,500PSIA 32-472DEGF		R267
BAPL 6600	F4	RS	T	I	SCYGRO2, STRESS ANALYSIS CYL FUEL ELEMENT		R266
BAPL 6600	F4	RS P	A		SGRAMP, R-M PARAMETERS OF UNRESOLVED RESONANCES		R470
BAPL 6600	F4	RS P	D		SCINDER,M0102, POINT DEPLETION FISSION PRODUCT		313
BAPL 6600	F4	RS P	F		SNOWIG, 1-D 2-GP KINETICS TEMPERATURE FEEDBACK		R371
BAPL 6600	F4	RS P	H		SBETTY, ENTRAINED PARTICLES SAMPLING STUDY		R545
BAPL 6600	F4	RS P	H		SM0899,HOH, STEAM TABLES 14.5-2538 PSIA		R294
BAPL 6600	F4	RS P	I		SBUBL1, FUEL SWELLING & GAS RELEASE SIMULATION		R468
BAPL 6600	F4	RS P	I		SFUGIT, DYNAMIC RESPONSE OF ELASTIC STRUCTURES		R537
BAPL 6600	F4	RS P	I		SM0266, LINEAR ELASTIC STRUCTURAL DYNAMICS		R383
BAPL 6600	F4	RS P	I		SM0552, DYNAMIC ANALYSIS LINEAR ELASTIC SYSTEMS		R283
BAPL 6600	F4	RS P	I		SSTRIPE, FUEL ROD CLAD STRAIN & PELLET CRACKING		R570
BAPL 6600	F4	RS P	I		STCB01, CREEP-BUCKLING OF TUBES UNDER PRESSURE		R604
BAPL 6600	F4	RS P	L		SBL47, DRAFTING TOOL TO PLOT PLANE STRUCTURES		R373
BAPL 6600	F4	RS P	O		SJITER, FLUCTUATION EXPERIMENT ANALYSIS		R394
BAPL 6600	F4	RS P	O		SREDUX, REACTOR FLUCTUATION EXPERIMENT ANALYSIS		R425
BAPL 6600	F4	RS P	P		SBH99, EXTREME VALUE DISTRIBUTION DATA ANALYSIS		R621
BAPL 6600	F4	RS P	P		SDAFT1, LEAST SQUARES FIT FISSION NUCLIDE DATA		R327
BAPL 6600	F4	RS P	P		SREL01, RELIABILITY FOR A SINGLE FAILURE MODE		R497
BAPL 6600	F4	RS P	T	A	SPUN1, UNRESOLVED RESONANCE INTEGRALS X-SECS		R359
BAPL 6600	F4	RS P	T	A	SSUMOR, S-WAVE NEUTRON X-SECTION CALCULATION		R399
BAPL 6600	F4	RS P	T	B	SEPOCH, NEUTRON AGE CALCULATION OF ENDF/B DATA		R461
BAPL 6600	F4	RS P	T	C	SBE21, FEW-GP DISCRETE ORDINATES SLAB GEOMETRY		R398
BAPL 6600	F4	RS P	T	F	STWIGL, 2-D 2-GP SPACE-TIME DIFFUSION FEEDBACK		R338
BAPL 6600	F4	RS P	T	F	SWIGL2, 1-D 2-GP SPACE-TIME DIFFUSION 3-GEOM		R274
BAPL 6600	F4	RS P	T	F	SWIGL3, 1-D SPACE-TIME DIFFUSION W/FEEDBACK		R708
BAPL 6600	F4	RS P	T	G	SFLASH3, LOSS-OF-COOLANT ACCIDENT ANALYSIS		R295
BAPL 6600	F4	RS P	T	G	SM0555,ACT1, LOSS-OF-COOLANT ACCIDENT ANALYSIS		R284
BAPL 6600	F4	RS P	T	H	SCHIC-KIN, FAST + INTERMEDIATE POWER TRANSIENTS		R473
BAPL 6600	F4	RS P	T	H	SFIGRO, LWBR FUEL SWELLING TEMPERATURE STUDY		R272
BAPL 6600	F4	RS P	T	H	SFLOT1,M0219, PWR FLOW TRANSIENT ANALYSIS		R331
BAPL 6600	F4	RS P	T	H	SGLUB1, WATER-LOGGED FUEL ELEMENT ANALYSIS		R424
BAPL 6600	F4	RS P	T	H	SHOT2, 2-D TRANSIENT HEAT CONDUCTION PROGRAM		R286
BAPL 6600	F4	RS P	T	H	STOPS, TRANSIENT THERMODYNAMICS OF PRESSURIZERS		R348
BAPL 6600	F4	RS P	T	I	SBUSHL, CYL SHELL BUCKLING COLLAPSE ANALYSIS		R481
BAPL 6600	F4	RS P	T	I	SCYGR03, OXIDE FUEL ROD STRESS & DEFORMATION		R449
BAPL 6600	F4	RS P	T	I	SM0457,PIPE, ELASTIC STRESS OF PIPING SYSTEM		R329
BAPL 6600	F4	RS P	T	I	SPELEN, FUEL PELLET TEMPERATURE & DEFORMATION		R598
BAPL 6600	F4	RS P	T	I	SSEALSHL2, SHELL STRESS ANALYSIS AXISYM LOAD		R282
BAPL 6600	F4	RS P	T	J	SM0756,LETO, 1-D SLAB GAMMA-RAY TRANSPORT		R343
BAPL 6600	F4	RS P	T	K	SPARK1, NUCLEAR REACTOR POWER PLANT ANALYSIS		R743
BAPL 6600	F4	RS P	T	M	SSHLOG, DATA MANAGEMENT, EDITING, & ANALYSIS		R557
BAPL 6600	F4	RS P	T	P	SM0661,M0657,M0626, POLYNOMIAL CURVE FITTING		R411
BAPL 6600A	F+ASC	RS	T	P	SBETTIS ENVIRONMENTAL ROUTINES, SUBROUTINE LIB.		478
BAPL 6600B	F+ASC	RS P	T	J	SSPAN4, A POINT-KERNEL SHIELD EVALUATION CODE		R462
BAPL 6600B	F4	RS P	I		SMANE1, RECTANGULAR MAGNETIC NETWORK SOLUTION		R412
BAPL 7600	F+COM	RS	T	P	SBETTIS PROGRAMMING ENVIRONMENT LIBRARY		R665
BAPL 7600	F+COM	RS P	T	C	SRECAP-12, MONTE CARLO CRITICALITY CALCULATIONS		R670

BAPL

BKC

BAPL	7600	F+COM	RS P T D	STPT01, 2-D FEW-GROUP TRANSPORT WITH DEPLETION	R669	
BAPL	7600	F4	RS P T G	SFLASH6, FULLY-IMPLICIT TRANSIENT SIMULATION	R448	
BAPL	7600	F4	RS P T H	SWASP2, WATER PROPERTIES FOR SAFETY ANALYSIS	R396	
BAPL	7600	F4	RS P T K	SPARK1, NUCLEAR REACTOR POWER PLANT ANALYSIS	R743	
BAPL	7600B	F+COM	RS P T D	SPDQ8, 1,2 OR 3-D FEW-GP DIFFUSION DEPLETION	R275	
BAPL	7600B	F4	RS P T H	SFLOW3, NETWORK ANALYSIS OF 3-D TWO-PHASE FLOW	R664	
BASE	RFD	360	COBOL RS P T M	SGLOVE CHANGE ANALYSIS SYSTEM, GLOVE DATA	813	
BASIC	R	M		SMAPPER, PREDICTING MANUFACTURING REQUIREMENTS GEPI GETS	595	
BASIC EVENT & CUT SET RANKING	ANL	370	F4 RS P T G	\$IMPORTANCE, FTA	779	
BASIC LANGUAGE	LLL	8080	ASM RS P T P	\$BASIC2 INTERPRETER, MINIMAL	803	
BASIC2 INTERPRETER, MINIMAL BASIC LANGUAGE	LLL	8080	ASM RS P T P	\$	803	
BATCH ANL	360	F+BAL	RSBP X T P	\$SPEAKEASY MU+, LANGUAGE PROCESSOR TSO OR	593	
BATCH ANALYSIS OF GAMMA-RAY SPECTRA	EG&G	360	F+P+A	RSBP XCT W \$GAUSS6,	622	
BC	625	F+MAP	RS P T C	\$DTF4, 1-D MULTI-GP DISCRETE ORDINATE PROGRAM	209	
BC	625	F4	RS T C	\$EXTERMINATOR2, 2-D MULTI-GP DIFFUSION PROGRAM	156	
BC	625	F4	RS T C	\$FOG, 1-D FEW-GP DIFFUSION SLAB CYLINDER SPHERE	28	
BC	625	F4	RS PLX T B	\$GAMTEC2, MULTI-GP CONSTANT CALC 0 TO 10 MEV	185	
BCAC	6600	F4	RS P T H	\$ASTEM, THERMODYNAMIC PROPERTIES WATER & STEAM	580	
BCD	R	L T Z		\$SETOG1 DATA LIBRARIES, MUFT4 OR 5, GAM1 OR 2	447	
BCD	R	L T Z		\$SOLDATA62, ALBUQUERQUE 1962 SOLAR DATA	693	
BCD	R	LX T Z		\$LASL XSEC SETS, SN 18- 24- AND 25-GROUP SETS	532	
BCD	R	LX T Z		\$THERMOS LIBRARY, 30-GP ENDF/B SCAT KERNELS	543	
BCD INPUT DATA PROCESSING MODULE	ANL	360	F4	RSBP CT L \$ARC-NUI002,	533	
BCL	6400	F4	RS P G	\$BOIL1, BOILOFF ACCIDENT CORE HEATUP & MELTDOWN	734	
BCL	6400	F4	RS P G	\$FRCRL2, LOCA FISSION PRODUCT RELEASE ANALYSIS	500	
BCL	6400	F4	RS P T F	\$ADEP, 1-D & 2-D FEW-GROUP SPACE-TIME KINETICS	494	
BCL	6400	F4	RS P T G	\$SCORRAL2, RADIONUCLIDE CONTAINMENT AFTER LOCA	745	
BCL	6400	F4	RS P T G	\$ECCSA4, LOSS-OF-COOLANT & EMERGENCY COOLING	330	
BCL	6400	F4	RS P T G	\$SHAARM3, AEROSOL BEHAVIOR LOG-NORMAL DIST MODEL	797	
BCL	6400	F4	RS P T G	\$SNURLOC-1.0, LOSS-OF-COOLANT THERMAL ANALYSIS	328	
BCL	6400	F4	RS P T I	\$SPIRAX2, SIMPLIFIED INELASTIC PIPING ANALYSIS	R735	
BCL	6400	F4	RS P X T G	\$MUCHA1,MUCHA2, MULTIPLE CHANNEL ANALYSIS ECC	508	
BCL	6400B	F4	RS P X T G	\$MIRAB,MIRAP, CONTAINMENT SYSTEM IODINE REMOVAL	499	
BCSS	6600D	F+ASC	R B T D	\$SPDQ7, 1,2 OR 3-D FEW-GP DIFFUSION DEPLETION	R275	
BEACON/MOD2A, CONTAINMENT SYSTEM FLUID FLOW	EG&G	7600	F+COM	RS P CT G \$	767	
BEAM CREEP ANALYSIS	HEDL	6600	F4	RS P T I	\$BEAMCRP, FINITE-ELEMENT	R701
BEAMCRP, FINITE-ELEMENT BEAM CREEP ANALYSIS	HEDL	6600	F4	RS P T I	\$	R701
BEAMS	SLAC	370	F4	RS P T V	\$TRANSPORT, DESIGN OF CHARGED PARTICLE	791
BEAMS	KAPL	6600	F4	RS P I	\$STEM, MATRIX GENERATION FOR A SYSTEM OF	R337
BECOM, AEC DP PURCHASE VERSUS LEASE ANALYSIS	SLA	360	COBOL	RSBP CT M \$	R589	
BECOM, AEC DP PURCHASE VERSUS LEASE ANALYSIS	SLA	1108	COBOL	RS P M \$	R589	
BEHAVE-SST, OVERPOWER TRANSIENT FUEL MECHANICS	FBRD	7600	F4	RS P T H \$	768	
BEHAVE2, OXIDE FUEL PERFORMANCE FINITE-ELEMENT	FBRD	635	F4	RS P CT I \$	R568	
BEHAVIOR	AAEC	360	F+BAL	RSBPXCT G	\$NAIAD, COMPRESSIBLE 2-PHASE COOLANT	726
BEHAVIOR	BNW	6600	F4	RS P X T I	\$GAPCON-THERMAL3, FUEL S& TRANSIENT	770
BEHAVIOR LOG-NORMAL DIST MODEL	BCL	6400	F4	RS P T G	\$SHAARM3, AEROSOL	797
BEHAVIOR LOGNORMAL MODEL	AI	370	F	RS P T G	\$SHAA3B, AEROSOL	443
BESFIT, DIFFRACTION MODEL ELASTIC SCAT X-SEC	BNL	6600	F4	RS P A \$	524	
BESSEL FUNCTIONS, AIRY & LOG GAMMA SUBROUTINES	SLA	6600	F4	RS P T P \$	656	
BETTIS ENVIRNMNTL LIB SCOPE2.0	CEND	7600B	F4	RS T P	\$MODEL, MODIFIED	478
BETTIS ENVIRNMNTL LIB SCOPE3.3	CDC	6600D	F+COM	RS T P	\$MODEL, MODIFIED	478
BETTIS ENVIRONMENTAL ROUTINES, SUBROUTINE LIB.	BAPL	6600A	F+ASC	RS T P \$	478	
BETTIS PROGRAMMING ENVIRONMENT LIBRARY	BAPL	6600	F+COM	RS T P \$	R665	
BETTIS PROGRAMMING ENVIRONMENT LIBRARY	BAPL	7600	F+COM	RS T P \$	R665	
BETTY, ENTRAINED PARTICLES SAMPLING STUDY	BAPL	6600	F4	RS P H \$	R545	
BE21, FEW-GP DISCRETE ORDINATES SLAB GEOMETRY	BAPL	6600	F4	RS P T C \$	R398	
BG&E	360C	F4	RS T H	\$STEAM-67, 1967 ASME STEAM AND WATER PROPERTIES	487	
BHSC	360	F4	RS P C	\$PERT, 1-D PERTURBATION FOR AIM AND FOG CODES	30	
BHSC	360	F4	RS P T C	\$FAIMOS, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	120	
BHSC	360	F4	RS PL T B	\$STEMPEST2, THERMAL NEUTRON SPECTRUM X-SECTIONS	50	
BH99, EXTREME VALUE DISTRIBUTION DATA ANALYSIS	BAPL	6600	F4	RS P P \$	R621	
BIN	R	L T Z		\$SOLDATA62, ALBUQUERQUE 1962 SOLAR DATA	693	
BIN	R	L T Z		\$ZPR-III ASSEMBLY 48 GAFGAR ENDF/B DATA TAPES	356	
BINARY COLLISION CASCADE SIMULATION	ORNL	360C	F+BAL	RS P X T Q	\$SMARLOWE,	680
BINARY COLLISION CASCADE SIMULATION	ORNL	7600	F+BAL	RS P X T Q	\$SMARLOWE,	680
BINARY CYCLE GEOTHERMAL COST STUDY	BNW	6600	F4	RS P T D	\$GEOCOST-BC,	711
BIOCHEMICAL KINETIC SIMULATION SYSTEM	CUP1	370	F+BAL	RS P CT U	\$BIOSSIM,	736
BIOSSIM, BIOCHEMICAL KINETIC SIMULATION SYSTEM	CUP1	370	F+BAL	RS P CT U	\$	736
BIRD, SPEC, TIME-OF-FLIGHT DATA ANALYSIS	GGA	1108	F5	RS P T O	\$CAGE,	476
BISYN, 2-D MULTI-GP DIFFUSION SYNTHESIS CALC	NED	635	F4	RS PL T C \$	287	
BISYN, 2-D MULTI-GP DIFFUSION SYNTHESIS CALC	NED	1108	F4	RS P T C \$	287	
BKC	360	F4	RS P P	\$COMQC, QUALITY CONTROL DATA ANALYSIS ROUTINES	649	

BKC										BUNDLE	
BKC	360	F4	RSBP	P	\$GRAPH, LINEAR REGRESSION W/CONFIDENCE LIMITS					624	
BKC	360	F4	RSBP	P	\$HISTOGRAMS, QUALITY CONTROL SAMPLE STATISTICS					614	
BKC	6600	F4	RS P	P	\$ANOVA, THREE FACTOR ANALYSIS OF VARIANCE					819	
BKC	6600	F4	RS P	T	\$F0355, SHAPER CUTTER CONTOUR GENERATOR					697	
BKY	7600	F+COM	RS P	T P	\$DUMP, USER-ORIENTED MEMORY DUMP UTILITY					698	
BKY	7600	F+COM	RS PLXCT	T	\$DOE2.0, BUILDING ENERGY CONSUMPTION ANALYSIS					782	
BKY	7600	F4	RS P	T H	\$SCHAFF, HEAT & WATER TRANSFER IN POROUS MEDIA					802	
BLAST, REACTOR KINETICS TEMPERATURE DIST STUDY	AEB	360	F4	RS P	E	\$				363	
BLOCKAGE STUDY	PNC	360	F4	RS P	T H	\$LOCK, FEW-CHANNEL COOLANT-FLOW				732	
BLOOST6, COMBINED KINETICS 2-D HEAT TRANSFER	GGA	1108	F+BAL	RS P	T E	\$				303	
BLOWDOWN	PPCO	360	F4	RS P X	G	\$BURST1, HYDRODYNAMIC ANALYSIS DURING				435	
BL47, DRAFTING TOOL TO PLOT PLANE STRUCTURES	BAPL	6600	F4	RS P	L	\$				R373	
BNL	6600	F4	RS	T M	\$CHECK3, RIGEL3, ENDF/B V3 PROCESSING CODES					571	
BNL	6600	F4	RS P	A	\$AVERAGE, UNRESOLVED REGION AVERAGE X-SEC CALC					376	
BNL	6600	F4	RS P	A	\$BESFIT, DIFFRACTION MODEL ELASTIC SCAT X-SEC					524	
BNL	6600	F4	RS P	A	\$RAMP1, REICH-MOORE RESOLVED REGION X-SECTIONS					492	
BNL	6600	F4	RS P	A	\$SIGPLOT, RESOLVED MULTILEVEL B-W X-SEC CALC					377	
BNL	6600	F4	RS P	T F	\$NOAH, 1-D ONE-GP SPACE-TIME DIFFUSION FEEDBACK					405	
BNL	6600	F4	RS P	T I	\$SAFE-PLANE, PLANE STRESS ANALYSIS, 2-D BODIES					252	
BNL	6600B	F4	RS	T M	\$CHECKER, CRECT, DAMMET, PLOTFB, ... ENDF/B V1 PROC					384	
BNL	6600B	F4	RS	T M	\$CRECT, CHECKER, RIGEL, PLOTFB, ... ENDF/B V2 PROC					475	
BNL	6600B	F4	RS	T M	\$RIGEL4, CHECK4, ... ENDF/B V4 PROCESSING CODES					638	
BNL	6600B	F4	RS P	A	\$THRES2, STATISTICAL MODEL REACTION X-SECTIONS					504	
BNL	6600B	F4	RS P	T A	\$RESEND, ADLER, ENDF/B RESONANCE XSECTION CODES					465	
BNL	7600	F+COM	RS P	T G	\$NALAP, LMFBR TRANSIENT RESPONSE TO ACCIDENT					780	
BNL	7600	F4	RS P	T G	\$RELAP3B/MOD110, REACTOR SYSTEM TRANSIENT CODE					733	
BNW	1107	F4	RS P	T C	\$HFN, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE					241	
BNW	1107	F4	RS PL	T B	\$GAMTEC2, MULTI-GP CONSTANT CALC 0 TO 10 MEV					185	
BNW	1108	F+BAL	RS P	T O	\$GSSLRN18, LEAST SQUARES PHOTOPEAK SPECTRA CODE					457	
BNW	1108	F4	RS P	C	\$PERT4, 2-D PERTURBATION XY RZ RTHETA GEOMETRY					304	
BNW	1108	F4	RS P	T B	\$FCC4, FUNDAMENTAL MODE FAST REACTOR X-SEC CALC					306	
BNW	1108	F4	RS P	T D	\$2DB, 2-D MULTIGROUP DIFFUSION AND DEPLETION					325	
BNW	1108	F4	RS P X	T B	\$1DX, 1-D DIFFUSION FAST X-SECTION GENERATION					374	
BNW	1108	F4	RS PLX	T B	\$HRG3, SLOWING-DOWN SPECTRUM, MULTIGP CONSTANTS					467	
BNW	1108	F5	RS P	T D	\$DBUFIT1, LEAST SQUARES TRANSMUTATION ANALYSIS					456	
BNW	1108	F5	RS P	CT H	\$REPP, THERMAL-HYDRAULIC WATER REACTOR DESIGN					483	
BNW	1108	F5	RS P X	T F	\$NOISY1, AUTO- AND CROSS-SPECTRAL DENSITIES					488	
BNW	1108	F5	RS PLX	T B	\$BRT1, THERMAL SPECTRUM X-SECTION CALC					184	
BNW	1108	F5	RSBPL	T D	\$ISOGEN, RADIONUCLIDE GENERATION AND DECAY					367	
BNW	6600	F4	RS P	T D	\$GEOCOST-BC, BINARY CYCLE GEOTHERMAL COST STUDY					711	
BNW	6600	F4	RS P	T D	\$GEOCOST, GEOTHERMAL ENERGY COST ANALYSIS					684	
BNW	6600	F4	RS P	T I	\$COVE1, CREEP COLLAPSE FOR OVAL FUEL PIN TUBE					817	
BNW	6600	F4	RS P	T I	\$GAPCON-THERMAL2, FUEL PIN GAP CONDUCTANCE CALC					618	
BNW	6600	F4	RS P X	T C	\$HFN, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE					241	
BNW	6600	F4	RS P X	T I	\$GAPCON-THERMAL3, FUEL SS & TRANSIENT BEHAVIOR					770	
BNW	6600C	F4	RS P	I	\$BUCKLE, CREEP BUCKLING OF INITIALLY OVAL TUBE					667	
BNW	7600D	F4	RS P XCT	H	\$COBRA41, ROD BUNDLE & CORE THERMAL-HYDRAULICS					432	
BOARDS	SLA	1108	F+BAL	RSBP	T T	\$ACCEL(MOD2), DESIGN OF PRINTED-CIRCUIT				681	
BOARDS	SLA	6600	F+COM	RS P	T T	\$ACCEL(MOD2), DESIGN OF PRINTED-CIRCUIT				681	
BODIES	BNL	6600	F4	RS P	T I	\$SAFE-PLANE, PLANE STRESS ANALYSIS, 2-D				252	
BODIES	GGA	1108	F4	RS P	I	\$SAFE-PLANE, PLANE STRESS ANALYSIS, 2-D				252	
BOILING FLOW STEAM	GGA	1108	F4	RS P	T H	\$DYNAM, DYNAMIC ANALYSIS				440	
BOILOFF ACCIDENT CORE HEATUP & MELTDOWN	BCL	6400	F4	RS P	G	\$BOIL1,				734	
BOIL1, BOILOFF ACCIDENT CORE HEATUP & MELTDOWN	BCL	6400	F4	RS P	G	\$				734	
BORATION-DILUTION TABLES FOR PWR OPN	OPPD	6400	F4	S P	H	\$PWR-PPM,				552	
BOUNDARY-VALUE PROBLEMS	ANL	370B	F4	RS P	T P	\$SUPPORT, SOLUTION OF				731	
BOUNDARY-VALUE PROBLEMS	SLA	6600	F4	RS P	T P	\$SUPPORT, SOLUTION OF				731	
BOWED REACTOR CORE ANALYSIS	ANL	370	F4	RS P	I	\$NUBOW2D-INELASTIC,				790	
BOWED REACTOR CORES	ANL	360B	F4	RS P	I	\$NUBOW, STRUCTURAL ANALYSIS				643	
BREEDERS	NED	635	F4	RS P	D	\$RAPFU, FUEL CYCLE PARAMETERS FAST				372	
BROADEN ENDF/B DATA	LLL	7600	F4	RS P	T B	\$LINEAR, SIGMA1, LINEARIZE &				747	
BRT1, THERMAL SPECTRUM X-SECTION CALC	BNW	1108	F5	RS PLX	T B	\$				184	
BUBL1, FUEL SWELLING & GAS RELEASE SIMULATION	BAPL	6600	F4	RS P	I	\$				R468	
BUCKLE, CREEP BUCKLING OF INITIALLY OVAL TUBE	BNW	6600C	F4	RS P	I	\$				667	
BUCKLING COLLAPSE ANALYSIS	BAPL	6600	F4	RS P	T I	\$BUSHL, CYL SHELL				R481	
BUCKLING CYL FUEL ELEMENTS	AEB	360	F4	RS P	B	\$SWELWING, MATERIAL				362	
BUCKLING OF INITIALLY OVAL TUBE	BNW	6600C	F4	RS P	I	\$BUCKLE, CREEP				667	
BUGTRI, 2D MULTIGP DIFFUSION & BURNUP TRI-MESH	GGA	1108	F+BAL	RS P	T D	\$				439	
BUG2, 2-D MULTIGROUP DIFFUSION & BURNUP XY, RZ	GGA	1108	F+BAL	RS P	T D	\$				438	
BUILDING ENERGY CONSUMPTION ANALYSIS	BKY	7600	F+COM	RS PLXCT	T	\$DOE2.0,				782	
BUILDUP FACTOR CALC	BAPL	6600	F+ASC	RS P	T J	\$ASPIS, GAMMA-RAY SOURCE				R429	
BUNDLE	NED	635	F4	RS P	T H	\$VELVET2, TURBULENT FLOW IN LMFBR ROD				458	

BUNDLE

CHI

BUNDLE & CORE THERMAL-HYDRAULICS	BNW	7600D	F4	RS P XCT H	\$COBRA41, ROD	432	
BUNDLE CHF DATA ANALYSIS	EG&G	360	F4	RS PL CT P	\$ERREST, LOCA ROD	518	
BUNDLE FLOW & TEMPERATURE DIST.	ORNL	360	F4	RS P T H	\$ORRIBLE, ROD	629	
BURNING OF SODIUM	ANL	370	F+CSM RS P	G	\$SPOOL-FIRE, SPRAY-POOL	1714	
BURNUP & MANAGEMENT	NED	635	F4	RS P T D	\$FUMBLE, FAST REACTOR FUEL	480	
BURNUP ANALYSIS	ANL	360	F4	RS P CT D	\$3DB, 3-D MULTIGROUP DIFFUSION	567	
BURNUP ANALYSIS	HEDL	1108	F4	RS P T D	\$3DB, 3-D MULTIGROUP DIFFUSION	567	
BURNUP ANALYSIS	NED	635	F4	RS P T O	\$BURNUP, HEAVY ELEMENT ISOTOPIC	311	
BURNUP CYL LATTICE	TVA	360B	F4	RSBPLXCT B	\$LASER, SPECTRUM CALC WITH	249	
BURNUP POWER DISTRIBUTION SEARCH	GGA	1108	F4	RS P T C	\$GASP7, 1-D	319	
BURNUP REFUELING HISTORY	LASL	6600	F4	RS P T D	\$PHENIX, 2-D DIFFUSION	454	
BURNUP TRI-MESH	GGA	1108	F+BAL RS P T D	\$BUGTRI, 2D MULTIGP DIFFUSION &	439		
BURNUP XY, RZ	GGA	1108	F+BAL RS P T D	\$BUG2, 2-D MULTIGROUP DIFFUSION &	438		
BURNUP, HEAVY ELEMENT ISOTOPIC BURNUP ANALYSIS	NED	635	F4	RS P T O	\$	311	
BURST1, HYDRODYNAMIC ANALYSIS DURING BLOWDOWN	PPCO	360	F4	RS P X G	\$	435	
BUSHL, CYL SHELL BUCKLING COLLAPSE ANALYSIS	BAPL	6600	F4	RS P T I	\$	1481	
BW	6600	F+COM	RS P X T D	\$FARED, 1-D FAST REACTOR DESIGN & SURVEY STUDY		427	
BWR CORE HEAT TRANSFER CODE	EG&G	360B	F4	RSBP XCT H	\$MOXY/MOD032,	551	
BWR GASEOUS RELEASE	ORNL	360	F4	RS P C G	\$STEFEG, ANALYSIS OF PWR &	583	
BWR/6 ANALYSIS	EI	360	F+BAL RS P CT H	\$6KILER, CORE HEATUP CODE FOR		636	
C+BAL RS PL CT M	\$JOURNAL CONTROL, LIBRARY	JOURNAL MANAGEMENT	ORNL	360		660	
CACECO, LMFBR CONTAINMENT ACCIDENT ANALYSIS	HEDL	6600	F4	RS P T G	\$	1762	
CAESAR4, LIBLST, 1-D MULTI-GP DIFFUSION & LIB.	AI	360	F4	RSBPLX T C	\$	270	
CAGE, BIRD, SPEC, TIME-OF-FLIGHT DATA ANALYSIS	GGA	1108	F5	RS P T O	\$	476	
CALCOMP PLOTTING ROUTINES	KAPL	6600	F+COM RS	T P	\$KAPLPLOT, KAPL	1496	
CALCOMP780	ANL	360	F4	RS P T N	\$PLOT-3D, 3-D PLOTS ON IBM2280 OR	544	
CAPITAL COST ESTIMATING	ORNL	360	F+BAL RS P T D	\$ORCOST2, POWER PLANT		588	
CARD INPUT PROCESSOR	LASL	360	F4	RS P L	\$GENRD, FREE-FORMAT	530	
CARD INPUT PROCESSOR	LASL	6600	F4	RS P L	\$GENRD, FREE-FORMAT	530	
CASCADE SIMULATION	ORNL	360C	F+BAL RS P X T Q	\$MARLOWE, BINARY COLLISION		680	
CASCADE SIMULATION	ORNL	7600	F+BAL RS P X T Q	\$MARLOWE, BINARY COLLISION		680	
CASCADE TRANSPORT	FNAL	370	F+BAL RS P T W	\$CASIM, SIMULATES HADRONIC		742	
CASCADE, COMPOUND NUCLEUS REACTION	AI	360	F+BAL RS P T A	\$COMNUC,		482	
CASIM, SIMULATES HADRONIC CASCADE TRANSPORT	FNAL	370	F+BAL RS P T W	\$		742	
CAT. A-E	ANL	360B	F+P+A RS	T P	\$AMDLIBAE, ARGONNE SUBROUTINE LIBRARY	562	
CAT. F	ANL	360B	F+BAL RS	T P	\$AMDLIBF, ARGONNE SUBROUTINE LIBRARY	563	
CAT. G-Z	ANL	360B	F+P+A RS	T P	\$AMDLIBGZ, ARGONNE SUBROUTINE LIBRARY	564	
CATALOG	DP	360B	EBCDC R L T Z	\$GAMTAB, RADIOACTIVE-DECAY GAMMA-RAY		637	
CATALOG UTILITY ROUTINE	ANL	360D	BAL RS X T P	\$COPYCAT, IBM OS SYSTEM		646	
CAUSE ANALYSIS	EG&G	360	F+BAL RS P T G	\$COMCAN, SYSTEM SAFETY COMMON		704	
CAVITY GEOM	GGA	1108	F4	RS P T J	\$MUSCAT, VIEW FACTOR SHIELDING CODE	259	
CCCC STANDARD INTERFACE FILE PROCESSOR	LASL	360	F4	RS P CT M	\$SLASIP3,	691	
CDC	6600D	F+COM RS	T P	\$MODEL, MODIFIED BETTIS ENVIRNMNTL LIB SCOPE3.3		478	
CEBUG, STEAM GENERATOR SODIUM-WATER REACTION	CEND	7600	F4	RS P G	\$	548	
CELL	BAPL	6600	F+ASC RS P X T B	\$RESQ2, RESQ0, DBF1, RESONANCE INTEGRAL HEX		1285	
CELL	AI	370	F4	RS P T G	\$SOMIX1, SODIUM SPRAY FIRES IN CYLINDRICAL	1751	
CELL CALCULATION	AI	360	F+BAL RS P X T B	\$HWOCR-SAFE, 2-D MONTE CARLO		307	
CELL COLLISION PROBABILITY CALC	ANL	360	F4	RS P T B	\$CLUP77, SQUARE	526	
CELL COLLISION PROBABILITY CALC	JAER	230	F4	RS P T B	\$CLUP77, SQUARE	526	
CEND	360	F4	RS P X T F	\$CEXE, INCEXE, 1-GP 3-D XYZ XENON OSCILLATION		415	
CEND	6600	F4	RS P T C	\$EXTERMINATOR2, 2-D MULTI-GP DIFFUSION PROGRAM		156	
CEND	7600	F4	RS P G	\$CEBUG, STEAM GENERATOR SODIUM-WATER REACTION		548	
CEND	7600B	F4	RS T P	\$MODEL, MODIFIED BETTIS ENVIRNMNTL LIB SCOPE2.0		478	
CEXE, INCEXE, 1-GP 3-D XYZ XENON OSCILLATION	CEND	360	F4	RS P X T F	\$	415	
CHAINS	GEC	635	F4	RSBP D	\$CHAINS, ANALYSIS OF RADIOACTIVE DECAY	418	
CHAINS, ANALYSIS OF RADIOACTIVE DECAY CHAINS	GEC	635	F4	RSBP D	\$	418	
CHANGE ANALYSIS SYSTEM, GLOVE DATA BASE	RFD	360	COBOL RS P T M	\$GLOVE		813	
CHANNEL ANALYSIS ECC	BCL	6400	F4	RS P X T G	\$MUCHA1, MUCHA2, MULTIPLE	508	
CHANNEL X-SEC EVALUATION	ENEA	360	F4	RS P CT A	\$JUPITOR1, COUPLED	308	
CHARCOAL ADSORBERS	ORNL	360	F4	RS P T G	\$SCHAT, IODINE DECAY HEAT ON	804	
CHARGED PARTICLE BEAMS	SLAC	370	F4	RS P T V	\$TRANSPORT, DESIGN OF	791	
CHART, IODINE DECAY HEAT ON CHARCOAL ADSORBERS	ORNL	360	F4	RS P T G	\$	804	
CHECKER	ANL	360B	PL1 S P CT P	\$SLOP, CROSS, IBM360 FORTRAN H PROGRAM		647	
CHECKER, ENDF/B V2 PROCESSING CODES	ANL	360	F4	RS P T M	\$CRECT,	475	
CHECKER, CRECT, DAMMET, PLOTFB, ...	ENDF/B V1 PROC	BNL	6600B	F4	RS T M	384	
CHECKER, RIGEL, PLOTFB, ...	ENDF/B V2 PROC	BNL	6600B	F4	RS T M	475	
CHECK3, RIGEL3, ENDF/B V3 PROCESSING CODES	BNL	6600	F4	RS T M	\$	571	
CHECK4, ...	ENDF/B V4 PROCESSING CODES	BNL	6600B	F4	RS T M	\$RIGEL4,	638
CHEMICALLY REACTIVE MIXTURE FLOW	LASL	6600	F4	RS P X T U	\$PRICE-LASL,	720	
CHEMISTRY IN A PLUME	ORNL	360	F4	RS P R	\$SULCAL, MODEL OF SULFUR	788	
CHF DATA ANALYSIS	EG&G	360	F4	RS PL CT P	\$ERREST, LOCA ROD BUNDLE	518	
CHI	1108A	F4	RS P T H	\$LION4, 3-D TEMPERATURE DISTRIBUTION PROGRAM		1299	

CHIC-KIN

CONDUCTION

CHIC-KIN, FAST + INTERMEDIATE POWER TRANSIENTS	BAPL	6600	F4	RS P	T H	\$	R473
CHILES, LINEAR ELASTIC SINGULARITY MODELING	SLA	6600	FTN	RS P	T I	\$	611
CHNSED, SEDIMENT & CONTAINMENT TRANSPORT MODEL	ORNL	360	F+BAL	RS P	CT R	\$	793
CINCAS, NUCLEAR FUEL CYCLE COST AND ECONOMICS	CWE	360	F4	RS P	T D	\$	354
CINCAS, NUCLEAR FUEL CYCLE COST AND ECONOMICS	WAPD	6600	F4	RS P	T D	\$	354
CINDER,M0102, POINT DEPLETION FISSION PRODUCT	BAPL	6600	F4	RS P	D	\$	313
CINDER,M0102, POINT DEPLETION FISSION PRODUCT	DP	360	F+BAL	RS P	T D	\$	313
CITATION, 1,2,3-D DIFFUSION DEPLETION MULTI-GP	ORNL	3601	F4	RS P	T K	\$	387
CLAD STRAIN & PELLET CRACKING	BAPL	6600	F4	RS P	I	\$	R570
CLADDING TEMPERATURE ANALYSIS	FBRD	7600	F4	RS P	T H	\$	S796
CLEM, ANGULAR DISTRIBUTION LEGENDRE FITTING	KAPL	6600	F4	RS P	A	\$	R531
CLIP, FORM OR THREDES LIBRARY UTILITY ROUTINE	AI	360	F4	RSB L	T M	\$	271
CLOTHO, NUCLEAR POWER PLANT COST CODE	HEDL	1108	F5	RS P X T	D	\$	540
CLOUD	DP	360	F4	RS P	G	\$	47
CLOUD, GAMMA-RAY DOSE RATE FROM A CLOUD	DP	360	F4	RS P	G	\$	47
CLUP77, SQUARE CELL COLLISION PROBABILITY CALC	ANL	360	F4	RS P	T B	\$	526
CLUP77, SQUARE CELL COLLISION PROBABILITY CALC	JAER	230	F4	RS P	T B	\$	526
CNEA 360 F4 RS P E STRIFIDO, PULSED NEUTRON SOURCE DATA ANALYSIS							489
COAL COMBUSTOR MODEL	ANL	370	PL1	RS P	T R	\$	811
COBOL RS CT M SNMSS, NUCLEAR MATERIALS MANAGEMENT SYSTEM	UCND	370					695
COBOL RS P M SAEC-ALO FAU, RADIO FREQUENCY MANAGEMENT SYSTEM	ALOO	360					587
COBOL RS P M SBECOM, AEC DP PURCHASE VERSUS LEASE ANALYSIS	SLA	1108					R589
COBOL RS P T M SGLOVE CHANGE ANALYSIS SYSTEM, GLOVE DATA BASE	RFD	360					813
COBOL RSBP CT M SBECOM, AEC DP PURCHASE VERSUS LEASE ANALYSIS	SLA	360					R589
COBRA3M, FUEL PIN THERMAL-HYDRAULIC ANALYSIS	ANL	360B	F4	RSBP	CT H	\$	659
COBRA4I, ROD BUNDLE & CORE THERMAL-HYDRAULICS	BNW	7600D	F4	RS P	XCT H	\$	432
CODILLI, LEAST SQUARES ANALYSIS RESONANCE DATA	UICS	360	F4	RS P	A	\$	347
COEFFICIENT CALCULATION	GGA	1108	F4	RS P	T C	\$	320
COHBE, COHERENT INELASTIC SCATTERING LAW CALC	GGA	1108	F4	RS P	X A	\$	385
COHERENT INELASTIC SCATTERING LAW CALC	GGA	1108	F4	RS P	X A	\$	385
COLLAPSE ANALYSIS	BAPL	6600	F4	RS P	T I	\$	R481
COLLAPSE FOR OVAL FUEL PIN TUBE	BNW	6600	F4	RS P	T I	\$	817
COLLAPSING	RW	6500	F4	RS P	B	\$	416
COLLISION CASCADE SIMULATION	ORNL	360C	F+BAL	RS P	X T Q	\$	680
COLLISION CASCADE SIMULATION	ORNL	7600	F+BAL	RS P	X T Q	\$	680
COLLISION PROBABILITIES MC	ORNL	360B	F+BAL	RS P	T B	\$	392
COLLISION PROBABILITY CALC	ANL	360	F4	RS P	T B	\$	526
COLLISION PROBABILITY CALC	JAER	230	F4	RS P	T B	\$	526
COLLOCATION SOLN OF STIFF ODE'S	ANL	360	F	RSBP	T P	\$	652
COLLOCATION SOLN OF STIFF ODE'S	SLA	6600	F	RS P	T P	\$	652
COLODE, COLLOCATION SOLN OF STIFF ODE'S	ANL	360	F	RSBP	T P	\$	652
COLODE, COLLOCATION SOLN OF STIFF ODE'S	SLA	6600	F	RS P	T P	\$	652
COMB, 1D HIGH-TEMPERATURE COAL COMBUSTOR MODEL	ANL	370	PL1	RS P	T R	\$	811
COMBUSTOR MODEL	ANL	370	PL1	RS P	T R	\$	811
COMCAN, SYSTEM SAFETY COMMON CAUSE ANALYSIS	EG&G	360	F+BAL	RS P	T G	\$	704
COMMON CAUSE ANALYSIS	EG&G	360	F+BAL	RS P	T G	\$	704
COMMUNITY ENERGY CONSUMPTION ANALYSIS	MIT	370	F4	RS P	T T	\$	799
COMNUC,CASCADE, COMPOUND NUCLEUS REACTION	AI	360	F+BAL	RS P	T A	\$	482
COMPARE-MOD1, TRANSIENT FLOW W/SINKS & DOORS	LASL	7600	F4	RS P	T H	\$	776
COMPARE, TRANSIENT FLOW IN VENTED FLUID SYSTEM	LASL	7600	F4	RS P	T H	\$	702
COMPARE, TRANSIENT FLOW IN VENTED FLUID SYSTEM	NRC	370	F4	RS P	T H	\$	702
COMPLEMENTARY ERROR FUNCTION	SLA	6600	F4	RS P	P	\$	601
COMPLEX GAMMA-RAY SPECTRA	KSUN	360	F4	RS P	O	\$	390
COMPLEX GAMMA-RAY SPECTRA ANALYSIS	KAPL	6600	F4	RS	T O	\$	R485
COMPONENT TEST FOR OUTLIERS	UCND	360	F4	RS P	P	\$	769
COMPOSITE STRUCTURE STRESS STUDY	GGA	1108	F4	RS P	T I	\$	332
COMPOSITE STRUCTURE STRESS STUDY	ORNL	360	F+BAL	RS P	T I	\$	332
COMPOSITION-DEPENDENT X-SECS	FBRD	635	F+GMP	RS P	XCT B	\$	505
COMPOUND NUCLEUS REACTION	AI	360	F+BAL	RS P	T A	\$	482
COMPRESSIBLE FLUID FLOW	LASL	7600	F4	RS P	H	\$	723
COMPRESSIBLE 2-PHASE COOLANT BEHAVIOR	AAEC	360	F+BAL	RSBPLXCT	G	\$	726
COMQC, QUALITY CONTROL DATA ANALYSIS ROUTINES	BKC	360	F4	RS P	P	\$	649
COMRADEX4, ACCIDENT RELEASED RADIOLOGICAL DOSE	AI	370	F4	RS P	T G	\$	663
CONCEPTUAL COST ESTIMATE	GGA	1108	F4	RS P	XCT D	\$	498
CONCEPTUAL COST ESTIMATE	ORNL	360	F+BAL	RS P	XCT D	\$	498
CONCEPT3, POWER PLANT CONCEPTUAL COST ESTIMATE	GGA	1108	F4	RS P	XCT D	\$	498
CONCEPT5, POWER PLANT CONCEPTUAL COST ESTIMATE	ORNL	360	F+BAL	RS P	XCT D	\$	498
CONCRETE	GGA	1108	F4	RS P	I	\$	300
CONCRETE	GGA	1108	F5	RS P	T I	\$	451
CONDUCTANCE CALC	BNW	6600	F4	RS P	T I	\$	618
CONDUCTION	ORNL	360	F4	RS P	X T H	\$	525
CONDUCTION PROGRAM	BAPL	6600	F4	RS P	T H	\$	R286

CONDUCTION

COST

CONDUCTION PROGRAM	ORNL	360	F4	RS P	T H	SHEATINGS, 1,2, OR 3-D HEAT	517
CONDYN, POLYA MODEL SECONDARY ELECTRON SPECTRA	KAPL	6600	F4	RS P	W S		786
CONFIGURATION FREQUENCY DOMAIN	LLL	7600	F4	RS P	T T	SWFLL2B, WIRE	721
CONSEQUENCES	NRC	370	F4	RS PLX T	G	SCRAC, CALC OF REACTOR ACCIDENT	722
CONSISTENCY	LASL	7600	F4	RS P	CT A	SALVIN, DIFFERENTIAL-INTEGRAL DATA	815
CONSTANT & FAST SPECTRA CALC	EG&G	360	F4	RS PLXCT B		SPHROG, MULTI-GP	520
CONSTANT CALC FROM TOR OUTPUT DATA	LASL	6600	F4	RS P	T B	SGLEN, GROUP	361
CONSTANT CALC 0 TO 10 MEV	BC	625	F4	RS PLX T	B	\$GAMTEC2, MULTI-GP	185
CONSTANT CALC 0 TO 10 MEV	BNW	1107	F4	RS PL T	B	\$GAMTEC2, MULTI-GP	185
CONSTANT CALC 0 TO 10 MEV	UVAC	6400	F4	RS PLX T	B	\$GAMTEC2, MULTI-GP	185
CONSTANTS	EG&G	360	F4	RS PL CT	B	SINCITE, THERMAL SPECTRA & MULTI-GP	565
CONSTANTS	BNW	1108	F4	RS PLX T	B	SHRG3, SLOWING-DOWN SPECTRUM, MULTIGP	467
CONSTANTS	TVA	360	F4	RS PLX T	B	SHRG3, SLOWING-DOWN SPECTRUM, MULTIGP	467
CONSTANTS FROM ENDF/B DATA	FBRD	635	F+GMP	RS P	XCT B	SENDRUN2, MULTIGROUP	501
CONSTANTS FROM ENDF/B FOR 1DX	HEDL	360	F4	RSBP	XCT B	SETOX3, MULTI-GP	388
CONSTANTS FROM ENDF/B FOR 1DX	HEDL	1108B	F4	RS P	X T B	SETOX3, MULTI-GP	388
CONSTANTS GENERATION	ORNL	360	F4	RS P	T B	\$SUPERTOG, ENDF/B FINE-GP	431
CONSUMPTION ANALYSIS	BKY	7600	F+COM	RS PLXCT	T	\$DOE2.0, BUILDING ENERGY	782
CONSUMPTION ANALYSIS	MIT	370	F4	RS P	T T	\$DIST2, COMMUNITY ENERGY	799
CONTAINER IMPACT ANALYSIS	LASL	7600	F4	RS P	I	\$IMPAC2, B SHIPPING	715
CONTAINMENT	EG&G	7600	F+COM	RSBP	XCT G	\$CONTEMPT4/MOD2, MULTICOMPARTMENT	818
CONTAINMENT	EG&G	7600B	F+COM	RS PLXCT	G	\$CONTEMPT4/MOD2, MULTICOMPARTMENT	818
CONTAINMENT ACCIDENT ANALYSIS	HEDL	6600	F4	RS P	T G	\$CACECO, LMFBR	R762
CONTAINMENT AFTER LOCA	BCL	6400	F4	RS P	T G	\$CORRAL2, RADIONUCLIDE	745
CONTAINMENT SYSTEM FLUID FLOW	EG&G	7600	F+COM	RS P	CT G	\$BEACON/MOD2A,	767
CONTAINMENT SYSTEM IODINE REMOVAL	BCL	6400B	F4	RS P	X T G	\$MIRAB, MIRAP,	499
CONTAINMENT TRANSPORT MODEL	ORNL	360	F+BAL	RS P	CT R	\$CHNSD, SEDIMENT &	793
CONTEMPT-LT/G26, PRESSURE-TEMPERATURE RESPONSE	EG&G	360B	F+BAL	RSBP	XCT G	\$	433
CONTEMPT4/MOD2, MULTICOMPARTMENT CONTAINMENT	EG&G	7600	F+COM	RSBP	XCT G	\$	818
CONTEMPT4/MOD2, MULTICOMPARTMENT CONTAINMENT	EG&G	7600B	F+COM	RS PLXCT	G	\$	818
CONTOUR GENERATOR	ANL	360	F4	RS P	T	\$F0355, SHAPER CUTTER	697
CONTOUR GENERATOR	BKC	6600	F4	RS P	T	\$F0355, SHAPER CUTTER	697
CONTOUR PLOTS & AREA CALCULATION	SLA	6600	F4	RS P	P	\$PLOTR, 2-D	R578
CONTROL DATA ANALYSIS ROUTINES	BKC	360	F4	RS P	P	\$COMQC, QUALITY	649
CONTROL SAMPLE STATISTICS	BKC	360	F4	RSBP	P	\$HISTOGRAMS, QUALITY	614
CONTROL, LIBRARY JOURNAL MANAGEMENT	ORNL	360	C+BAL	RS PL	CT M	\$JOURNAL	660
CONVERSION TO OR FROM SI UNITS	RDYN	370B	F4	RS P	T P	\$METRICATION,	G668
CONVERTS R-MATRIX RESONANCE PARAMETERS	ORNL	360	F4	RS P	A	\$POLLA,	639
COOLANT & CLADDING TEMPERATURE ANALYSIS	FBRD	7600	F4	RS P	T H	\$PACT2,	S796
COOLANT BEHAVIOR	AAEC	360	F+BAL	RSBP	XCT G	\$NAIAD, COMPRESSIBLE 2-PHASE	726
COOLANT INLET PLENUM DP	360	F4	RS P	H	\$PLENUM, FLOW DIST. IN CYL		586
COOLANT TEMPERATURE PREDICTION	MIT	370	F4	RS P	T H	\$ENERGY, LMFBR	696
COOLANT-FLOW BLOCKAGE STUDY	PNC	360	F4	RS P	T H	\$LOCK, FEW-CHANNEL	732
COOLING	BCL	6400	F4	RS P	T G	\$ECCSA4, LOSS-OF-COOLANT & EMERGENCY	330
COOLING ENERGY USE	ORNL	360	F4	RS P	X R	\$MOBY, MOBILE HOME HEATING &	724
COORDINATE ANALYSES SEMI-RIGID MOLECULES	EG&G	360	F4	RS P	W	\$MMM3,	632
COPYCAT, IBM OS SYSTEM CATALOG UTILITY ROUTINE	ANL	360D	BAL	RS	X T P	\$	646
CORE ACCIDENT ANALYSIS	NED	635	F4	RS P	T G	\$FREADM1, FAST REACTOR	479
CORE ANALYSIS	ANL	370	F4	RS P	I	\$NUBOW2D-INELASTIC, BOWED REACTOR	790
CORE HEAT TRANSFER CODE	EG&G	360B	F4	RSBP	XCT H	\$MOXY/MOD032, BWR	551
CORE HEATUP & MELTDOWN	BCL	6400	F4	RS P	G	\$BOIL1, BOILOFF ACCIDENT	734
CORE HEATUP CODE FOR BWR/6 ANALYSIS	EI	360	F+BAL	RS P	CT H	\$6KILER,	636
CORE THERMAL-HYDRAULICS	BNW	7600D	F4	RS P	XCT H	\$COBRA41, ROD BUNDLE &	432
CORE TRANSIENT ANALYSIS	EG&G	360	F+BAL	RSBP	CT G	\$PARET, WATER-COOLED	555
COREL, RASE4, DAMG2, ION IMPLANTATION DEPOSITION	SLA	6600	F4	RS P	T Q	\$	758
CORES	FBRD	6000	F4	RS P	T D	\$COROPT, OPTIMIZING LMFBR MIXED-OXIDE	S752
CORES	ANL	360B	F4	RS P	I	\$NUBOW, STRUCTURAL ANALYSIS BOWED REACTOR	643
CORGAM, UNFOLDING OF COMPLEX GAMMA-RAY SPECTRA	KSUN	360	F4	RS P	O	\$	390
COROPT, OPTIMIZING LMFBR MIXED-OXIDE CORES	FBRD	6000	F4	RS P	T D	\$	S752
CORRAL2, RADIONUCLIDE CONTAINMENT AFTER LOCA	BCL	6400	F4	RS P	T G	\$	745
CORRECTION CALC	AI	360	F4	RS P	Q	\$RESPOND, DISSIMILAR MEDIA TLD	566
CORRELATION	ORNL	360	F4	RS P	T P	\$SPEKEN, PEARSON SPEARMAN & KENDALL	781
CORTES FEM PROGRAMS	ORNL	360	F4	RS P	CT N	\$GRFPK, PLOT PACKAGE FOR	760
CORTES, THERMAL & MECHANICAL ANALYSIS OF TEES	ORNL	360B	F4	RS P	CT I	\$	759
COST ANALYSIS	BNW	6600	F4	RS P	T D	\$GEUCOST, GEOTHERMAL ENERGY	684
COST AND ECONOMICS	CWE	360	F4	RS P	T D	\$CINCAS, NUCLEAR FUEL CYCLE	354
COST AND ECONOMICS	WAPD	6600	F4	RS P	T D	\$CINCAS, NUCLEAR FUEL CYCLE	354
CCST CALCULATION	GGA	1108	F4	RS P	T D	\$PWOCOST, REACTOR FUEL CYCLE	441
COST CODE	HEDL	1108	F5	RS P	X T D	\$PACTOLUS, CLOTHO, NUCLEAR POWER PLANT	540
COST ESTIMATE	GGA	1108	F4	RS P	XCT D	\$CONCEPT3, POWER PLANT CONCEPTUAL	498
COST ESTIMATE	ORNL	360	F+BAL	RS P	X T D	\$CONCEPT5, POWER PLANT CONCEPTUAL	498
COST ESTIMATING	ORNL	360	F+BAL	RS P	T D	\$ORCOST2, POWER PLANT CAPITAL	588

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COST STUDY	ORNL	360	F+BAL	RS P	D	SOMCST, POWER PLANT NON-FUEL O & M	688
COST STUDY	BNW	6600	F4	RS P	T D	\$GEOCOST-BC, BINARY CYCLE GEOTHERMAL	711
COSTS	UEC	6600	F4	RS P	D	\$POWERCO, NUCLEAR STATION ELECTRICITY	340
COSTS PERFORMANCE DATA	ANL	360	F4	RS P	D	\$NPRFCCP, FUEL CYCLE	146
COSTS PERFORMANCE DATA	UEC	6600	F4	RS P	D	\$NPRFCCP, FUEL CYCLE	146
COSTS PERFORMANCE STUDY	UEC	6600	F4	RS P	D	\$WAMPUM, FUEL CYCLE	224
COUPLED CHANNEL X-SEC EVALUATION	ENEA	360	F4	RS P	CT A	\$JUPITOR1,	308
COUPLED-CHANNEL SCATTERING X-SEC CALC	KAPL	6600	F4	RS P	T A	\$JP1XR,	R506
COVE1, CREEP COLLAPSE FOR OVAL FUEL PIN TUBE	BNW	6600	F4	RS P	T I	\$	817
CRAC, CALC OF REACTOR ACCIDENT CONSEQUENCES	NRC	370	F4	RS PLX	T G	\$	722
CRACKING BAPL	6600	F4	RS P	I	\$STRIPPE, FUEL ROD CLAD STRAIN & PELLET	R570	
CRBR REACTOR & PLANT TRANSIENT ANALYSIS	WARD	7600	F4	RS P	T K	\$DEMO4,	R676
CRBRP 2-D TRANSIENT FLUID FLOW ANALYSIS	WARD	7600	F+COM	RS P	XCT H	\$VARR2,	755
CRECT,CHECKER, ENDF/B V2 PROCESSING CODES	ANL	360	F4	RS P	T M	\$	475
CRECT,CHECKER,RIGEL,PLOTFB,... ENDF/B V2 PROC	BNL	6600B	F4	RS	T M	\$	475
CRECT,DAMMET,PLOTFB,... ENDF/B V1 PROC	BNL	6600B	F4	RS	T M	\$	384
CREEP ANALYSIS	HEDL	6600	F4	RS P	T I	\$BEAMCRP, FINITE-ELEMENT BEAM	R701
CREEP ANALYSIS	HEDL	6600	F4	RS P	CT I	\$SAXICRP, FINITE ELEMENT CODE FOR	785
CREEP BUCKLING OF INITIALLY OVAL TUBE	BNW	6600C	F4	RS P	I	\$BUCKLE,	667
CREEP COLLAPSE FOR OVAL FUEL PIN TUBE	BNW	6600	F4	RS P	T I	\$COVE1,	817
CREEP-BUCKLING OF TUBES UNDER PRESSURE	BAPL	6600	F4	RS P	I	\$TCB01,	R604
CREEP-PLAST, 2-D INELASTIC STRUCTURAL ANALYSIS	ORNL	360B	F+BAL	RS P	X T I	\$	R707
CREEP-PLAST2, 2D INELASTIC STRUCTURAL ANALYSIS	ORNL	360	F+BAL	RS P	XCT I	\$	R810
CRITICAL ANALYSIS SYSTEM	DP	360	F+BAL	RS P	XCT B	\$HAMMER,LITHE,HELP,	277
CRITICAL ASSEMBLY ANALYSIS	A1	7600	F4	RS PLX	T C	\$VIM1, MONTE CARLO	510
CRITICAL ASSEMBLY ANALYSIS	A1-A	360	F4	RSBPLXCT	C	\$VIM1X, MONTE CARLO	510
CRITICALITY CALCULATIONS	BAPL	7600	F+COM	RS P	T C	\$RECAP-12, MONTE CARLO	R670
CRITICALITY CODE	DP	360B	F+BAL	RSBP	CT C	\$KENO2, MONTE CARLO MULTIGROUP	450
CRITICALITY CODE	ORNL	360C	F+BAL	RSBPLXCT	C	\$KENO4, MONTE CARLO MULTIGROUP	450
CRITICALITY CODE	RFD	6600B	F+COM	RS PLX	T C	\$KENO2, MONTE CARLO MULTIGROUP	450
CRITICALITY SAFETY	DP	360	F4	RS P	T C	\$KEFF,MGBS,TGAN, NUCLEAR	617
CRNL	6600B	F4	RS P	CT P	\$FORSIM, SOLN OF PARTIAL OR ORDINARY DIFF EQNS	514	
CROSS SECTIONS	LASL	6600	F4	RS P	N	\$LARCA, FLUX-WEIGHTING OF DTF4	409
CROSS-REF LIST FROM JCL PROCLIBS	HCI	370	F+C+A	RS	XC P	\$JCLCROSS, DSN	725
CROSS-SPECTRAL DENSITIES	BNW	1108	F5	RS P	X T F	\$NOISY1, AUTO- AND	488
CROSS, IBM360 FORTRAN H PROGRAM CHECKER	ANL	360B	PL1	S	P CT P	\$SLOP,	647
CRYSTALLINE MATERIALS	LASL	6600	F4	RS P	T A	\$TOR, THERMAL SCATTERING	360
CSMP	S	R	\$TRITMOD, ADVECTION MODEL OF TRITIUM DISPERSION	DP	360		814
CSMP	RS	R	\$POLUTE, FOREST AIR POLLUTANT UPTAKE MODEL	DP	360		774
CUP1	370	F+BAL	RS P	CT U	\$BIOSSIM, BIOCHEMICAL KINETIC SIMULATION SYSTEM		736
CURFIT, CURVE FITTING EXPERIMENTAL DATA POINTS	KAPL	6600	F+ASC	RS P	T P	\$	R 43
CURIE, FISSION PRODUCT INVENTORY DECAY HISTORY	ANL	370	F4	RS PL	C G	\$	196
CURT2, CURVED TUBES OR ELBOWS & ATTACHED PIPES	ORNL	360	F+BAL	RS P	XCT I	\$	R750
CURVE FITTING	BAPL	6600	F4	RS P	T P	\$M0661,M0657,M0626, POLYNOMIAL	R411
CURVE FITTING EXPERIMENTAL DATA POINTS	KAPL	6600	F+ASC	RS P	T P	\$CURFIT,	R 43
CURVE PLOT	KAPL	6600	F+ASC	RS P	T P	\$SNEQ, NONLINEAR ALGEBRAIC EQN SOLN	R364
CURVED TUBES OR ELBOWS & ATTACHED PIPES	ORNL	360	F+BAL	RS P	XCT I	\$CURT2,	R750
CURVES LLL	7600	F4	RS P	P	\$EXPALS, LEAST SQUARES EXPONENTIAL DECAY		321
CUSTOMARY UNITS	MLMO	360	F4	RS P	XC P	\$MTRC0001, SI METRIC TO U.S.	812
CUT SET RANKING	ANL	370	F4	RS P	T G	\$IMPORTANCE, FTA BASIC EVENT &	779
CUTTER CONTOUR GENERATOR	ANL	360	F4	RS P	T	\$F0355, SHAPER	697
CUTTER CONTOUR GENERATOR	BKC	6600	F4	RS P	T	\$F0355, SHAPER	697
CWE	360	F4	RS P	T D	\$CINCAS, NUCLEAR FUEL CYCLE COST AND ECONOMICS		354
CYCLE ANALYSIS	ORNL	360B	F4	RS P	T H	\$ORCENT, NUCLEAR STEAM TURBINE	703
CYCLE ANALYSIS FOR FAST REACTORS	ANL	360B	F+BAL	RSBPL	CT D	\$REBUS2, FUEL	634
CYCLE CALCULATION	GGA	1108	F4	S	T D	\$GAFFE, EQUILIBRIUM FUEL	302
CYCLE COST AND ECONOMICS	CWE	360	F4	RS P	T D	\$CINCAS, NUCLEAR FUEL	354
CYCLE COST AND ECONOMICS	WAPD	6600	F4	RS P	T D	\$CINCAS, NUCLEAR FUEL	354
CYCLE COST CALCULATION	GGA	1108	F4	RS P	T D	\$PWOCOST, REACTOR FUEL	441
CYCLE COSTS PERFORMANCE DATA	ANL	360	F4	RS P	D	\$NPRFCCP, FUEL	146
CYCLE COSTS PERFORMANCE DATA	UEC	6600	F4	RS P	D	\$NPRFCCP, FUEL	146
CYCLE COSTS PERFORMANCE STUDY	UEC	6600	F4	RS P	D	\$WAMPUM, FUEL	224
CYCLE ECONOMICS	UICS	360	F4	RS P	CT D	\$GEM, ANALYSIS OF NUCLEAR FUEL	576
CYCLE GEOTHERMAL COST STUDY	BNW	6600	F4	RS P	T D	\$GEOCOST-BC, BINARY	711
CYCLE PARAMETERS FAST BREEDERS	NED	635	F4	RS P	D	\$RAPFU, FUEL	372
CYCLE REQUIREMENTS	ERDA	370C	F4	RS P	CT D	\$NUFUEL, NUCLEAR FUEL	683
CYGR02, STRESS ANALYSIS CYL FUEL ELEMENT	BAPL	6600	F4	RS	T I	\$	R266
CYGR03, OXIDE FUEL ROD STRESS & DEFORMATION	AN-T	360B	F4	RSBP	CT I	\$	R449
CYGR03, OXIDE FUEL ROD STRESS & DEFORMATION	BAPL	6600	F4	RS P	T I	\$	R449
CYL	GGA	1108	F+BAL	RS P	T C	\$GAZE2, 1-D MULTIGROUP DIFFUSION SLAB, SPH,	430
CYL COOLANT INLET PLENUM	DP	360	F4	RS P	H	\$PLENUM, FLOW DIST. IN	586
CYL FUEL ELEMENT	BAPL	6600	F4	RS	T I	\$CYGR02, STRESS ANALYSIS	R266

CYL.

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CYL FUEL ELEMENTS	AEB	360	F4	RS P	B	SWELWING, MATERIAL BUCKLING	362	
CYL LATTICE	TVA	360B	F4	RSBPLXCT	B	\$LASER, SPECTRUM CALC WITH BURNUP	249	
CYL SHELL BUCKLING COLLAPSE ANALYSIS				BAPL	6600	F4 RS P T I \$BUSHL,	R481	
CYL SPHERE	BNW	1107	F4	RS P T C	\$HFN,	1-D MULTI-GP DIFFUSION SLAB	241	
CYL SPHERE	BNW	6600	F4	RS P X T C	\$HFN,	1-D MULTI-GP DIFFUSION SLAB	241	
CYL SPHERE	OSUC	370	F4	RS PL CT C	\$AIM6,	1-D MULTI-GP DIFFUSION SLAB	29	
CYL SPHERE	MTS	360	F4	RSBPLXCT	C	\$MACH1, 1-D MULTI-GP DIFFUSION SLAB	262	
CYL SPHERE	PURD	6500	F4	RS PLX T C	\$MACH1,	1-D MULTI-GP DIFFUSION SLAB	262	
CYL SPHERE	BHSC	360	F4	RS P T C	\$FAIMOS,	1-D MULTI-GP DIFFUSION SLAB	120	
CYL-CYL INTERSECTION MESH GENERATOR				WARD	7600	F4 RS P T L \$EURCYL1,	R746	
CYL, SPH	EG&G	360	F4	RSBP CT C	\$MONA,	1-D MULTIGROUP DIFFUSION SLAB,	582	
CYLINDER SPHERE	AEB	360	F4	RS L T C	\$CFIRE5,	1-D AGE-DIFFUSION SLAB	0	
CYLINDER SPHERE	BC	625	F4	RS	T C	\$FOG, 1-D FEW-GP DIFFUSION SLAB	28	
CYLINDRICAL CELL	AI	370	F4	RS P T G	\$SOMIX1,	SODIUM SPRAY FIRES IN	R751	
CYLINDRICAL PINS	EG&G	360	F4	RSBP CT J	\$VIEWPIN,	VIEW FACTOR CALC FOR	569	
CY74	F4	RS P	G	\$SPRAY3,	SODIUM SPRAY RELEASE SAFETY ANALYSIS	HEDL	716	
DAC1, SN PERTURBATION CODE USING DTF4 FLUXES	LASL	6600	F4	RS P	N	\$	455	
DAFT1, LEAST SQUARES FIT FISSIONUCLIDE DATA	BAPL	6600	F4	RS P	P	\$	R327	
DAMG2, ION IMPLANTATION DEPOSITION SLA	6600	F4	RS P	T Q	\$COREL, RASE4,		758	
DAMMET, PLOTFB, ... ENDF/B V1 PROC BNL	6600B	F4	RS	T M	\$CHECKER, CRECT,		384	
DATA	ORNL	360	F+BAL	RS P T I	\$LINDA,	EVALUATION OF STRAIN-GAGE	657	
DATA	SLA	6600	BCD	R L T Z	\$SOLDATABQ62,	ALBUQUERQUE 1962 SOLAR	693	
DATA	SLA	6600B	BIN	R L T Z	\$SOLDATABQ62,	ALBUQUERQUE 1962 SOLAR	693	
DATA	WAPD	7600	F4	RS P T B	\$ETOT2,	THERMAL LIBRARIES FROM ENDF/B	509	
DATA	ANL	360	F4	RS P	D	\$NPRFCCP, FUEL CYCLE COSTS PERFORMANCE	146	
DATA	UEC	6600	F4	RS P	D	\$NPRFCCP, FUEL CYCLE COSTS PERFORMANCE	146	
DATA	NED	635	F4	RS P T O	\$EXPN,	ANALYSIS OF PULSED NEUTRON SOURCE	258	
DATA	BAPL	6600	F4	RS P	P	\$DAFT1, LEAST SQUARES FIT FISSIONUCLIDE	R327	
DATA	BAPL	6600	F4	RS P T B	\$EPOCH,	NEUTRON AGE CALCULATION OF ENDF/B	R461	
DATA	DP	360B	F4	RS P XCT B	\$FLANGE2(71-1),	ENDF/B THERMAL SCATTERING	368	
DATA	ORNL	360	F4	RS P T B	\$PRICE,	PRIMARY RECOIL ATOM SPECTRA ENDF/B	453	
DATA	FBRD	635	F+GMP	RS P XCT B	\$ENDRUN2,	MULTIGROUP CONSTANTS FROM ENDF/B	501	
DATA	LASL	6600	F4	RS P T B	\$GLEN,	GROUP CONSTANT CALC FROM TOR OUTPUT	361	
DATA	LLL	7600	F4	RS P T B	\$LINEAR, SIGMA1,	LINEARIZE & BROADEN ENDF/B	747	
DATA	UICS	360	F4	RS P	A	\$CODILLI,	LEAST SQUARES ANALYSIS RESONANCE	347
DATA ANALYSIS	EG&G	360	F4	RS PL CT P	\$ERREST,	LOCA ROD BUNDLE CHF	518	
DATA ANALYSIS	CNEA	360	F4	RS P	E	\$TRIFIDO,	PULSED NEUTRON SOURCE	489
DATA ANALYSIS	GGA	1108	F5	RS P T O	\$CAGE, BIRD, SPEC,	TIME-OF-FLIGHT	476	
DATA ANALYSIS	BAPL	6600	F4	RS P	P	\$BH99,	EXTREME VALUE DISTRIBUTION	R621
DATA ANALYSIS ROUTINES	BKC	360	F4	RS P	P	\$COMQC,	QUALITY CONTROL	649
DATA BASE	RFD	360	COBOL	RS P T M	\$GLOVE CHANGE ANALYSIS SYSTEM,	GLOVE	813	
DATA CONSISTENCY	LASL	7600	F4	RS P CT A	\$ALVIN,	DIFFERENTIAL-INTEGRAL	815	
DATA HEAT TRANSFER STUDY	SLL	6600	F4	RS P	N	\$SHEATMESH,	GEOMETRICAL	434
DATA LIBRARIES, MUFT4 OR 5, GAM1 OR 2				WAPD	6600	BCD R L T Z \$ETOG1	447	
DATA MANAGEMENT, EDITING, & ANALYSIS				BAPL	6600	F4 RS P T M \$SSHLOG,	R557	
DATA POINTS	KAPL	6600	F+ASC	RS P T P	\$CURFIT,	CURVE FITTING EXPERIMENTAL	R 43	
DATA PROCESSING CODE				ANL	360	F4 RS T M \$RIGEL,	ENDF/B V3	571
DATA PROCESSING MODULE				ANL	360	F4 RSBP CT L \$ARC-NU1002,	BCD INPUT	533
DATA SET REORDERING				DP	370	F+BAL RS P XCT P \$SDYNDSK,	OPTIMAL DISK	729
DATA SYSTEM	KAPL	6600B	F+COM	RS P X T M	\$DATATRAN2,	MODULAR PROGRAMMING AND	386	
DATA SYSTEM	KAPL	7600C	F+COM	RS P T M	\$DATATRAN2,	MODULAR PROGRAMMING AND	386	
DATA TAPES	GGA	1108	BIN	R L T Z	\$ZPR-III ASSEMBLY 48	GAFGAR ENDF/B	356	
DATA TO THERMAL LIBRARY FORM	WAPD	7600	F4	RS P T B	\$ETOT3,	ENDF/B V3	628	
DATATRAN2, MODULAR PROGRAMMING AND DATA SYSTEM	KAPL	6600B	F+COM	RS P X T M	\$		386	
DATATRAN2, MODULAR PROGRAMMING AND DATA SYSTEM	KAPL	7600C	F+COM	RS P T M	\$		386	
DATATRAN2, RADI GEOMETRY MODULES 2-D INPUT GEN	KAPL	6600B	F+C	RS P T L	\$		406	
DATATRAN2, UTILITY PLOT MODULES F(X) & F(X,Y)	KAPL	6600B	F+COM	RS P T P	\$		407	
DBF1, RESONANCE INTEGRAL HEX CELL	BAPL	6600	F+ASC	RS P X T B	\$RESQ2, RESQ0,		R285	
DBUFIT1, LEAST SQUARES TRANSMUTATION ANALYSIS	BNW	1108	F5	RS P T D	\$		456	
DCF METHOD	ORNL	360	F4	RS P	D	\$SPRP,	PRODUCT PRICE CALCULATED BY	739
DE/STEP, INTRP, SOLN OF ORDINARY DIFF EQUATIONS	SLA	360D	F4	RS P X T P	\$		640	
DE/STEP, INTRP, SOLN OF ORDINARY DIFF EQUATIONS	SLA	6600D	F4	RS P X T P	\$		640	
DECAY	BNW	1108	F5	RSBPL T D	\$SISOGEN,	RADIONUCLIDE GENERATION AND	367	
DECAY LMSC	1100	F5	RS P	D	\$ISOTOPES,	MAXIMUM YIELD FROM REACTION OR	179	
DECAY CHAINS	GEC	635	F4	RSBP	D	\$CHAINS,	ANALYSIS OF RADIOACTIVE	418
DECAY CURVES	LLL	7600	F4	RS P	P	\$SEXPALS,	LEAST SQUARES EXPONENTIAL	321
DECAY HEAT ON CHARCOAL ADSORBERS	ORNL	360	F4	RS P T G	\$CHART,	IODINE	804	
DECAY HISTORY	ANL	370	F4	RS PL C	G	\$CURIE,	FISSION PRODUCT INVENTORY	196
DEFLECTION STRESS STUDY	BAPL	6600	F+COM	RS P T I	\$GAPL3,	INELASTIC LARGE	R397	
DEFORMATION	AN-T	360B	F4	RSBP CT I	\$CYGR03,	OXIDE FUEL ROD STRESS &	R449	
DEFORMATION	BAPL	6600	F4	RS P T I	\$CYGR03,	OXIDE FUEL ROD STRESS &	R449	
DEFORMATION	BAPL	6600	F4	RS P T I	\$FELEN,	FUEL PELLETT TEMPERATURE &	R598	

DEMONR

DIFFUSION

DEMONR, UNBIASED MONTECARLO SLAB SHIELD CODE	LSU	360	F4	RS P	J	S	754		
DEMO4, CRBR REACTOR & PLANT TRANSIENT ANALYSIS	WARD	7600	F4	RS P	T	K	S	R676	
DENSITIES	BNW	1108	F5	RS P	X	T	F	488	
DEPLETION	AI	360	F4	RSBP	X	T	D	58	
DEPLETION	KAPL	6600	F4	RS P	T	D		R477	
DEPLETION	BAPL	7600B	F+COM	RS P	T	D	\$PDQ8, 1,2 OR 3-D FEW-GP DIFFUSION	R275	
DEPLETION	BUSS	6600D	F+ASC	R	B	T	D	R275	
DEPLETION	BNW	1108	F4	RS P	T	D	\$2DB, 2-D MULTIGROUP DIFFUSION AND	325	
DEPLETION	EG&G	360G	F+BAL	RSBP	XCT	D	\$PDQ7, 1,2 OR 3-D FEW-GP DIFFUSION	R275	
DEPLETION	EG&G	7600	FTN	RS	LXCT	D	\$PDQ7, 1,2 OR 3-D FEW-GP DIFFUSION	R275	
DEPLETION	JNC	1108B	F5	RS	PLX	T	B	\$LEOPARD, SPOTS, SPECTRUM CALC WITH	279
DEPLETION	LASL	6600	F4	RS P	T	D	\$2DB, 2-D MULTIGROUP DIFFUSION AND	325	
DEPLETION	WAPD	360C	F4	RS	PLXCT	B	\$LEOPARD, SPOTS, SPECTRUM CALC WITH	279	
DEPLETION	BAPL	7600	F+COM	RS P	T	D	STPT01, 2-D FEW-GROUP TRANSPORT WITH	R669	
DEPLETION	GGA	1108	F4	RS P	T	D	SFEVER7, 1-D MULTIGROUP DIFFUSION AND	318	
DEPLETION	GGA	1108	F4	RS P	T	D	\$GAUGE, 2-D FEW-GP HEX GEOM DIFFUSION	339	
DEPLETION	NED	635	F+GMP	RS P	T	D	\$SYN, 2D SYNTHESIS MULTIGP DIFF & 1GP	495	
DEPLETION FISSION PRODUCT	BAPL	6600	F4	RS P	T	D	\$CINDER,M0102, POINT	313	
DEPLETION FISSION PRODUCT	DP	360	F+BAL	RS P	T	D	\$CINDER,M0102, POINT	313	
DEPLETION MULTI-GP	ORNL	360I	F4	RS P	T	K	\$CITATION, 1,2,3-D DIFFUSION	387	
DEPLETION PROGRAM	EG&G	360	F4	RSBP	CT	D	\$DWARF, 1-D FEW-GP DIFFUSION	579	
DEPOSITION SLA	6600	F4	RS P	T	Q		\$COREL,RASE4,DAMG2, ION IMPLANTATION	758	
DEP3, 3-D XENON TRANSIENT & DEPLETION	KAPL	6600	F4	RS P	T	D	\$3DXT,	R477	
DESALINATION PLANT OPTIMIZATION	ORNL	360	F+BAL	RS P	T	D	\$MSF21,VTE21,	798	
DESIGN	BNW	1108	F5	RS P	CT	H	\$REPP, THERMAL-HYDRAULIC WATER REACTOR	483	
DESIGN	MLMO	360	F4	RSBP	C	P	\$LATIN SQ, NXN LATIN SQUARE EXPERIMENTAL	630	
DESIGN & SURVEY STUDY	BW	6600	F+COM	RS P	X	T	D	\$FARED, 1-D FAST REACTOR	427
DESIGN OF CHARGED PARTICLE BEAMS	SLAC	370	F4	RS P	T	V	\$TRANSPORT,	791	
DESIGN OF PRINTED-CIRCUIT BOARDS	SLA	1108	F+BAL	RSBP	T	T	\$ACCEL(MOD2),	681	
DESIGN OF PRINTED-CIRCUIT BOARDS	SLA	6600	F+COM	RS P	T	T	\$ACCEL(MOD2),	681	
DESIGN SYSTEM	AI	360	F4	RSBP	T	K	\$THREDES, 1-D FEW-GP DIFFUSION	273	
DESIGN SYSTEM	LASL	6600	F+COM	RS P	T	P	\$LENDES, NONLINEAR LEAST SQ LENS	602	
DESK CALCULATOR FORM SHEET DP PACKAGE	KAPL	6600	F+ASC	RS P	T	P	\$DOGGY,	R428	
DIELECTRICS	ANL	360	F4	RS P	CT	T	\$FFEARS, LAPLACE EQUATION ISOTROPIC	577	
DIELECTRICS	SLA	6600B	F4	RS P	T	T	\$FFEARS, LAPLACE EQUATION ISOTROPIC	577	
DIFF & 1GP DEPLETION	NED	635	F+GMP	RS P	T	D	\$SYN, 2D SYNTHESIS MULTIGP	495	
DIFF EQNS	CRNL	6600B	F4	RS P	CT	P	\$FORSIM, SOLN OF PARTIAL OR ORDINARY	514	
DIFF EQUATION SYSTEM SOLVER	LLL	360	F4	RS P	X	T	P	\$EPISODE, ORDINARY	675
DIFF EQUATIONS	SLA	360D	F4	RS P	X	T	P	\$DE/STEP,INTRP, SOLN OF ORDINARY	640
DIFF EQUATIONS	SLA	6600D	F4	RS P	X	T	P	\$DE/STEP,INTRP, SOLN OF ORDINARY	640
DIFFERENTIAL EQN SYSTEM SOLVER	ANL	360C	F4	RS P	X	P	\$GEAR, ORDINARY	592	
DIFFERENTIAL EQN SYSTEM SOLVER	LLL	6600C	F4	RS P	X	P	\$GEAR, ORDINARY	592	
DIFFERENTIAL EQNS	LLL	7600	F4	RS P		P	\$PDEONE, SOLUTIONS OF PARTIAL	777	
DIFFERENTIAL EQNS. SOLUTION	KAPL	6600	F+ASC	RS P	T	P	\$LIZARD, NONLINEAR	R445	
DIFFERENTIAL-INTEGRAL DATA CONSISTENCY	LASL	7600	F4	RS P	CT	A	\$ALVIN,	815	
DIFRACTION MODEL ELASTIC SCAT X-SEC	BNL	6600	F4	RS P		A	\$BESFIT,	524	
DIFRACTION POWDER PATTERN INDEXING	LASL	6600	F+COM	RS P		Q	\$INDX, XRAY	609	
DIFFUSER PERFORMANCE	ANL	370	F4	RS P	H		\$DIFFUSER, 2D SUBSONIC MHD	737	
DIFFUSER, 2D SUBSONIC MHD DIFFUSER PERFORMANCE	ANL	370	F4	RS P	H			737	
DIFFUSION	ANL	360	F4	RS P	T	F	\$TWIGGLE, 2-D 2-GP SPACE-TIME	R338	
DIFFUSION	ORNL	360	F+BAL	RSBP	CT	C	\$VENTURE, 1, 2, OR 3-D MULTIGROUP	686	
DIFFUSION	UMCC	360	F4	RS P	T	C	\$VARI-QUIR, TIME-DEP 2-D MULTI-GP	212	
DIFFUSION	WANL	6600	F4	RS P	T	C	\$VARI-QUIR, TIME-DEP 2-D MULTI-GP	212	
DIFFUSION	ANL	370B	F+BAL	RS P	XCT	C	\$SYN3D, SINGLE-CHANNEL FLUX SYNTHESIS	713	
DIFFUSION	ANL	7600	F+COM	RS P	XCT	C	\$SYN3D, SINGLE-CHANNEL FLUX SYNTHESIS	713	
DIFFUSION	UFCC	370B	F4	RS P	T	F	\$GAKIN2, 10 MULTIGROUP TIME-DEPENDENT	310	
DIFFUSION & BURNUP TRI-MESH	GGA	1108	F+BAL	RS P	T	D	\$BUGTRI, 2D MULTIGP	439	
DIFFUSION & BURNUP XY, RZ	GGA	1108	F+BAL	RS P	T	D	\$SUG2, 2-D MULTIGROUP	438	
DIFFUSION & INVENTORY	ANL	360	F4	RSBP	CT	C	\$ARC-DIF1D, 1-D MULTI-GP	626	
DIFFUSION & LIB.	AI	360	F4	RSBP	PLX	T	C	\$CAESAR4,LIBLST, 1-D MULTI-GP	270
DIFFUSION & SN THEORY	NED	635	F4	RS P	T	C	\$DOT2DB, 2-D MULTIGROUP	459	
DIFFUSION ABSORPTION REMOVAL X-SECS	BAPL	6600	F4	RS		B	\$M0807, 2-D	R280	
DIFFUSION AND DEPLETION	BNW	1108	F4	RS P	T	D	\$2DB, 2-D MULTIGROUP	325	
DIFFUSION AND DEPLETION	LASL	6600	F4	RS P	T	D	\$2DB, 2-D MULTIGROUP	325	
DIFFUSION AND DEPLETION	GGA	1108	F4	RS P	T	D	SFEVER7, 1-D MULTIGROUP	318	
DIFFUSION BURNUP ANALYSIS	ANL	360	F4	RS P	CT	D	\$3DB, 3-D MULTIGROUP	567	
DIFFUSION BURNUP ANALYSIS	HEDL	1108	F4	RS P	T	D	\$3DB, 3-D MULTIGROUP	567	
DIFFUSION BURNUP REFUELING HISTORY	LASL	6600	F4	RS P	T	D	\$PHENIX, 2-D	454	
DIFFUSION CALC	KAPL	6600	F4	RS P		F	\$RAUMZEIT, 1-D TIME-DEPENDENT	R352	
DIFFUSION CALC HEX-Z MESH	GGA	1108	F4	RS P	T	C	\$GATT, 3-D FEW-GP	380	
DIFFUSION DEPLETION	AI	360	F4	RSBP	X	T	D	\$SIZZLE, 1-D MULTIGROUP	58
DIFFUSION DEPLETION	BAPL	7600B	F+COM	RS P	T	D	\$PDQ8, 1,2 OR 3-D FEW-GP	R275	

DIFFUSION

DP

DIFFUSION DEPLETION	BCSS	6600D	F+ASC	R B	T D	SPDQ7, 1,2 OR 3-D FEW-GP	R275	
DIFFUSION DEPLETION	EG&G	360G	F+BAL	RSBP	XCT D	SPDQ7, 1,2 OR 3-D FEW-GP	R275	
DIFFUSION DEPLETION	EG&G	7600	FTN	RS	LXCT D	SPDQ7, 1,2 OR 3-D FEW-GP	R275	
DIFFUSION DEPLETION	GGA	1108	F4	RS P	T D	\$GAUGE, 2-D FEW-GP HEX GEOM	339	
DIFFUSION DEPLETION MULTI-GP	ORNL	3601	F4	RS P	T K	\$CITATION, 1,2,3-D	387	
DIFFUSION DEPLETION PROGRAM	EG&G	360	F4	RSBP	CT D	\$DWARF, 1-D FEW-GP	579	
DIFFUSION DESIGN SYSTEM	AI	360	F4	RSBP	T K	\$THREDES, 1-D FEW-GP	273	
DIFFUSION FAST X-SECTION GENERATION	ANL	360	F+BAL	RSBP	XCT B	\$1DX, 1-D	374	
DIFFUSION FAST X-SECTION GENERATION	BNW	1108	F4	RS P	X T B	\$1DX, 1-D	374	
DIFFUSION FEEDBACK	BAPL	6600	F4	RS P	T F	\$TWIGL, 2-D 2-GP SPACE-TIME	R338	
DIFFUSION FEEDBACK	BNL	6600	F4	RS P	T F	\$NOAH, 1-D ONE-GP SPACE-TIME	405	
DIFFUSION MODEL	ORNL	360	F+BAL	RS P	T R	\$ATM, ATMOSPHERIC TRANSPORT &	787	
DIFFUSION PROGRAM	BC	625	F4	RS	T C	\$EXTERMINATOR2, 2-D MULTI-GP	156	
DIFFUSION PROGRAM	CEND	6600	F4	RS P	T C	\$EXTERMINATOR2, 2-D MULTI-GP	156	
DIFFUSION PROGRAM	ORNL	360	F4	RS P	T C	\$EXTERMINATOR2, 2-D MULTI-GP	156	
DIFFUSION SLAB CYL SPHERE	BNW	1107	F4	RS P	T C	\$HFN, 1-D MULTI-GP	241	
DIFFUSION SLAB CYL SPHERE	BNW	6600	F4	RS P	X T C	\$HFN, 1-D MULTI-GP	241	
DIFFUSION SLAB CYL SPHERE	OSUC	370	F4	RS PL	CT C	\$AIM6, 1-D MULTI-GP	29	
DIFFUSION SLAB CYL SPHERE	MTS	360	F4	RSBP	PLXCT C	\$SMACH1, 1-D MULTI-GP	262	
DIFFUSION SLAB CYL SPHERE	PURD	6500	F4	RS PL	T C	\$SMACH1, 1-D MULTI-GP	262	
DIFFUSION SLAB CYL SPHERE	BHSC	360	F4	RS P	T C	\$FAIMOS, 1-D MULTI-GP	120	
DIFFUSION SLAB CYLINDER SPHERE	BC	625	F4	RS	T C	\$FOG, 1-D FEW-GP	28	
DIFFUSION SLAB, CYL, SPH	EG&G	360	F4	RSBP	CT C	\$MONA, 1-D MULTIGROUP	582	
DIFFUSION SLAB, SPH, CYL	GGA	1108	F+BAL	RS P	T C	\$GAZE2, 1-D MULTIGROUP	430	
DIFFUSION SYNTHESIS CALC	NED	635	F4	RS PL	T C	\$BISYN, 2-D MULTI-GP	287	
DIFFUSION SYNTHESIS CALC	NED	1108	F4	RS P	T C	\$BISYN, 2-D MULTI-GP	287	
DIFFUSION TRIANGULAR MESH	GGA	1108	F+BAL	RS P	T C	\$GAMTRI, 2-D MULTI-GP	401	
DIFFUSION W/FEEDBACK	BAPL	6600	F4	RS P	T F	\$WIGL3, 1-D SPACE-TIME	R708	
DIFFUSION XY RZ GEOMETRY	GGA	1108	F+BAL	RS P	T C	\$GAMBLE5, 2-D MULTI-GP	222	
DIFFUSION XYZ R-THETA-Z	LASL	6600	F4	RS P	T D	\$3DDT, 3-D MULTIGROUP	463	
DIFFUSION 3-GEOM	BAPL	6600	F4	RS P	T F	\$WIGL2, 1-D 2-GP SPACE-TIME	R274	
DIFFUSION 3-GEOM	GGA	1108	F4	RS P	T F	\$WIGL2, 1-D 2-GP SPACE-TIME	R274	
DIFFUSION 3-GEOM	UFCC	370	F4	RS P	T F	\$WIGL2, 1-D 2-GP SPACE-TIME	R274	
DISASSEMBLY	ANL	360	F4	RS P	XCT F	\$VENUS, 2-D LMFBR POWER EXCURSION	511	
DISCHARGE STUDY	HEDL	1108	F5	RS P	T R	\$STOPLYR2, POWER PLANT THERMAL	599	
DISCRETE ORDINATE CODE	GGA	1108	F5	RS P	T C	\$2DF, 2-D MULTI-GP	173	
DISCRETE ORDINATE PROGRAM	ANL	360	F+BAL	RS P	T C	\$DTF4, 1-D MULTI-GP	209	
DISCRETE ORDINATE PROGRAM	EC	625	F+MAP	RS P	T C	\$DTF4, 1-D MULTI-GP	209	
DISCRETE ORDINATE PROGRAM	LASL	6600	F4	RS P	T C	\$DTF4, 1-D MULTI-GP	209	
DISCRETE ORDINATES	LASL	360	F4	RS P	T F	\$TIMEX, 1-D TIME-DEP MULTIGP	756	
DISCRETE ORDINATES	LASL	7600	F4	RS P	T F	\$TIMEX, 1-D TIME-DEP MULTIGP	756	
DISCRETE ORDINATES SLAB GEOMETRY	BAPL	6600	F4	RS P	T C	\$BE21, FEW-GP	R398	
DISCRETE-ELEMENT ANALYSIS THIN SHELLS	MIT	360	F4	RS P	T I	\$SABOR4,	R402	
DISK DATA SET REORDERING	DP	370	F+BAL	RS P	XCT P	\$DYNSK, OPTIMAL	729	
DISPERSION DP	360	CSMP	S	R	\$TRITMOD, ADVECTION MODEL OF TRITIUM	814		
DISPER1, AEROSOL PARTICLE TRANSPORT STUDY	ANL	370	F4	RS P	G	\$	554	
DISSIMILAR MEDIA TLD CORRECTION CALC	AI	360	F4	RS P	Q	\$RESPOND,	566	
DISPLA	ANL	360	F4	RS P	CT P	\$DRAFTMAN, DRAW FIGURES & GRAPHS WITH	748	
DISPLA-LETTERED SLIDES & POSTERS	ANL	370	F4	RS P	C P	\$SLIDES, FOR	728	
DLC-2B LIBRARY GROUP-COLLAPSING	APG	6600	F4	RS	B	\$APRFX1, 99-GP	466	
DOCUMENT INFORMATION SYSTEM	KAPL	6600B	F+ASC	RSB	X T M	\$TIGIR2, MODULAR	R403	
DOE2.0, BUILDING ENERGY CONSUMPTION ANALYSIS	BKY	7600	F+COM	RS	PLXCT T	\$	782	
DOGGY, DESK CALCULATOR FORM SHEET DP PACKAGE	KAPL	6600	F+ASC	RS P	T P	\$	R428	
DOMAIN	LLL	7600	F4	RS P	T T	\$WFLL2B, WIRE CONFIGURATION FREQUENCY	721	
DOORS	LASL	7600	F4	RS P	T H	\$COMPARE-MOD1, TRANSIENT FLOW W/SINKS &	776	
DOPSEL, SELF-SHIELDING IN THE RESONANCE REGION	RRC	370	F4	RS P	T A	\$	805	
DOS-MFT REMOTE WORKSTATION PKG	ANL	360B	F+ASM	RSB	CT P	\$WSP-HASP/DOS,	541	
DOS, NEUTRON FLUX-DOSIMETER ACTIVITY RELATION	GEC	635	F4	RSBP	D	\$	423	
DOSE	PGE	360	F4	RS P	T G	\$EMERALD-NORMAL, PWR ACTIVITY RELEASE AND	685	
DOSE	AI	370	F4	RS P	T G	\$COMRADEX4, ACCIDENT RELEASED RADIOLOGICAL	663	
DOSE CALC	GGA	1108	F4	RS	T G	\$GADOSE,DOSET, HTGR ACCIDENT ANALYSIS	261	
DOSE INTEGRALS	DP	360	F4	RS P	G	\$EGAD, CALC OF EXTERNAL GAMMA	600	
DOSE RATE FROM A CLOUD	DP	360	F4	RS P	G	\$CLOUD, GAMMA-RAY	47	
DOSET, HTGR ACCIDENT ANALYSIS	DOSE CALC	GGA	1108	F4	RS	T G	\$GADOSE,	261
DOT2DB, 2-D MULTIGROUP DIFFUSION & SN THEORY	NED	635	F4	RS P	T C	\$	459	
DP	360	BCD	R	LX T	Z	\$THERMOS LIBRARY, 30-GP ENDF/B SCAT KERNELS	543	
DP	360	CSMP	S	R	\$TRITMOD, ADVECTION MODEL OF TRITIUM DISPERSION	814		
DP	360	CSMP	RS	R	\$POLUTE, FOREST AIR POLLUTANT UPTAKE MODEL	774		
DP	360	F+BAL	S	X T	B	\$RAHAB, JOSHUA SYSTEM LATTICE PHYSICS MODULES	536	
DP	360	F+BAL	RS P	T	D	\$CINDER,M0102, POINT DEPLETION FISSION PRODUCT	313	
DP	360	F+BAL	RS P	XCT	B	\$HAMMER,LITHE,HELP, CRITICAL ANALYSIS SYSTEM	277	
DP	360	F4	RS P	G	\$CLOUD, GAMMA-RAY DOSE RATE FROM A CLOUD	47		

DP

EG&G

DP	360	F4	RS P	G	\$EGAD, CALC OF EXTERNAL GAMMA DOSE INTEGRALS	600
DP	360	F4	RS P	G	\$INTEG, INSPEC, MARKOV SIMULATION OF REACTOR OPN	590
DP	360	F4	RS P	H	\$PLENUM, FLOW DIST. IN CYL COOLANT INLET PLENUM	586
DP	360	F4	RS P	P	\$NIXLIN, LEAST SQUARES FIT TO NONLINEAR FORMS	709
DP	360	F4	RS P	U	\$SOLVEX, SOLVENT EXTRACTION PROCESS SIMULATION	662
DP	360	F4	RS P	T C	\$KEFF, MGBS, TGAN, NUCLEAR CRITICALITY SAFETY	617
DP	360	F4	RSBP	Q	\$XDTRAP, HYDROGEN PERMEATION WITH TRAPPING	655
DP	360B	EBCDC	R L T Z		\$GAMTAB, RADIOACTIVE-DECAY GAMMA-RAY CATALOG	637
DP	360B	F+BAL	RSBP	CT C	\$KENO2, MONTE CARLO MULTIGROUP CRITICALITY CODE	450
DP	360B	F4	RS P	XCT B	\$FLANGE2(71-1), ENDF/B THERMAL SCATTERING DATA	368
DP	360B	F4	RSBP	CT C	\$HERESY3, 2-D HETEROGENEOUS REACTOR CALCULATION	136
DP	370	F+BAL	RS P	XCT P	\$DYNSK, OPTIMAL DISK DATA SET REORDERING	729
DP PACKAGE	KAPL	6600	F+ASC	RS P T P	\$DOGGY, DESK CALCULATOR FORM SHEET	R428
DP PURCHASE VERSUS LEASE ANALYSIS	SLA	360	COBOL	RSBP CT M	\$BECOM, AEC	R589
DP PURCHASE VERSUS LEASE ANALYSIS	SLA	1108	COBOL	RS P M	\$BECOM, AEC	R589
DPOLE, HELMHOLTZ EQUATION ON GENERAL 3D REGION	NYU	6600	F4	RS P T P	\$	816
DRAFTING TOOL TO PLOT PLANE STRUCTURES	BAPL	6600	F4	RS P L	\$BL47,	R373
DRAFTMAN, DRAW FIGURES & GRAPHS WITH DISSPLA	ANL	360	F4	RS P CT P	\$	748
DRAW FIGURES & GRAPHS WITH DISSPLA	ANL	360	F4	RS P CT P	\$DRAFTMAN,	748
DRVOCR, UNCONSTRAINED OPTIMIZATION	ANL	360	F4	RS P T P	\$OCOPTH,	753
DSN CROSS-REF LIST FROM JCL PROCLIBS	HCI	370	F+C+A	RS XC	\$SJCLCROSS,	725
DSNP, DYNAMIC SIMULATION NUCLEAR POWER PLANTS	ANL	370	F4	RS P X T K	\$	784
DTF4 CROSS SECTIONS	LASL	6600	F4	RS P N	\$LARCA, FLUX-WEIGHTING OF	409
DTF4 FLUXES	LASL	6600	F4	RS P N	\$DAC1, SN PERTURBATION CODE USING	455
DTF4, 1-D MULTI-GP DISCRETE ORDINATE PROGRAM	ANL	360	F+BAL	RS P T C	\$	209
DTF4, 1-D MULTI-GP DISCRETE ORDINATE PROGRAM	BC	625	F+MAP	RS P T C	\$	209
DTF4, 1-D MULTI-GP DISCRETE ORDINATE PROGRAM	LASL	6600	F4	RS P T C	\$	209
DUCO 635 F4 RS	G	\$ANVENT, LOCA ANALYSIS DUKE POWER MCGUIRE UNITS				529
DUCT SURFACES	ANL	370	F4	RS P H	\$SLGTR, SLAG TRANSPORT MODELS FOR	783
DUKE POWER MCGUIRE UNITS	DUCO	635	F4	RS	G \$ANVENT, LOCA ANALYSIS	529
DUMP UTILITY	BKY	7600	F+COM	RS P T P	\$DUMP, USER-ORIENTED MEMORY	698
DUMP, USER-ORIENTED MEMORY DUMP UTILITY	BKY	7600	F+COM	RS P T P	\$	698
DUZ2, 2-D AXISYMMETRIC & PLANE ELASTIC-PLASTIC	BAPL	6600	F+COM	RS P T I	\$	R503
DWARF, 1-D FEW-GP DIFFUSION DEPLETION PROGRAM	EG&G	360	F4	RSBP CT D	\$	579
DYNAM, DYNAMIC ANALYSIS BOILING FLOW STEAM	GGA	1108	F4	RS P T H	\$	440
DYNAMIC ANALYSIS BOILING FLOW STEAM	GGA	1108	F4	RS P T H	\$DYNAM,	440
DYNAMIC ANALYSIS LINEAR ELASTIC SYSTEMS	BAPL	6600	F4	RS P I	\$M0552,	R283
DYNAMIC ANALYSIS OF GASES BY MASS SPECTROMETRY	RFD	360	F4	RS P U	\$	645
DYNAMIC ANALYSIS OF THIN SHELLS	SLA	6600	F4	RS P T I	\$SLADE-D,	581
DYNAMIC RESPONSE FINITE-ELEMENT CODE	SLA	6600B	F4	RS P T I	\$HONDO, A	672
DYNAMIC RESPONSE OF ELASTIC STRUCTURES	BAPL	6600	F4	RS P I	\$FUGIT,	R537
DYNAMIC RESPONSE OF LUMPED-MASS SYSTEMS	SLL	6600	F4	RS P T I	\$SHOCK,	795
DYNAMIC SIMULATION NUCLEAR POWER PLANTS	ANL	370	F4	RS P X T K	\$DSNP,	784
DYNAMIC STORAGE ALLOC	ORNL	360	BAL+F	RS P C P	\$GETCOR, FRECOR, FORTRAN	644
DYNAMIC STRUCTURAL ANALYSIS	EG&G	360	F4	RSBP CT I	\$STRAP, STATIC &	539
DYNAMICS	AI	360	F+BAL	RS P T E	\$AIROS2A, SIMULATION OF REACTOR	326
DYNAMICS	ANL	360	F4	RS P T Q	\$GROUP2, GROUP THEORY OF LATTICE	620
DYNAMICS	LASL	6600	F4	RS P T Q	\$GROUP2, GROUP THEORY OF LATTICE	620
DYNAMICS	BAPL	6600	F4	RS P I	\$M0266, LINEAR ELASTIC STRUCTURAL	R383
DYNSK, OPTIMAL DISK DATA SET REORDERING	DP	370	F+BAL	RS P XCT P	\$	729
DYN01, PHOTOMULTIPLIER ELECTRON DISTRIBUTION	ANL	360	F4	RS P O	\$	R464
DYN01, PHOTOMULTIPLIER ELECTRON DISTRIBUTION	KAPL	6600	F4	RS P O	\$	R464
EBCDC R L T Z	\$GAMTAB, RADIOACTIVE-DECAY GAMMA-RAY CATALOG	DP	360B			637
ECC	BCL	6400	F4	RS P X T G	\$MUCHA1, MUCHA2, MULTIPLE CHANNEL ANALYSIS	508
ECCSA4, LOSS-OF-COOLANT & EMERGENCY COOLING	BCL	6400	F4	RS P T G	\$	330
ECONOMICS	CWE	360	F4	RS P T D	\$CINCAS, NUCLEAR FUEL CYCLE COST AND	354
ECONOMICS	UICS	360	F4	RS P CT D	\$GEM, ANALYSIS OF NUCLEAR FUEL CYCLE	576
ECONOMICS	WAPD	6600	F4	RS P T D	\$CINCAS, NUCLEAR FUEL CYCLE COST AND	354
EDITING	ORNL	360B	F4	RS PL CT M	\$EDITOR, ENDF/B TAPE PROCESSING AND	502
EDITING	ORNL	6600	F4	RS PL T M	\$EDITOR, ENDF/B TAPE PROCESSING AND	502
EDITING, & ANALYSIS	BAPL	6600	F4	RS P T M	\$SHLOG, DATA MANAGEMENT,	R557
EDITOR, ENDF/B TAPE PROCESSING AND EDITING	ORNL	360B	F4	RS PL CT M	\$	502
EDITOR, ENDF/B TAPE PROCESSING AND EDITING	ORNL	6600	F4	RS PL T M	\$	502
EG&G	360	BAL	RSB	T P	\$NRTS-RJE, OS/360 MVT REMOTE JOB ENTRY SYSTEM	519
EG&G	360	F+BAL	RS P T G		\$COMCAN, SYSTEM SAFETY COMMON CAUSE ANALYSIS	704
EG&G	360	F+BAL	RS P X T H		\$FRAP-S1, STEADY STATE ANALYSIS OXIDE FUEL RODS	694
EG&G	360	F+BAL	RSBP	XCT B	\$FRAP-T, TRANSIENT ANALYSIS OF OXIDE FUEL RODS	658
EG&G	360	F+BAL	RSBP	CT B	\$RAFFLE2/MOD2, MONTE CARLO NEUTRON TRANSPORT	631
EG&G	360	F+BAL	RSBP	CT G	\$FRET, WATER-COOLED CORE TRANSIENT ANALYSIS	555
EG&G	360	F+P+A	RSBP	XCT W	\$GAUSS6, BATCH ANALYSIS OF GAMMA-RAY SPECTRA	622
EG&G	360	F4	RS P	P	\$ARSTEC, NONLINEAR MIXED INTEGER OPTIMIZATION	738
EG&G	360	F4	RS P	P	\$SOERP, SECOND-ORDER ERROR PROPAGATION CODE	764

EG&G

ENDF/B

EG&G	360	F4	RS P	W	SM3, COORDINATE ANALYSES SEMI-RIGID MOLECULES	632
EG&G	360	F4	RS P CT	W	SMACS LATTICE VIBRATION NEUTRON SCATTERING CODES	574
EG&G	360	F4	RS PL CT	B	SINCITE, THERMAL SPECTRA & MULTI-GP CONSTANTS	565
EG&G	360	F4	RS PL CT	P	SERREST, LOCA ROD BUNDLE CHF DATA ANALYSIS	518
EG&G	360	F4	RS PLXCT	B	SPHROG, MULTI-GP CONSTANT & FAST SPECTRA CALC	520
EG&G	360	F4	RSBP CT	C	SMONA, 1-D MULTIGROUP DIFFUSION SLAB, CYL, SPH	582
EG&G	360	F4	RS3P CT	D	\$DWARF, 1-D FEW-GP DIFFUSION DEPLETION PROGRAM	579
EG&G	360	F4	RSBP CT	G	\$FPFM, STEADY-STATE FISSION PRODUCT FUEL MODEL	584
EG&G	360	F4	RSBP CT	G	\$MOCUS, MINIMAL SETS FROM FAULT TREES	653
EG&G	360	F4	RSBP CT	G	\$PREP,KITT, SYSTEM FAULT TREE EVALUATION CODES	528
EG&G	360	F4	RSBP CT	I	\$STRAP, STATIC & DYNAMIC STRUCTURAL ANALYSIS	539
EG&G	360	F4	RSBP CT	J	\$VIEWPIN, VIEW FACTOR CALC FOR CYLINDRICAL PINS	569
EG&G	360	F4	RSBP X T	G	\$THETA1-B, FUEL ROD THERMAL RESPONSE LOCA	512
EG&G	360	F4	RSBP XCT	U	\$GAUSS5, ANALYSIS OF GAMMA-RAY SPECTRA GE(LI)	605
EG&G	360	PL1	RS P T	P	\$PTAC11, 2-PASS ASSEMBLER FOR THE PDP-11 ON 360	516
EG&G	360B	F+BAL	RS P T	G	\$WHAM6, LIQUID-FILLED PIPING SYSTEM ANALYSIS	278
EG&G	360B	F+BAL	RSB T	P	\$NRTS ENVIRONMENTAL ROUTINES, FORTRAN UTILITIES	613
EG&G	360B	F+BAL	RSBPLXCT	G	\$CONTEMPT-LT/026, PRESSURE-TEMPERATURE RESPONSE	433
EG&G	360B	F4	RSBP CT	G	\$RSAC, RADIOLOGICAL SAFETY ANALYSIS PROGRAM	265
EG&G	360B	F4	RSBP XCT	H	\$MOXY/MOD032, BWR CORE HEAT TRANSFER CODE	551
EG&G	360F	F+BAL	RSBPLXCT	G	\$RELAP4/MOD6, TRANSIENT THERMAL-HYDRAULIC STUDY	369
EG&G	360G	F+BAL	RSBP XCT	D	\$PDQ7, 1,2 OR 3-D FEW-GP DIFFUSION DEPLETION	R275
EG&G	1108	F4	RS P T	G	\$PREP,KITT, SYSTEM FAULT TREE EVALUATION CODES	528
EG&G	7600	F+COM	RS P CT	G	\$BEACON/MOD2A, CONTAINMENT SYSTEM FLUID FLOW	767
EG&G	7600	F+COM	RSBPLXCT	G	\$CONTEMPT4/MOD2, MULTICOMPARTMENT CONTAINMENT	818
EG&G	7600	FTN	RS LXCT	D	\$PDQ7, 1,2 OR 3-D FEW-GP DIFFUSION DEPLETION	R275
EG&G	7600	F4	RS P	P	\$SOERP, SECOND-ORDER ERROR PROPAGATION CODE	764
EG&G	7600	F4	RS P T	H	\$FRAP-S3, STEADY STATE ANALYSIS OXIDE FUEL RODS	694
EG&G	7600	F4	RSBP XCT	G	\$FRAP-T3, TRANSIENT ANALYSIS OF OXIDE FUEL RODS	658
EG&G	7600B	F+COM	RS PLXCT	G	\$CONTEMPT4/MOD2, MULTICOMPARTMENT CONTAINMENT	818
EG&G	7600D	F+COM	RS PLX T	G	\$RELAP4/MOD6, TRANSIENT THERMAL-HYDRAULIC STUDY	369
EG&G	7600E	F+COM	RS PLX T	G	\$RELAP4/MOD6, TRANSIENT THERMAL-HYDRAULIC STUDY	369
EG-D	360B	F4	RS P X T	H	\$ASTEM, THERMODYNAMIC PROPERTIES WATER & STEAM	580
EGAD,	CALC OF EXTERNAL GAMMA DOSE INTEGRALS				DP 360 F4 RS P G \$	600
EI	360	F+BAL	RS P CT	H	\$6KILER, CORE HEATUP CODE FOR BWR/6 ANALYSIS	636
EIGENVALUE PROBLEM FOR VIBRATING SYSTEMS	KAPL	6600	F+ASC	RS P T I	\$GEM,	R344
EIGENVALUE SOLNS.	PURD	6500	F4	RS P CT	P \$2DEPEP, ELLIPTIC PARABOLIC &	806
EIGENVALUE/VECTOR PACKAGE	ANL	360B	F4	RSBP XCT	P \$EISPACK2, MATRIX	534
EIGENVALUE/VECTOR PACKAGE	ANL	PD10B	F4	RS P X T	P \$EISPACK2, MATRIX	534
EIGENVALUE/VECTOR PACKAGE	ANL	1110B	F4	RS P X T	P \$EISPACK2, MATRIX	534
EIGENVALUE/VECTOR PACKAGE	ANL	6600B	F4	RS P X T	P \$EISPACK2, MATRIX	534
EIGENVALUE/VECTOR PACKAGE	ANL	6700B	F4	RS P X T	P \$EISPACK2, MATRIX	534
EISPACK2, MATRIX EIGENVALUE/VECTOR PACKAGE	ANL	360B	F4	RSBP XCT	P \$	534
EISPACK2, MATRIX EIGENVALUE/VECTOR PACKAGE	ANL	PD10B	F4	RS P X T	P \$	534
EISPACK2, MATRIX EIGENVALUE/VECTOR PACKAGE	ANL	1110B	F4	RS P X T	P \$	534
EISPACK2, MATRIX EIGENVALUE/VECTOR PACKAGE	ANL	6600B	F4	RS P X T	P \$	534
EISPACK2, MATRIX EIGENVALUE/VECTOR PACKAGE	ANL	6700B	F4	RS P X T	P \$	534
ELASTIC ANALYSIS	BAPL	6600	F+COM	RS P X T	I \$MATUS, 3-D FINITE-ELEMENT	R597
ELASTIC SCAT RESONANCES	AI	360	F4	RS PLX T	B \$AILMOE, X-SECTION CALC	147
ELASTIC SCAT X-SEC	BNL	6600	F4	RS P	A \$BESFIT, DIFFRACTION MODEL	524
ELASTIC SCAT X-SECTIONS HEX LATTICE	GGA	1108	F4	RS	B \$HEXSCAT,	291
ELASTIC SINGULARITY MODELING	SLA	6600	FTN	RS P T I	\$CHILES, LINEAR	611
ELASTIC STRESS OF PIPING SYSTEM	BAPL	6600	F4	RS P T I	\$M0457, PIPE,	R329
ELASTIC STRUCTURAL DYNAMICS	BAPL	6600	F4	RS P	I \$M0266, LINEAR	R383
ELASTIC STRUCTURES	BAPL	6600	F4	RS P	I \$FUGIT, DYNAMIC RESPONSE OF	R537
ELASTIC SYSTEMS	BAPL	6600	F4	RS P	I \$M0552, DYNAMIC ANALYSIS LINEAR	R283
ELASTIC-PLASTIC	BAPL	6600	F+COM	RS P T I	\$DUZ2, 2-D AXISYMMETRIC & PLANE	R503
ELASTICMAGNETO PLASTIC	LLL	7600	F4	RS P T F	\$HEMP, HYDRODYNAMIC	775
ELBOW-ORNL, PIPE STRESS & FLEXIBILITY CALC	ORNL	360	F+BAL	RS P	I \$	650
ELBOWS & ATTACHED PIPES	ORNL	360	F+BAL	RS P XCT	I \$CURT2, CURVED TUBES OR	R750
ELECTRIC UTILITY EXPANSION	TVA	370	F4	RS P CT	D \$SAGE-WASP, OPTIMAL	S744
ELECTRICITY COSTS	UEC	6600	F4	RS P	D \$POWERCO, NUCLEAR STATION	340
ELECTRON DISTRIBUTION	ANL	360	F4	RS P	O \$SDYNO1, PHOTOMULTIPLIER	R464
ELECTRON DISTRIBUTION	KAPL	6600	F4	RS P	O \$SDYNO1, PHOTOMULTIPLIER	R464
ELECTRON SPECTRA	KAPL	6600	F4	RS P	W \$CONDYN, POLYA MODEL SECONDARY	786
ELEM STUDY	NRC	370	F4	RSBP CT	G \$WREM-TOODEE2/MOD3, 2D TIME-DEP FUEL	712
ELLIPTIC PARABOLIC & EIGENVALUE SOLNS.	PURD	6500	F4	RS P CT	P \$2DEPEP,	806
EMERALD REV. 1, PWR ACCIDENT ACTIVITY RELEASE	PGE	360	F4	RS P T G	\$	546
EMERALD-NORMAL, PWR ACTIVITY RELEASE AND DOSE	PGE	360	F4	RS P T G	\$	685
EMERGENCY COOLING	BCL	6400	F4	RS P T G	\$ECCSA4, LOSS-OF-COOLANT &	330
ENDF/B DATA	WAPD	7600	F4	RS P T B	\$ETOT2, THERMAL LIBRARIES FROM	509
ENDF/B DATA	BAPL	6600	F4	RS P T B	\$EPOCH, NEUTRON AGE CALCULATION OF	R461

ETOT3

ETOT3

ENDF/B DATA	ORNL	360	F4	RS P T B	\$PRICE, PRIMARY RECOIL ATOM SPECTRA	453
ENDF/B DATA	FBRD	635	F+GMP	RS P XCT B	SENDRUN2, MULTIGROUP CONSTANTS FROM	501
ENDF/B DATA	LLL	7600	F4	RS P T B	\$LINEAR, SIGMA1, LINEARIZE & BROADEN	747
ENDF/B DATA	TAPES	GGA	1108	BIN R L T Z	\$ZPR-111 ASSEMBLY 48 GAFGAR	356
ENDF/B FINE-GP CONSTANTS GENERATION	ORNL	360	F4	RS P T B	\$SUPER TOG,	431
ENDF/B FOR 1DX	HEDL	360	F4	RSBP XCT B	SETOX3, MULTI-GP CONSTANTS FROM	388
ENDF/B FOR 1DX	HEDL	1108B	F4	RS P X T B	SETOX3, MULTI-GP CONSTANTS FROM	388
ENDF/B FORMAT TO MUFT FORMAT X-SECTIONS	WAPD	6600	F4	RS P T B	SETOM1,	436
ENDF/B GRAPHIC X-SEC EVALUATION	AI	360	F+BAL	RSB L CT M	\$SCORE3, SCISRS	375
ENDF/B RESONANCE XSECTION CODES	BNL	6600B	F4	RS P T A	\$RESEND, ADLER,	465
ENDF/B SCAT KERNELS	DP	360	BCD	R LX T Z	\$THERMOS LIBRARY, 30-GP	543
ENDF/B TAPE PROCESSING AND EDITING	ORNL	360B	F4	RS PL CT M	EDITOR,	502
ENDF/B TAPE PROCESSING AND EDITING	ORNL	6600	F4	RS PL T M	EDITOR,	502
ENDF/B THERMAL SCATTERING DATA	DP	360B	F4	RS P XCT B	\$FLANGE2(71-1),	368
ENDF/B TO GAFGAR X-SECTIONS	GGA	1108	F5	RS P T B	SENDFB2, GAND2, GFE2,	596
ENDF/B TO MUFT, GAM, ANISN X-SEC FORMAT	WAPD	6600	F4	RS PL T B	SETOG1,	437
ENDF/B TO MUFT, GAM, ANISN X-SEC FORMAT	WAPD	7600	F4	RS P T B	SETOG3,	538
ENDF/B V1 PROC	BNL	6600B	F4	RS T M	\$CHECKER, CRECT, DAMMET, PLOTFB, ...	384
ENDF/B V2 PROC	BNL	6600B	F4	RS T M	\$CRECT, CHECKER, RIGEL, PLOTFB, ...	475
ENDF/B V2 PROCESSING CODES	ANL	360	F4	RS P T M	\$CRECT, CHECKER,	475
ENDF/B V3 DATA PROCESSING CODE	ANL	360	F4	RS T M	\$RIGEL,	571
ENDF/B V3 DATA TO THERMAL LIBRARY FORM	WAPD	7600	F4	RS P T B	SETOT3,	628
ENDF/B V3 PROCESSING CODES	BNL	6600	F4	RS T M	\$CHECK3, RIGEL3,	571
ENDF/B V4 PROCESSING CODES	BNL	6600B	F4	RS T M	\$RIGEL4, CHECK4, ...	638
ENDFB2, GAND2, GFE2, ENDF/B TO GAFGAR X-SECTIONS	GGA	1108	F5	RS P T B	\$	596
SENDRUN2, MULTIGROUP CONSTANTS FROM ENDF/B DATA	FBRD	635	F+GMP	RS P XCT B	\$	501
ENEA 360 F4 RS P A	\$PSEUDO, STATISTICAL RESONANCE PARAMETER CALC					292
ENEA 360 F4 RS P A	\$THRES2, STATISTICAL MODEL REACTION X-SECTION					504
ENEA 360 F4 RS P CT A	\$JUPITOR1, COUPLED CHANNEL X-SEC EVALUATION					308
ENERGY CONSUMPTION ANALYSIS	BNL	7600	F+COM	RS PLXCT T	\$DOE2.0, BUILDING	782
ENERGY CONSUMPTION ANALYSIS	MIT	370	F4	RS P T T	\$STDIST2, COMMUNITY	799
ENERGY COST ANALYSIS	BNW	6600	F4	RS P T D	\$GEOCOST, GEOTHERMAL	684
ENERGY FACILITY SITING ASSESSMENT	ANL	360	F4	RS P T R	\$SITE2,	687
ENERGY SYSTEM SIMULATION PROGRAM	SLA	6600B	F4	RS PL T R	\$SOLSYS, SOLAR	692
ENERGY USE	ORNL	360	F4	RS P X R	\$MOBY, MOBILE HOME HEATING & COOLING	724
ENERGY, LMFBR COOLANT TEMPERATURE PREDICTION	MIT	370	F4	RS P T H	\$	696
ENTRAINED PARTICLES SAMPLING STUDY	BAPL	6600	F4	RS P H	\$SBETTY,	R545
ENTRY SYSTEM	EG&G	360	BAL	RSB T P	\$NRTS-RJE, OS/360 MVT REMOTE JOB	519
ENVIRNMNTL LIB SCOPE2.0	CEND	7600B	F4	RS T P	\$MODEL, MODIFIED BETTIS	478
ENVIRNMNTL LIB SCOPE3.3	CDC	6600D	F+COM	RS T P	\$MODEL, MODIFIED BETTIS	478
ENVIRONMENT LIBRARY	BAPL	6600	F+COM	RS T P	\$BETTIS PROGRAMMING	R665
ENVIRONMENT LIBRARY	BAPL	7600	F+COM	FS T P	\$BETTIS PROGRAMMING	R665
ENVIRONMENTAL ROUTINES, FORTRAN UTILITIES	EG&G	360B	F+BAL	RSB T P	\$NRTS	613
ENVIRONMENTAL ROUTINES, SUBROUTINE LIB.	NED	635	F+GMP	RS T P	\$GENED	515
ENVIRONMENTAL ROUTINES, SUBROUTINE LIB.	BAPL	6600A	F+ASC	RS T P	\$BETTIS	478
EPISODE, ORDINARY DIFF EQUATION SYSTEM SOLVER	LLL	360	F4	RS P X T P	\$	675
EPISODEB, SOLVE ODE SYST WITH BANDED JACOBIAN	LLL	360	F4	RS P X T P	\$	705
EPITHERMAL X-SECTIONS	NED	635	F4	RS P T B	\$REAX, RESOLVED RESONANCE	257
EPOCH, NEUTRON AGE CALCULATION OF ENDF/B DATA	BAPL	6600	F4	RS P T B	\$	R461
EQN SOLN CURVE PLOT	KAPL	6600	F+ASC	RS P T P	\$SNEQ, NONLINEAR ALGEBRAIC	R364
EQN SYSTEM SOLVER	ANL	360C	F4	RS P X P	\$GEAR, ORDINARY DIFFERENTIAL	592
EQN SYSTEM SOLVER	LLL	6600C	F4	RS P X P	\$GEAR, ORDINARY DIFFERENTIAL	592
EQUATNS	ANL	370	F4	RS P X T P	\$SLINPACK, SIMULTANEOUS LINEAR ALGEBRAIC	800
EQUILIBRIUM FUEL CYCLE CALCULATION	GGA	1108	F4	S T D	\$GAFFE,	392
ERDA 370C F4 RS P CT D	\$NUFUEL, NUCLEAR FUEL CYCLE REQUIREMENTS					683
ERF, ERFC, ERROR & COMPLEMENTARY ERROR FUNCTION	SLA	6600	F4	RS P P	\$	601
ERFC, ERROR & COMPLEMENTARY ERROR FUNCTION	SLA	6600	F4	RS P P	\$SERF,	601
ERREST, LOCA ROD BUNDLE CHF DATA ANALYSIS	EG&G	360	F4	RS PL CT P	\$	518
ERROR & COMPLEMENTARY ERROR FUNCTION	SLA	6600	F4	RS P P	\$SERF, ERFC,	601
ERROR FUNCTION	SLA	6600	F4	RS P P	\$SERF, ERFC, ERROR & COMPLEMENTARY	601
ERROR PROPAGATION CODE	EG&G	360	F4	RS P P	\$SOERP, SECOND-ORDER	764
ERROR PROPAGATION CODE	EG&G	7600	F4	RS P P	\$SOERP, SECOND-ORDER	764
ESP, MONTE CARLO REACTOR ANALYSIS CALCULATION	ORNL	360	F+BAL	RSBPL CT C	\$	523
ESTIMATE	GGA	1108	F4	RS P XCT D	\$CONCEPT3, POWER PLANT CONCEPTUAL COST	498
ESTIMATE	ORNL	360	F+BAL	RS P X T D	\$CONCEPT5, POWER PLANT CONCEPTUAL COST	498
ESTIMATING	ORNL	360	F+BAL	RS P T D	\$SORCOST2, POWER PLANT CAPITAL COST	588
ETOG1 DATA LIBRARIES, MUFT4 OR 5, GAM1 OR 2	WAPD	6600	BCD	R L T Z	\$	447
ETOG1, ENDF/B TO MUFT, GAM, ANISN X-SEC FORMAT	WAPD	6600	F4	RS PL T B	\$	437
ETOG3, ENDF/B TO MUFT, GAM, ANISN X-SEC FORMAT	WAPD	7600	F4	RS P T B	\$	538
ETOM1, ENDF/B FORMAT TO MUFT FORMAT X-SECTIONS	WAPD	6600	F4	RS P T B	\$	436
ETOT2, THERMAL LIBRARIES FROM ENDF/B DATA	WAPD	7600	F4	RS P T B	\$	509
ETOT3, ENDF/B V3 DATA TO THERMAL LIBRARY FORM	WAPD	7600	F4	RS P T B	\$	628

ETOX3

F+BAL

ETOX3, MULTI-GP CONSTANTS FROM ENDF/B FOR 1DX	HEDL	360	F4	RSBP	XCT	B	S	388	
ETOX3, MULTI-GP CONSTANTS FROM ENDF/B FOR 1DX	HEDL	1108B	F4	RS	P	X	T	388	
EURCYL1, CYL-CYL INTERSECTION MESH GENERATOR	WARD	7630	F4	RS	P	T	L	R746	
EVENT & CUT SET RANKING	ANL	370	F4	RS	P	T	G	779	
EVITS, STEADY STATE TWO-DIMENSIONAL FLUID FLOW	ANL	360	F4	RS	P	T	H	792	
EXCHANGER STRESS ANALYSIS	KAPL	6600	F4	RS	P	I	STUBE, U-TUBE HEAT	R378	
EXCURSION	ANL	360	F4	RS	P	CT	F	550	
EXCURSION	ANL	360	F4	RS	P	CT	F	R615	
EXCURSION CALCULATIONS	ANL	360	F4	RS	P	X	T	174	
EXCURSION CALCULATIONS	NED	635	F4	RS	P	X	T	174	
EXCURSION DISASSEMBLY	ANL	360	F4	RS	P	XCT	F	511	
EXPALS, LEAST SQUARES EXPONENTIAL DECAY CURVES	LLL	7600	F4	RS	P	P	S	321	
EXPANSION	TVA	370	F4	RS	P	CT	D	S744	
EXPERIMENT	UCND	360B	F+BAL	RS	P	O	SPMS1, FAST NEUTRON POLARIZATION	469	
EXPERIMENT ANALYSIS	BAPL	6600	F4	RS	P	O	SJITER, FLUCTUATION	R394	
EXPERIMENT ANALYSIS	BAPL	6600	F4	RS	P	O	SREDUX, REACTOR FLUCTUATION	R425	
EXPERIMENTAL DATA POINTS	KAPL	6600	F+ASC	RS	P	T	P	R 43	
EXPERIMENTAL DESIGN	MLMO	360	F4	RSBP	C	P	SLATIN SQ, NXN LATIN SQUARE	630	
EXPERIMENTS	ORNL	360	F4	RS	P	T	H	730	
EXPN, ANALYSIS OF PULSED NEUTRON SOURCE DATA	NED	635	F4	RS	P	T	O	258	
EXPONENTIAL DECAY CURVES	LLL	7600	F4	RS	P	P	SEXPLS, LEAST SQUARES	321	
EXPONENTIALS	ANL	370	F4	RS	P	P	SFRANTIC, LEAST SQUARES FIT SUM OF	324	
EXTERMINATOR2, 2-D MULTI-GP DIFFUSION PROGRAM	BC	625	F4	RS	T	C	S	156	
EXTERMINATOR2, 2-D MULTI-GP DIFFUSION PROGRAM	CEND	6600	F4	RS	P	T	C	156	
EXTERMINATOR2, 2-D MULTI-GP DIFFUSION PROGRAM	ORNL	360	F4	RS	P	T	C	156	
EXTERNAL GAMMA DOSE INTEGRALS	DP	360	F4	RS	P	G	SEGAD, CALC OF	600	
EXTRACTION PROCESS SIMULATION	DP	360	F4	RS	P	U	SSOLVEX, SOLVENT	662	
EXTRACTION SIMULATION	ORNL	360	F4	RS	P	T	U	R690	
EXTREME VALUE DISTRIBUTION DATA ANALYSIS	BAPL	6600	F4	RS	P	P	SBH99,	R621	
F	S	P	X	T	P	SFUNPACK2, SPECIAL FUNCTION ROUTINES	ANL	6600B	610
F	R	P	R	SPLETHS, ISOPLETH-AREA CALC FROM SINGLE SOURCE	ANL	GETS	591		
F	RS	P	H	SSOLA, SOLA-SURF, TRANSIENT FLUID FLOW ALGORITHM	LASL	7600B	651		
F	RS	P	T	G	SHAA3B, AEROSOL BEHAVIOR LOGNORMAL MODEL	AI	370	443	
F	RS	P	T	H	SSIEX, LMFBR FUEL PIN THERMAL PERFORMANCE MODEL	HEDL	6600	673	
F	RS	P	T	N	SZONE, 2-D FINITE ELEMENT MESH GENERATOR	LLL	7600	765	
F	RS	P	T	P	SSTFODE, COLODE, COLLOCATION SOLN OF STIFF ODE'S	SLA	6600	652	
F	RSBP	T	P	SSTFODE, COLODE, COLLOCATION SOLN OF STIFF ODE'S	ANL	360	652		
F(X) & F(X,Y)	KAPL	6600B	F+COM	RS	P	T	P	SDATATRAN2, UTILITY PLOT MODULES	407
F(X,Y)	KAPL	6600B	F+COM	RS	P	T	P	SDATATRAN2, UTILITY PLOT MODULES F(X) &	407
F+ASC	R	B	T	D	SPDQ7, 1,2 OR 3-D FEW-GP DIFFUSION DEPLETION	BCSS	6600D	R275	
F+ASC	RS	P	P	SSIMPLE1, TIME-SHARING PROGRAMMING LANGUAGE	KAPL	6600	R442		
F+ASC	RS	P	T	P	SBETTIS ENVIRONMENTAL ROUTINES, SUBROUTINE LIB.	BAPL	6600A	478	
F+ASC	RS	P	T	H	SLION4, 3-D TEMPERATURE DISTRIBUTION PROGRAM	KAPL	6600B	R299	
F+ASC	RS	P	T	I	SGEM, EIGENVALUE PROBLEM FOR VIBRATING SYSTEMS	KAPL	6600	R344	
F+ASC	RS	P	T	J	SASPIS, GAMMA-RAY SOURCE BUILDUP FACTOR CALC	BAPL	6600	R429	
F+ASC	RS	P	T	J	SSPAN4, A POINT-KERNEL SHIELD EVALUATION CODE	BAPL	6600B	R462	
F+ASC	RS	P	T	P	SCURFIT, CURVE FITTING EXPERIMENTAL DATA POINTS	KAPL	6600	R 43	
F+ASC	RS	P	T	P	SDOGGY, DESK CALCULATOR FORM SHEET DP PACKAGE	KAPL	6600	R428	
F+ASC	RS	P	T	P	SLIZARD, NONLINEAR DIFFERENTIAL EQNS. SOLUTION	KAPL	6600	R445	
F+ASC	RS	P	T	P	SSNEQ, NONLINEAR ALGEBRAIC EQN SOLN CURVE PLOT	KAPL	6600	R364	
F+ASC	RS	P	X	T	B	SRESQ2, RESQ0, DBF1, RESONANCE INTEGRAL HEX CELL	BAPL	6600	R285
F+ASC	RSB	X	T	M	STIGIR2, MODULAR DOCUMENT INFORMATION SYSTEM	KAPL	6600B	R403	
F+ASM	RSB	CT	P	SWSP-HASP/DOS, DOS-MFT REMOTE WORKSTATION PKG	ANL	360B	541		
F+BAL	S	X	T	B	SRAHAB, JOSHUA SYSTEM LATTICE PHYSICS MODULES	DP	360	536	
F+BAL	RS	T	P	SAMDLIBF, ARGONNE SUBROUTINE LIBRARY CAT. F	ANL	360B	563		
F+BAL	RS	T	P	SFIGS, IBM360&2250 FORTRAN GRAPHICS SUBROUTINES	AI	360	484		
F+BAL	RS	P	D	SISOSEARCH, ISOTOPE PRODUCTION FLUX, X-SEC CALC	ORNL	360	322		
F+BAL	RS	P	D	SOMCST, POWER PLANT NON-FUEL O & M COST STUDY	ORNL	360	688		
F+BAL	RS	P	I	SELBOW-ORNL, PIPE STRESS & FLEXIBILITY CALC	ORNL	360	650		
F+BAL	RS	P	O	SPMS1, FAST NEUTRON POLARIZATION EXPERIMENT	UCND	360B	469		
F+BAL	RS	P	T	A	SCOMNUC, CASCADE, COMPOUND NUCLEUS REACTION	AI	360	482	
F+BAL	RS	P	T	B	SRAFFLE, 1ST FLIGHT COLLISION PROBABILITIES MC	ORNL	360B	392	
F+BAL	RS	P	T	C	SDTF4, 1-D MULTI-GP DISCRETE ORDINATE PROGRAM	ANL	360	209	
F+BAL	RS	P	T	C	SGAMBLES, 2-D MULTI-GP DIFFUSION XY RZ GEOMETRY	GGA	1108	222	
F+BAL	RS	P	T	C	SGAMTRI, 2-D MULTI-GP DIFFUSION TRIANGULAR MESH	GGA	1108	401	
F+BAL	RS	P	T	C	SGAZE2, 1-D MULTIGROUP DIFFUSION SLAB, SPH, CYL	GGA	1108	430	
F+BAL	RS	P	T	D	SBUGTRI, 2D MULTIGP DIFFUSION & BURNUP TRI-MESH	GGA	1108	439	
F+BAL	RS	P	T	D	SBUG2, 2-D MULTIGROUP DIFFUSION & BURNUP XY, RZ	GGA	1108	438	
F+BAL	RS	P	T	D	SCINDER, M0102, POINT DEPLETION FISSION PRODUCT	DP	360	313	
F+BAL	RS	P	T	D	SMSF21, VTE21, DESALINATION PLANT OPTIMIZATION	ORNL	360	798	
F+BAL	RS	P	T	D	SORCOST2, POWER PLANT CAPITAL COST ESTIMATING	ORNL	360	588	
F+BAL	RS	P	T	E	SAIROS2A, SIMULATION OF REACTOR DYNAMICS	AI	360	326	

F+BAL

F+COM

F+BAL	RS	P	T	E	SBLOOST6, COMBINED KINETICS 2-D HEAT TRANSFER	GGA	1108	303	
F+BAL	RS	P	T	G	SCOMCAN, SYSTEM SAFETY COMMON CAUSE ANALYSIS	EG&G	360	704	
F+BAL	RS	P	T	G	SROSA1, PROBABLISTIC RESPONSE SURFACE CODE	ANL	370	R778	
F+BAL	RS	P	T	G	SWHAM6, LIQUID-FILLED PIPING SYSTEM ANALYSIS	EG&G	360B	278	
F+BAL	RS	P	T	I	SLINDA, EVALUATION OF STRAIN-GAGE DATA	ORNL	360	657	
F+BAL	RS	P	T	I	3SAFE-3D, 3-D COMPOSITE STRUCTURE STRESS STUDY	ORNL	360	332	
F+BAL	RS	P	T	O	SGSSLRN10, LEAST SQUARES PHOTOPEAK SPECTRA CODE	BNW	1108	457	
F+BAL	RS	P	T	O	STOAD, PROCESSING OF ANALYZER GAMMA-RAY SPECTRA	GGA	1108	333	
F+BAL	RS	P	T	R	SATM, ATMOSPHERIC TRANSPORT & DIFFUSION MODEL	ORNL	360	787	
F+BAL	RS	P	T	W	SCASIM, SIMULATES HADRONIC CASCADE TRANSPORT	FNAL	370	742	
F+BAL	RS	P	CT	A	SU3R, UNRESOL RESONANCE XSEC PROBABILITY TABLES	AI	360	553	
F+BAL	RS	P	CT	C	STRIDENT, 2D MULTIGP TRANSPORT TRIANGULAR MESH	LASL	360	741	
F+BAL	RS	P	CT	H	S6KILER, CORE HEATUP CODE FOR BWR/6 ANALYSIS	EI	360	636	
F+BAL	RS	P	CT	R	CHNSD, SEDIMENT & CONTAINMENT TRANSPORT MODEL	ORNL	360	793	
F+BAL	RS	P	CT	R	SODMOD, SOIL-WATER TRACE-CONTAINMENT TRANSPORT	ORNL	360	789	
F+BAL	RS	P	CT	R	SOPTRM, HYDROLOGIC TRANSPORT WITH OPTIMIZATION	ORNL	360	794	
F+BAL	RS	P	CT	R	SWHTM, WISCONSIN HYDROLOGIC TRANSPORT MODEL	ORNL	360	808	
F+BAL	RS	P	CT	U	SBIOSIM, BIOCHEMICAL KINETIC SIMULATION SYSTEM	CUP1	370	736	
F+BAL	RS	P	X	T	B	SHWOCR-SAFE, 2-D MONTE CARLO CELL CALCULATION	AI	360	307
F+BAL	HS	P	X	T	D	SCONCEPT5, POWER PLANT CONCEPTUAL COST ESTIMATE	ORNL	360	498
F+BAL	RS	P	X	T	D	SORSIM, OPTIMIZING UTILITY GENERATION PLANNING	ORNL	360	699
F+BAL	RS	P	X	T	H	SFRAP-S1, STEADY STATE ANALYSIS OXIDE FUEL RODS	EG&G	360	694
F+BAL	RS	P	X	T	I	SCREEP-PLAST, 2-D INELASTIC STRUCTURAL ANALYSIS	ORNL	360B	R707
F+BAL	RS	P	X	T	Q	SMARLOWE, BINARY COLLISION CASCADE SIMULATION	ORNL	360C	660
F+BAL	RS	P	X	T	Q	SMARLOWE, BINARY COLLISION CASCADE SIMULATION	ORNL	7600	680
F+BAL	RS	P	XCT	B	SHAMMER,LITHE,HELP, CRITICAL ANALYSIS SYSTEM	DP	360	277	
F+BAL	RS	P	XCT	C	SSYN3D, SINGLE-CHANNEL FLUX SYNTHESIS DIFFUSION	ANL	370B	713	
F+BAL	RS	P	XCT	I	SCREEP-PLAST2, 2D INELASTIC STRUCTURAL ANALYSIS	ORNL	360	R810	
F+BAL	RS	P	XCT	I	SCURT2, CURVED TUBES OR ELBOWS & ATTACHED PIPES	ORNL	360	R750	
F+BAL	RS	P	XCT	P	SDYNSK, OPTIMAL DISK DATA SET REORDERING	DP	370	729	
F+BAL	RS	PLXCT	H		STRUMP, TRANSIENT & S-STATE TEMPERATURE DIST	ORNL	360	771	
F+BAL	RSB	T	P		SNRTS ENVIRONMENTAL ROUTINES, FORTRAN UTILITIES	EG&G	360B	613	
F+BAL	RSB	CT	P		SROGLOOK, USER PROGRAM PERFORMANCE MONITOR	SLAC	360B	642	
F+BAL	RSB	L	CT	M	SSCORE3, SCISRS ENDF/B GRAPHIC X-SEC EVALUATION	AI	360	375	
F+BAL	RSBP	T	M		SSPIRAL, FULL-TEXT STORAGE, SEARCH & RETRIEVAL	SLA	1108	R607	
F+BAL	RSBP	T	T		SACCEL(MOD2), DESIGN OF PRINTED-CIRCUIT BOARDS	SLA	1108	681	
F+BAL	RSBP	CT	C		SKENO2, MONTE CARLO MULTIGROUP CRITICALITY CODE	DP	360B	450	
F+BAL	RSBP	CT	C		SVENTURE, 1, 2, OR 3-D MULTIGROUP DIFFUSION	ORNL	360	686	
F+BAL	RSBP	CT	M		SARC-SYSTEM, SYSTEM SUBPROGRAMS AND MODULES	ANL	360	522	
F+BAL	RSBP	X	T	P	SSPEAKEASY MU+, LANGUAGE PROCESSOR TSO OR BATCH	ANL	360	593	
F+BAL	RSBP	XCT	B		S1DX, 1-D DIFFUSION FAST X-SECTION GENERATION	ANL	360	374	
F+BAL	RSBP	XCT	D		SPDQ7, 1,2 OR 3-D FEW-GP DIFFUSION DEPLETION	EG&G	360G	R275	
F+BAL	RSBP	XCT	G		SFRAP-T, TRANSIENT ANALYSIS OF OXIDE FUEL RODS	EG&G	360	658	
F+BAL	RSBPL	CT	B		SMC+2-2, FAST NEUTRON SPECTRA & MULTIGP X-SECS	ANL	370	355	
F+BAL	RSBPL	CT	B		SRAFFLE2/MOD2, MONTE CARLO NEUTRON TRANSPORT	EG&G	360	631	
F+BAL	RSBPL	CT	C		SESP, MONTE CARLO REACTOR ANALYSIS CALCULATION	ORNL	360	523	
F+BAL	RSBPL	CT	D		SREBUS2, FUEL CYCLE ANALYSIS FOR FAST REACTORS	ANL	360B	634	
F+BAL	RSBPL	CT	G		SPARET, WATER-COOLED CORE TRANSIENT ANALYSIS	EG&G	360	555	
F+BAL	RSBPLXCT	C			SKENO4, MONTE CARLO MULTIGROUP CRITICALITY CODE	ORNL	360C	450	
F+BAL	RSBPLXCT	G			SCONTEMP-LT/026, PRESSURE-TEMPERATURE RESPONSE	EG&G	360B	433	
F+BAL	RSBPLXCT	G			SNAIAD, COMPRESSIBLE 2-PHASE COOLANT BEHAVIOR	AAEC	360	726	
F+BAL	RSBPLXCT	G			SRELAP4/MOD6, TRANSIENT THERMAL-HYDRAULIC STUDY	EG&G	360F	369	
F+C	RS	P	T	L	SDATATRAN2, RADI GEOMETRY MODULES 2-D INPUT GEN	KAPL	6600B	406	
F+C+A	RS	XC	P		SJCLCROSS, DSN CROSS-REF LIST FROM JCL PROCLIBS	HCI	370	725	
F+C+R	RSBP	T	M		SRALCRPH, RESOURCE ALLOCATION PROJECT PLANNING	MLMO	360	G603	
F+COM	RSBP	XC	M		SRANDOM SAMPLING TABLE, FOR NON-BIAS ORDERING	MLMO	360	679	
F+COM	RS	T	P		SBETTIS PROGRAMMING ENVIRONMENT LIBRARY	BAPL	6600	R665	
F+COM	RS	T	P		SBETTIS PROGRAMMING ENVIRONMENT LIBRARY	BAPL	7600	R665	
F+COM	RS	T	P		SKAPLPLOT, KAPL CALCOMP PLOTTING ROUTINES	KAPL	6600	R496	
F+COM	RS	T	P		SLASLIB, LOS ALAMOS SUBROUTINE LIBRARY ROUTINES	LASL	6600C	633	
F+COM	RS	T	P		SMODEL, MODIFIED BETTIS ENVIRONMENTAL LIB SCOPE3.3	CDC	6600D	478	
F+COM	RS	P	H		SHYMAS, HYDRODYNAMIC MASS MATRIX GENERATION	BAPL	6600	R560	
F+COM	RS	P	Q		SINDX, XRAY DIFFRACTION POWDER PATTERN INDEXING	LASL	6600	609	
F+COM	RS	P	T	B	SRECAP-0, RECAP-12 X-SECTION LIBRARY GENERATION	BAPL	6600	R671	
F+COM	RS	P	T	C	SRECAP-12, MONTE CARLO CRITICALITY CALCULATIONS	BAPL	7600	R670	
F+COM	RS	P	T	D	SPDQ8, 1,2 OR 3-D FEW-GP DIFFUSION DEPLETION	BAPL	7600B	R275	
F+COM	RS	P	T	D	STPT01, 2-D FEW-GROUP TRANSPORT WITH DEPLETION	BAPL	7600	R669	
F+COM	RS	P	T	G	SNALAP, LMFBR TRANSIENT RESPONSE TO ACCIDENT	BNL	7600	780	
F+COM	RS	P	T	I	SDU22, 2-D AXISYMMETRIC & PLANE ELASTIC-PLASTIC	BAPL	6600	R503	
F+COM	RS	P	T	I	SGAPL3, INELASTIC LARGE DEFLECTION STRESS STUDY	BAPL	6600	R397	
F+COM	RS	P	T	I	\$GNATS,MESH2,GPRINT, 2-D NONLINEAR ANALYSIS	SLL	6600	682	
F+COM	RS	P	T	M	SDATATRAN2, MODULAR PROGRAMMING AND DATA SYSTEM	KAPL	7600C	386	

F+COM

FBRD

F+COM	RS	P	T	P	SDATATRAN2, UTILITY PLOT MODULES F(X) & F(X,Y)	KAPL	6600B	407							
F+COM	RS	P	T	P	\$DUMP, USER-ORIENTED MEMORY DUMP UTILITY	BKY	7600	698							
F+COM	RS	P	T	P	\$LENDES, NONLINEAR LEAST SQ LENS DESIGN SYSTEM	LASL	6600	602							
F+COM	RS	P	T	T	\$ACCEL(MOD2), DESIGN OF PRINTED-CIRCUIT BOARDS	SLA	6600	681							
F+COM	RS	P	CT	G	\$BEACON/MOD2A, CONTAINMENT SYSTEM FLUID FLOW	EG&G	7600	767							
F+COM	RS	P	CT	G	\$FTA, FAULT TREE ANALYSIS SYSTEM	ARHC	6600	666							
F+COM	RS	P	X	T	\$PAX03, HARMONY-PDQ X-SECTION GENERATION CODE	BAPL	6600	R426							
F+COM	RS	P	X	T	\$FARED, 1-D FAST REACTOR DESIGN & SURVEY STUDY	BW	6600	427							
F+COM	RS	P	X	T	\$MATUS, 3-D FINITE-ELEMENT ELASTIC ANALYSIS	BAPL	6600	R597							
F+COM	RS	P	X	T	SDATATRAN2, MODULAR PROGRAMMING AND DATA SYSTEM	KAPL	6600B	386							
F+COM	RS	P	X	T	\$MATHLIB, SANDIA MATHEMATICAL SUBROUTINES	SLA	6600C	654							
F+COM	RS	P	X	CT	\$SYN3D, SINGLE-CHANNEL FLUX SYNTHESIS DIFFUSION	ANL	7600	713							
F+COM	RS	P	X	CT	\$VARR2, CRBRP 2-D TRANSIENT FLUID FLOW ANALYSIS	WARD	7600	755							
F+COM	RS	PL	T	A	\$GNASH, PARTICLE INDUCED X-SECTIONS & SPECTRA	LASL	7600B	757							
F+COM	RS	PL	X	T	\$KENO2, MONTE CARLO MULTIGROUP CRITICALITY CODE	RFD	6600B	450							
F+COM	RS	PL	X	T	\$RELAP4/MOD6, TRANSIENT THERMAL-HYDRAULIC STUDY	EG&G	7600D	369							
F+COM	RS	PL	X	T	\$RELAP4/MOD6, TRANSIENT THERMAL-HYDRAULIC STUDY	EG&G	7600E	369							
F+COM	RS	PL	X	CT	\$MC-2-2, FAST NEUTRON SPECTRA & MULTIGP X-SECS	ANL	7600	355							
F+COM	RS	PL	X	CT	\$CONTEMPT4/MOD2, MULTICOMPARTMENT CONTAINMENT	EG&G	7600B	818							
F+COM	RS	PL	X	CT	\$DOE2.0, BUILDING ENERGY CONSUMPTION ANALYSIS	BKY	7600	782							
F+COM	RS	PL	X	CT	\$CONTEMPT4/MOD2, MULTICOMPARTMENT CONTAINMENT	EG&G	7600	818							
F+CSM	RS	P		G	\$SPOOL-FIRE, SPRAY-POOL BURNING OF SODIUM	ANL	370	R714							
F+GMP	RS		T	P	\$GENED ENVIRONMENTAL ROUTINES, SUBROUTINE LIB.	NED	635	515							
F+GMP	RS	P	T	D	\$SYN, 2D SYNTHESIS MULTIGP DIFF & 1GP DEPLETION	NED	635	495							
F+GMP	RS	P	X	CT	\$ENDRUN2, MULTIGROUP CONSTANTS FROM ENDF/B DATA	FBRD	635	501							
F+GMP	RS	P	X	CT	\$TDOWN, SPATIAL & COMPOSITION-DEPENDENT X-SECS	FBRD	635	505							
F+MAP	RS	P	T	C	\$DTF4, 1-D MULTI-GP DISCRETE ORDINATE PROGRAM	BC	625	209							
F+P+A	RS		T	P	\$AMDLIBAE, ARGONNE SUBROUTINE LIBRARY CAT. A-E	ANL	360B	562							
F+P+A	RS		T	P	\$AMDLIBGZ, ARGONNE SUBROUTINE LIBRARY CAT. G-Z	ANL	360B	564							
F+P+A	RS	BP	X	CT	\$GAUSS6, BATCH ANALYSIS OF GAMMA-RAY SPECTRA	EG&G	360	622							
F+SLE	RS	P		G	\$SAFTAC, MONTE CARLO FAULT TREE SIMULATION CODE	UNI	1108	674							
F+SLE	RS	P	X	CT	\$HERMES, REGIONAL RADIOLOGICAL EFFECTS ANALYSIS	HEDL	1108	527							
FACILITY SITING ASSESSMENT					ANL	360	F4	RS	P	T	R	\$SITE2, ENERGY	687		
FACTOR ANALYSIS OF VARIANCE					BKC	6600	F4	RS	P		P	\$ANOVA, THREE	819		
FACTOR CALC					BAPL	6600	F+ASC	RS	P	T	J	\$ASPIS, GAMMA-RAY SOURCE BUILDUP	R429		
FACTOR CALC FOR CYLINDRICAL PINS					EG&G	360	F4	RS	BP	CT	J	\$VIEWPIN, VIEW	569		
FACTOR SHIELDING CODE CAVITY GEOM					GGA	1108	F4	RS	P	T	J	\$MUSCAT, VIEW	259		
FACTORS					ORNL	360	F4	RS	P	T	A	\$ATHENA4, INELASTIC SCATTERING FORM	417		
FAILURE MODE					BAPL	6600	F4	RS	P		P	\$REL01, RELIABILITY FOR A SINGLE	R497		
FAIMOS, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE					BHSC	360	F4	RS	P	T	C	\$	120		
FARED, 1-D FAST REACTOR DESIGN & SURVEY STUDY					BW	6600	F+COM	RS	P	X	T	D	\$	427	
FAST + INTERMEDIATE POWER TRANSIENTS					BAPL	6600	F4	RS	P	T	H	\$SCHIC-KIN,	R473		
FAST BREEDERS					NED	635	F4	RS	P		D	\$RAPFU, FUEL CYCLE PARAMETERS	372		
FAST NEUTRON POLARIZATION EXPERIMENT					UCND	360B	F+BAL	RS	P		O	\$SPMS1,	469		
FAST NEUTRON SPECTRA & MULTIGP X-SECS					ANL	370	F+BAL	RS	BP	CT	B	\$MC-2-2,	355		
FAST NEUTRON SPECTRA & MULTIGP X-SECS					ANL	7600	F+COM	RS	PL	X	CT	B	\$MC-2-2,	355	
FAST NEUTRON SPECTRUM X-SECTION CALC						OSUC	370	F4	RS	PL	X	CT	B	\$FORM,	51
FAST REACTOR CORE ACCIDENT ANALYSIS					NED	635	F4	RS	P	T	G	\$FREADM1,	479		
FAST REACTOR DESIGN & SURVEY STUDY					BW	6600	F+COM	RS	P	X	T	D	\$FARED, 1-D	427	
FAST REACTOR EXCURSION CALCULATIONS					ANL	360	F4	RS	P	X	T	F	\$FORE2,	174	
FAST REACTOR EXCURSION CALCULATIONS					NED	635	F4	RS	P	X	T	F	\$FORE2,	174	
FAST REACTOR FUEL BURNUP & MANAGEMENT					NED	635	F4	RS	P	T	D	\$FUMBLE,	480		
FAST REACTOR POWER AND FLOW TRANSIENTS					ANL	360	F4	RS	P	T	F	\$SAS1A,	400		
FAST REACTOR POWER AND FLOW TRANSIENTS					ANL	6600	F4	RS	P	T	F	\$SAS1A,	400		
FAST REACTOR TRANSIENT OVERPOWER STUDY					HEDL	6600	F4	RS	P	CT	F	\$MELT3,	700		
FAST REACTOR X-SEC CALC					BNW	1108	F4	RS	P	T	B	\$FCC4, FUNDAMENTAL MODE	306		
FAST REACTORS					ANL	360B	F+BAL	RS	BP	CT	D	\$REBUS2, FUEL CYCLE ANALYSIS FOR	634		
FAST SPECTRA CALC					EG&G	360	F4	RS	PL	X	CT	B	\$PHROG, MULTI-GP CONSTANT &	520	
FAST THERMAL SPECTRA					GGA	1108B	F4	RS	PL	X	CT	B	\$GGC4, MULTI-GP X-SECTIONS	298	
FAST THERMAL SPECTRA					WANL	6600	F4	RS	L	T	B	\$GGC4, MULTI-GP X-SECTIONS	298		
FAST X-SECTION GENERATION					ANL	360	F+BAL	RS	BP	X	CT	B	\$1DX, 1-D DIFFUSION	374	
FAST X-SECTION GENERATION					BNW	1108	F4	RS	P	X	T	B	\$1DX, 1-D DIFFUSION	374	
FATIGUE					KAPL	6600	F4	RS		I	\$SORSDB, PRESSURE VESSEL STRESS AND	R391			
FAU, RADIO FREQUENCY MANAGEMENT SYSTEM					ALOC	360	COBOL	RS	P		M	\$AEC-ALO	587		
FAULT TREE ANALYSIS SYSTEM						ARHC	6600	F+COM	RS	P	CT	G	\$FTA,	666	
FAULT TREE EVALUATION CODES					EG&G	360	F4	RS	BP	CT	G	\$PREP,KITT, SYSTEM	528		
FAULT TREE EVALUATION CODES					EG&G	1108	F4	RS	P	T	G	\$PREP,KITT, SYSTEM	528		
FAULT TREE SIMULATION CODE					NEA	360	F4	RS	P		G	\$SAFTAC, MONTE CARLO	674		
FAULT TREE SIMULATION CODE					UNI	1108	F+SLE	RS	P		G	\$SAFTAC, MONTE CARLO	674		
FAULT TREES					EG&G	360	F4	RS	BP	CT	G	\$MOCUS, MINIMAL SETS FROM	653		
FBRD					635	F+GMP	RS	P	X	CT	B	\$ENDRUN2, MULTIGROUP CONSTANTS FROM ENDF/B DATA	501		
FBRD					635	F+GMP	RS	P	X	CT	B	\$TDOWN, SPATIAL & COMPOSITION-DEPENDENT X-SECS	505		

FBRD

FLIGHT

FBRD	635	F4	RS P CT I	SBEHAVE2, OXIDE FUEL PERFORMANCE FINITE-ELEMENT	R568
FBRD	6000	F4	RS P T D	SCOROPT, OPTIMIZING LMFBR MIXED-OXIDE CORES	S752
FBRD	6000	F4	RS P C C	STRIAL, 3-D REACTION RATES FROM 2-D FLUX SETS	585
FBRD	7600	F4	RS P T H	SBEHAVE-SST, OVERPOWER TRANSIENT FUEL MECHANICS	768
FBRD	7600	F4	RS P T H	SPACT2, COOLANT & CLADDING TEMPERATURE ANALYSIS	S796
FCC4, FUNDAMENTAL MODE FAST REACTOR X-SEC CALC	BNW	1108	F4	RS P T B S	306
FEEDBACK	BAPL	6600	F4	RS P F SNOWIG, 1-D 2-GP KINETICS TEMPERATURE	R371
FEEDBACK	BAPL	6600	F4	RS P T F STWIGL, 2-D 2-GP SPACE-TIME DIFFUSION	R338
FEEDBACK	BNL	6600	F4	RS P T F SNOAH, 1-D ONE-GP SPACE-TIME DIFFUSION	405
FEEDBACK	GGA	1108	F4	RS P T F SGAKIT, 1-D MULTIGP KINETICS WITH TEMP	370
FEM INELASTIC STRUCTURAL ANALYSIS	ORNL	360	F4	RS P CT I SPLACRE,	R740
FEM PROGRAMS	ORNL	360	F4	RS P CT N SGRFPAK, PLOT PACKAGE FOR CORTES	760
FEVER7, 1-D MULTIGROUP DIFFUSION AND DEPLETION	GGA	1108	F4	RS P T D S	318
FEW-CHANNEL COOLANT-FLOW BLOCKAGE STUDY	PNC	360	F4	RS P T H SLOCK,	732
FEW-GP DIFFUSION CALC HEX-Z MESH	GGA	1108	F4	RS P T C SGATT, 3-D	380
FEW-GP DIFFUSION DEPLETION	BAPL	7600B	F+COM RS P T D	SPDQ8, 1,2 OR 3-D	R275
FEW-GP DIFFUSION DEPLETION	BCSS	6600D	F+ASC R B T D	SPDQ7, 1,2 OR 3-D	R275
FEW-GP DIFFUSION DEPLETION	EG&G	360G	F+BAL RSBP XCT D	SPDQ7, 1,2 OR 3-D	R275
FEW-GP DIFFUSION DEPLETION	EG&G	7600	FTN RS LXCT D	SPDQ7, 1,2 OR 3-D	R275
FEW-GP DIFFUSION DEPLETION PROGRAM	EG&G	360	F4	RSBP CT D SDWARF, 1-D	579
FEW-GP DIFFUSION DESIGN SYSTEM	AI	360	F4	RSBP T K STHREDES, 1-D	273
FEW-GP DIFFUSION SLAB CYLINDER SPHERE	BC	625	F4	RS T C SFOG, 1-D	28
FEW-GP DISCRETE ORDINATES SLAB GEOMETRY	BAPL	6600	F4	RS P T C SBE21,	R398
FEW-GP HEX GEOM DIFFUSION DEPLETION	GGA	1108	F4	RS P T D SGAUGE, 2-D	339
FEW-GROUP SPACE-TIME KINETICS	BCL	6400	F4	RS P T F SADEP, 1-D & 2-D	494
FEW-GROUP TRANSPORT WITH DEPLETION	BAPL	7600	F+COM RS P T D	STPT01, 2-D	R669
FFEARS, LAPLACE EQUATION ISOTROPIC DIELECTRICS	ANL	360	F4	RS P CT T S	577
FFEARS, LAPLACE EQUATION ISOTROPIC DIELECTRICS	SLA	6600B	F4	RS P T T S	577
FIGRO, LWBR FUEL SWELLING TEMPERATURE STUDY	BAPL	6600	F4	RS P T H S	R272
FIGS, IBM360&2250 FORTRAN GRAPHICS SUBROUTINES	AI	360	F+BAL RS	T P S	484
FIGURES & GRAPHS WITH DISSPLA	ANL	360	F4	RS P CT P SORAFMAN, DRAW	748
FILE PROCESSOR	LASL	360	F4	RS P CT M SLASIP3, CCCC STANDARD INTERFACE	691
FINDING ROOTS OF A POLYNOMIAL	KAPL	6600	F4	RS P P SROPE,	R444
FINE-GP CONSTANTS GENERATION	ORNL	360	F4	RS P T B SSUPERTOG, ENDF/B	431
FINEL, FINITE-ELEMENT STUDY 2,3-D STRUCTURES	KAPL	6600	F4	RS P X I S	R404
FINITE ELEMENT CODE FOR CREEP ANALYSIS	HEDL	6600	F4	RS P CT I SAXICRP,	785
FINITE ELEMENT MESH GENERATOR	LLL	7600	F	RS P T N SZONE, 2-D	765
FINITE-ELEMENT FBRD	635	F4	RS P CT I	SBEHAVE2, OXIDE FUEL PERFORMANCE	R568
FINITE-ELEMENT BEAM CREEP ANALYSIS	HEDL	6600	F4	RS P T I SBEAMCRP,	R701
FINITE-ELEMENT CODE	SLA	6600B	F4	RS P T I SHONDO, A DYNAMIC RESPONSE	672
FINITE-ELEMENT ELASTIC ANALYSIS	BAPL	6600	F+COM RS P X T I	SMATUS, 3-D	R597
FINITE-ELEMENT STUDY 2,3-D STRUCTURES	KAPL	6600	F4	RS P X I SFINEL,	R404
FIRE 1- & 2-CELL ANALYSIS	AI	360	F4	RS P G SSOFIRE2, SODIUM POOL	559
FIRES IN CYLINDRICAL CELL	AI	370	F4	RS P T G SSOMIX1, SODIUM SPRAY	R751
FIRES, 1-D AGE-DIFFUSION SLAB CYLINDER SPHERE	AEB	360	F4	RS L T C S	9
FISSILE NUCLIDE DATA	BAPL	6600	F4	RS P P SDAFT1, LEAST SQUARES FIT	R327
FISSION PRODUCT	BAPL	6600	F4	RS P D SCINDER,M0102, POINT DEPLETION	313
FISSION PRODUCT	DP	360	F+BAL RS P T D	SCINDER,M0102, POINT DEPLETION	313
FISSION PRODUCT FUEL MODEL	EG&G	360	F4	RSBP CT G SFFPM, STEADY-STATE	584
FISSION PRODUCT INVENTORY DECAY HISTORY	ANL	370	F4	RS PL G G SCURIE,	196
FISSION PRODUCT RELEASE	GGA	1108	F4	RS P D SFREVAP6, HTGR METALLIC	301
FISSION PRODUCT RELEASE ANALYSIS	BCL	6400	F4	RS P G SFRCRL2, LOCA	500
FIT FISSILE NUCLIDE DATA	BAPL	6600	F4	RS P P SDAFT1, LEAST SQUARES	R327
FIT SUM OF EXPONENTIALS	ANL	370	F4	RS P P SFRANTIC, LEAST SQUARES	324
FIT TO NONLINEAR FORMS	DP	360	F4	RS P P SNIXLIN, LEAST SQUARES	709
FITTING	BAPL	6600	F4	RS P T P SM0661,M0657,M0626, POLYNOMIAL CURVE	R411
FITTING	KAPL	6600	F4	RS P A SCLEM, ANGULAR DISTRIBUTION LEGENDRE	R531
FITTING EXPERIMENTAL DATA POINTS	KAPL	6600	F+ASC RS P T P	SCURFIT, CURVE	R 43
FLAC, STEADY-STATE FLOW, PRESSURE DISTRIBUTION	A&TS	370	F4	RS P C H S	395
FLAC, STEADY-STATE FLOW, PRESSURE DISTRIBUTION	GGA	1108	F5	RS P H S	395
FLANGE-ORNL, ANALYSIS OF FLANGED JOINTS	ORNL	360B	F4	RS P T I S	689
FLANGED JOINTS	ORNL	360B	F4	RS P T I SFLANGE-ORNL, ANALYSIS OF	689
FLANGE1, SCATTERING LAW X-SECTION CALCULATION	GGA	1108	F5	RS P A S	247
FLANGE2(71-1), ENDF/B THERMAL SCATTERING DATA	DP	360B	F4	RS P XCT B S	368
FLARE, 3-D REACTIVITY AND POWER DISTRIBUTION	AINS	7600	F4	RS P T C S	167
FLARE, 3-D REACTIVITY AND POWER DISTRIBUTION	MSS	360	F4	RS P CT C S	167
FLARE, 3-D REACTIVITY AND POWER DISTRIBUTION	NED	635	F4	RS P T C S	167
FLASH3, LOSS-OF-COOLANT ACCIDENT ANALYSIS	BAPL	6600	F4	RS P T G S	R295
FLASH4, FULLY-IMPLICIT TRANSIENT SIMULATION	MA-G	360	F4	RSBP CT G S	R448
FLASH6, FULLY-IMPLICIT TRANSIENT SIMULATION	BAPL	7600	F4	RS P T G S	R448
FLEXIBILITY CALC	ORNL	360	F+BAL RS P I	SELBOW-ORNL, PIPE STRESS &	650
FLIGHT COLLISION PROBABILITIES MC	ORNL	360B	F+BAL RS P T B	SRAFFLE, 1ST	392

FLOT1

FPFM

FLOT1.M0219, PWR FLOW TRANSIENT ANALYSIS	BAPL 6600 F4	RS P T H S	R331
FLOW MSS 360 F4	RS P T H	SFLOW-MODEL, MULTI-CHANNEL 2-D 2-PHASE	246
FLOW EG&G 7600 F+COM	RS P CT G	SBEACON/MOD2A, CONTAINMENT SYSTEM FLUID	767
FLOW LASL 6600 F4	RS P X T U	SRICE-LASL, CHEMICALLY REACTIVE MIXTURE	720
FLOW LASL 7600 F4	RS P F	SSOLA-ICE, TRANSIENT COMPRESSIBLE FLUID	723
FLOW LASL 7600 F4	RS P X T H	SK-FIX, TRANSIENT 2-DIMENSIONAL 2-FLUID	727
FLOW BAPL 7600B F4	RS P T H	SFLOW3, NETWORK ANALYSIS OF 3-D TWO-PHASE	R664
FLOW ANL 360 F4	RS P T H	SEVITS, STEADY STATE TWO-DIMENSIONAL FLUID	792
FLOW & TEMPERATURE DIST. ORNL 360 F4	RS P T H	SORRIBLE, ROD BUNDLE	629
FLOW ALGORITHM LASL 7600B F	RS P H	SSOLA, SOLA-SURF, TRANSIENT FLUID	651
FLOW ANALYSIS WARD 7600 F+COM	RS P XCT H	SVARR2, CRBRP 2-D TRANSIENT FLUID	755
FLOW DIST. IN CYL COOLANT INLET PLENUM DP 360 F4	RS P H	SPLENUM,	586
FLOW DISTRIBUTION KAPL 6600 F4	RS P T H	SHAFMAT, SYSTEM STEADY-STATE	R616
FLOW IN LMFBR ROD BUNDLE NED 635 F4	RS P T H	SVELVET2, TURBULENT	458
FLOW IN VENTED FLUID SYSTEM LASL 7600 F4	RS P T H	SCOMPARE, TRANSIENT	702
FLOW IN VENTED FLUID SYSTEM NRC 370 F4	RS P T H	SCOMPARE, TRANSIENT	702
FLOW STEAM GGA 1108 F4	RS P T H	SDYNAM, DYNAMIC ANALYSIS BOILING	440
FLOW STUDY STEAM-WATER MIX KAPL 6600 F4	RS P H	SRAPP, HIGH-VELOCITY	R382
FLOW TRANSIENT ANALYSIS BAPL 6600 F4	RS P T H	SFLOT1.M0219, PWR	R331
FLOW TRANSIENTS ANL 360 F4	RS P T F	SSAS1A, FAST REACTOR POWER AND	400
FLOW TRANSIENTS ANL 6600 F4	RS P T F	SSAS1A, FAST REACTOR POWER AND	400
FLOW W/SINKS & DOORS LASL 7600 F4	RS P T H	SCOMPARE-MOD1, TRANSIENT	776
FLOW-MODEL, MULTI-CHANNEL 2-D 2-PHASE FLOW MSS 360 F4	RS P H S		246
FLOW PRESSURE DISTRIBUTION A&T 370 F4	RS P C H	SFLAC, STEADY-STATE	395
FLOW PRESSURE DISTRIBUTION GGA 1108 F5	RS P H	SFLAC, STEADY-STATE	395
FLOW3, NETWORK ANALYSIS OF 3-D TWO-PHASE FLOW BAPL 7600B F4	RS P T H S		R664
FLUCTUATION EXPERIMENT ANALYSIS BAPL 6600 F4	RS P O	SJITER,	R394
FLUCTUATION EXPERIMENT ANALYSIS BAPL 6600 F4	RS P O	SREDUX, REACTOR	R425
FLUID FLOW EG&G 7600 F+COM	RS P CT G	SBEACON/MOD2A, CONTAINMENT SYSTEM	767
FLUID FLOW LASL 7600 F4	RS P H	SSOLA-ICE, TRANSIENT COMPRESSIBLE	723
FLUID FLOW ANL 360 F4	RS P T H	SEVITS, STEADY STATE TWO-DIMENSIONAL	792
FLUID FLOW ALGORITHM LASL 7600B F	RS P H	SSOLA, SOLA-SURF, TRANSIENT	651
FLUID FLOW ANALYSIS WARD 7600 F+COM	RS P XCT H	SVARR2, CRBRP 2-D TRANSIENT	755
FLUID HAMMER ANALYSIS OF PIPING SYSTEM HEDL 6600 F4	RS P T G	SHAMOC,	710
FLUID HAMMER ANALYSIS PIPING SYSTEM ANL 360 F4	RS P G	SHAMHAMMER,	717
FLUID HAMMER ANALYSIS PIPING SYSTEM ANL 7600 F4	RS P G	SHAMHAMMER,	717
FLUID HAMMER ANALYSIS 1-D PIPING ANL 360 F4	RS P G	SNATRANSIENT,	718
FLUID HAMMER ANALYSIS 1D & 2D SYSTEMS ANL 360 F4	RS P T G	SNATRAN2,	719
FLUID SYSTEM LASL 7600 F4	RS P T H	SCOMPARE, TRANSIENT FLOW IN VENTED	702
FLUID SYSTEM NRC 370 F4	RS P T H	SCOMPARE, TRANSIENT FLOW IN VENTED	702
FLUX SETS FBRO 6000 F4	RS P C C	STRIAL, 3-D REACTION RATES FROM 2-D	585
FLUX SYNTHESIS DIFFUSION ANL 370B F+BAL	RS P XCT C	SSYN3D, SINGLE-CHANNEL	713
FLUX SYNTHESIS DIFFUSION ANL 7600 F+COM	RS P XCT C	SSYN3D, SINGLE-CHANNEL	713
FLUX-DOSIMETER ACTIVITY RELATION GEC 635 F4	RSBP D	SDOS, NEUTRON	423
FLUX-WEIGHTING OF DTF4 CROSS SECTIONS LASL 6600 F4	RS P N	SLARCA,	409
FLUX, X-SEC CALC ORNL 360 F+BAL	RS P D	SISOSEARCH, ISOTOPE PRODUCTION	322
FLUXES LASL 6600 F4	RS P N	SDAC1, SN PERTURBATION CODE USING DTF4	455
FNAL 370 F+BAL	RS P T W	SCASIM, SIMULATES HADRONIC CASCADE TRANSPORT	742
FOG CODES BHSC 360 F4	RS P C	SPERT, 1-D PERTURBATION FOR AIM AND	30
FOG, 1-D FEW-GP DIFFUSION SLAB CYLINDER SPHERE BC 625 F4	RS T C S		28
FOREST AIR POLLUTANT UPTAKE MODEL DP 360 CSMP	RS R	SPOLUTE,	774
FORE2, FAST REACTOR EXCURSION CALCULATIONS ANL 360 F4	RS P X T F S		174
FORE2, FAST REACTOR EXCURSION CALCULATIONS NED 635 F4	RS P X T F S		174
FORM WAPD 7600 F4	RS P T B	SETOT3, ENDF/B V3 DATA TO THERMAL LIBRARY	628
FORM FACTORS ORNL 360 F4	RS P T A	SATHENA4, INELASTIC SCATTERING	417
FORM OR THREDES LIBRARY UTILITY ROUTINE AI 360 F4	RSB L T M	SCLIP,	271
FORM SHEET DP PACKAGE KAPL 6600 F+ASC	RS P T P	SDOGGY, DESK CALCULATOR	R428
FORM, FAST NEUTRON SPECTRUM X-SECTION CALC OSUC 370 F4	RS PLXCT B S		51
FORMAT WAPD 6600 F4	RS PL T B	SETOG1, ENDF/B TO MUFT, GAM, ANISN X-SEC	437
FORMAT WAPD 7600 F4	RS P T B	SETOG3, ENDF/B TO MUFT, GAM, ANISN X-SEC	538
FORMAT TO MUFT FORMAT X-SECTIONS WAPD 6600 F4	RS P T B	SETOM1, ENDF/B	436
FORMAT X-SECTIONS WAPD 6600 F4	RS P T B	SETOM1, ENDF/B FORMAT TO MUFT	436
FORMS DP 360 F4	RS P P	SNIXLIN, LEAST SQUARES FIT TO NONLINEAR	709
FORSIM, SOLN OF PARTIAL OR ORDINARY DIFF EQNS CRNL 6600B F4	RS P CT P S		514
FORTIO, FORTRAN INTERFACE TO IBM370 MACROS ANL 370 BAL	RSBP CT P S		772
FORTTRAN SLAC 360 F4	RSBP XCT P	SMORTRAN2, MACRO-BASED STRUCTURED	678
FORTTRAN DYNAMIC STORAGE ALLOC ORNL 360 BAL+F	RS P C P	SGETCOR, FRECOR,	644
FORTTRAN GRAPHICS SUBROUTINES AI 360 F+BAL	RS T P	SFIGS, IBM360&2250	484
FORTTRAN H PROGRAM CHECKER ANL 360B PL1	S P CT P	SSLOP, CROSS, IBM360	647
FORTTRAN INTERFACE TO IBM370 MACROS ANL 370 BAL	RSBP CT P	SFORTIO,	772
FORTTRAN UTILITIES EG&G 360B F+BAL	RSB T P	SNRTS ENVIRONMENTAL ROUTINES,	613
FPFM, STEADY-STATE FISSION PRODUCT FUEL MODEL EG&G 360 F4	RSBP CT G S		584

FRANTIC-NRC

F0355

FRANTIC-NRC, TIME SYSTEM UNAVAILABILITY	NRC	370	F4	RS P XCT G	\$	766
FRANTIC, LEAST SQUARES FIT SUM OF EXPONENTIALS	ANL	370	F4	RS P	P	\$ 324
FRAP-S1, STEADY STATE ANALYSIS OXIDE FUEL RODS	EG&G	360	F+BAL	RS P X T H	\$	694
FRAP-S3, STEADY STATE ANALYSIS OXIDE FUEL RODS	EG&G	7600	F4	RS P T H	\$	694
FRAP-T, TRANSIENT ANALYSIS OF OXIDE FUEL RODS	EG&G	360	F+BAL	RSBP XCT G	\$	658
FRAP-T3, TRANSIENT ANALYSIS OF OXIDE FUEL RODS	EG&G	7600	F4	RSBP XCT G	\$	658
FRCL2, LOCA FISSION PRODUCT RELEASE ANALYSIS	BCL	6400	F4	RS P	G	\$ 500
FREADM1, FAST REACTOR CORE ACCIDENT ANALYSIS	NED	635	F4	RS P T G	\$	479
FRECOR, FORTRAN DYNAMIC STORAGE ALLOC	ORNL	360	BAL+F	RS P C P	\$GETCOR,	644
FREE-FORMAT CARD INPUT PROCESSOR	LASL	360	F4	RS P	L \$GENRD,	530
FREE-FORMAT CARD INPUT PROCESSOR	LASL	6600	F4	RS P	L \$GENRD,	530
FREQUENCY DOMAIN	LLL	7600	F4	RS P T T	\$WFLLL2B, WIRE CONFIGURATION	721
FREQUENCY MANAGEMENT SYSTEM	ALOO	360	COBOL	RS P	M \$AEC-ALO FAU, RADIO	587
FREVAP6, HTGR METALLIC FISSION PRODUCT RELEASE	GGA	1108	F4	RS P	D	\$ 301
FSDP3, POINTWISE XSECS. FROM B-W PARAMETERS	GGA	1108	F5	RS P CT A	\$	216
FTA BASIC EVENT & CUT SET RANKING	ANL	370	F4	RS P T G	\$IMPORTANCE,	779
FTA, FAULT TREE ANALYSIS SYSTEM	ARHC	6600	F+COM	RS P CT G	\$	668
FTN RS LXCT D \$PDQ7, 1,2 OR 3-D FEW-GP DIFFUSION DEPLETION	EG&G	7600				R275
FTN RS P T I \$CHILES, LINEAR ELASTIC SINGULARITY MODELING	SLA	6600				611
FTN RS P T P \$SETS, SET EQUATION TRANSFORMATION SYSTEM	SLA	6600B				623
FUEL BURNUP & MANAGEMENT	NED	635	F4	RS P T D	\$FUMBLE, FAST REACTOR	480
FUEL CYCLE ANALYSIS FOR FAST REACTORS	ANL	360B	F+BAL	RSBP CT D	\$REBUS2,	634
FUEL CYCLE CALCULATION	GGA	1108	F4	S	T D \$GAFFE, EQUILIBRIUM	302
FUEL CYCLE COST AND ECONOMICS	CWE	360	F4	RS P T D	\$CINCAS, NUCLEAR	354
FUEL CYCLE COST AND ECONOMICS	WAPD	6600	F4	RS P T D	\$CINCAS, NUCLEAR	354
FUEL CYCLE COST CALCULATION	GGA	1108	F4	RS P T D	\$PWCOST, REACTOR	441
FUEL CYCLE COSTS PERFORMANCE DATA	ANL	360	F4	RS P	D \$NPRFCCP,	146
FUEL CYCLE COSTS PERFORMANCE DATA	UEC	6600	F4	RS P	D \$NPRFCCP,	146
FUEL CYCLE COSTS PERFORMANCE STUDY	UEC	6600	F4	RS P	D \$WAMPUM,	224
FUEL CYCLE ECONOMICS	UICS	360	F4	RS P CT D	\$GEM, ANALYSIS OF NUCLEAR	576
FUEL CYCLE PARAMETERS FAST BREEDERS	NED	635	F4	RS P	D \$RAPFU,	372
FUEL CYCLE REQUIREMENTS	ERDA	370C	F4	RS P CT D	\$NUFUEL, NUCLEAR	683
FUEL ELEM STUDY	NRC	370	F4	RSBP CT G	\$WREM-TOODEE2/MOD3, 2D TIME-DEP	712
FUEL ELEMENT	BAPL	6600	F4	RS	T I \$CYGRO2, STRESS ANALYSIS CYL	R266
FUEL ELEMENT ANALYSIS	BAPL	6600	F4	RS P T H	\$GLUB1, WATER-LOGGED	R424
FUEL ELEMENT PERFORMANCE	ANL	370	F4	RS P CT I	\$LIFE3, MIXED-OXIDE	R460
FUEL ELEMENT PERFORMANCE	ANL	7600	F4	RS P T I	\$LIFE3, MIXED-OXIDE	R460
FUEL ELEMENTS	AEB	360	F4	RS P	B \$WELWING, MATERIAL BUCKLING CYL	362
FUEL MECHANICS	FBRD	7600	F4	RS P T H	\$BEHAVE-SST, OVERPOWER TRANSIENT	768
FUEL MODEL	EG&G	360	F4	RSBP CT G	\$FPFM, STEADY-STATE FISSION PRODUCT	584
FUEL PELLET TEMPERATURE & DEFORMATION	BAPL	6600	F4	RS P T I	\$PELEN,	R598
FUEL PERFORMANCE FINITE-ELEMENT	FBRD	635	F4	RS P CT I	\$BEHAVE2, OXIDE	R568
FUEL PIN THERMAL PERFORMANCE MODEL	HEDL	6600	F	RS P T H	\$S1EX, LMFBR	673
FUEL PIN THERMAL-HYDRAULIC ANALYSIS	ANL	360B	F4	RSBP CT H	\$COBRA3M,	659
FUEL PIN TUBE	BNW	6600	F4	RS P T I	\$SCOVE1, CREEP COLLAPSE FOR OVAL	817
FUEL ROD CLAD STRAIN & PELLET CRACKING	BAPL	6600	F4	RS P	I \$STRIPE,	R570
FUEL ROD RESPONSE LOCA EXPERIMENTS	ORNL	360	F4	RS P T H	\$HETRAP,	730
FUEL ROD STRESS & DEFORMATION	AN-T	360B	F4	RSBP CT I	\$CYGR03, OXIDE	R449
FUEL ROD STRESS & DEFORMATION	BAPL	6600	F4	RS P T I	\$CYGR03, OXIDE	R449
FUEL ROD THERMAL RESPONSE LOCA	EG&G	360	F4	RSBP X T G	\$THETA1-B,	512
FUEL RODS	EG&G	360	F+BAL	RSBP XCT G	\$FRAP-T, TRANSIENT ANALYSIS OF OXIDE	658
FUEL RODS	EG&G	360	F+BAL	RS P X T H	\$FRAP-S1, STEADY STATE ANALYSIS OXIDE	694
FUEL RODS	EG&G	7600	F4	RS P T H	\$FRAP-S3, STEADY STATE ANALYSIS OXIDE	694
FUEL RODS	EG&G	7600	F4	RSBP XCT G	\$FRAP-T3, TRANSIENT ANALYSIS OF OXIDE	658
FUEL SS & TRANSIENT BEHAVIOR	BNW	6600	F4	RS P X T I	\$GAPCON-THERMAL3,	770
FUEL SWELLING & GAS RELEASE SIMULATION	BAPL	6600	F4	RS P	I \$SUBL1,	R468
FUEL SWELLING TEMPERATURE STUDY	BAPL	6600	F4	RS P T H	\$FIGRO, LWBR	R272
FUEL PIN ANAL	360	F4	RS P	H	\$MARGE/SLUMP, MAXIMUM TEMPERATURE LMFBR	677
FUEL PIN GAP CONDUCTANCE CALC	BNW	6600	F4	RS P T I	\$GAPCON-THERMAL2,	618
FUGIT, DYNAMIC RESPONSE OF ELASTIC STRUCTURES	BAPL	6600	F4	RS P	I	\$ R537
FULL-TEXT STORAGE, SEARCH & RETRIEVAL	SLA	1108	F+BAL	RSBP	T M \$SPIRAL,	R607
FULLY-IMPLICIT TRANSIENT SIMULATION	BAPL	7600	F4	RS P T G	\$FLASH6,	R448
FULLY-IMPLICIT TRANSIENT SIMULATION	MA-G	360	F4	RSBP CT G	\$FLASH4,	R448
FUMBLE, FAST REACTOR FUEL BURNUP & MANAGEMENT	NED	635	F4	RS P T D	\$	480
FUNDAMENTAL MODE FAST REACTOR X-SEC CALC	BNW	1108	F4	RS P T B	\$FCC4,	306
FUNPACK2, SPECIAL FUNCTION ROUTINES	ANL	370B	F4	S P X T P	\$	610
FUNPACK2, SPECIAL FUNCTION ROUTINES	ANL	1108B	F5	S P X T P	\$	610
FUNPACK2, SPECIAL FUNCTION ROUTINES	ANL	6600B	F	S P X T P	\$	610
FUSION REACTOR STUDY	ANL	360	F4	RS P	X \$TOKMINA/TOKMINA2, TOKAMAK	561
FW	360	F4	RS P CT H	SLION4, 3-D TEMPERATURE DISTRIBUTION PROGRAM		R299
FW	1108B	F4	RS P T H	SLION4, 3-D TEMPERATURE DISTRIBUTION PROGRAM		R299
F0355, SHAPER CUTTER CONTOUR GENERATOR	ANL	360	F4	RS P	T	\$ 697

F0355

F4

F0355	SHAPER CUTTER	CONTOUR GENERATOR	BKC 6600	F4	RS P	T	S	697
F36	RS P	T I	STOODY2, 2-D LAGRANGIAN EQNS OF MOTION SOLUTION	SLA	3600			627
F4	S	T D	SGAFFE, EQUILIBRIUM FUEL CYCLE CALCULATION	GGA	1108			302
F4	S P	H	SPWR-PPM, BORATION-DILUTION TABLES FOR PWR OPN	OPPD	6400			552
F4	S P X T	P	\$FUNPACK2, SPECIAL FUNCTION ROUTINES	ANL	370B			610
F4	RS	B	\$APRFX1, 99-GP DLC-2B LIBRARY GROUP-COLLAPSING	APG	6600			466
F4	RS	B	\$HEXSCAT, ELASTIC SCAT X-SECTIONS HEX LATTICE	GGA	1108			291
F4	RS	B	\$M0807, 2-D DIFFUSION ABSORPTION REMOVAL X-SECS	BAPL	6600			R280
F4	RS	C	\$M0648, 1-D SLAB TRANSPORT WITH SLOWING DOWN	BAPL	6600			R342
F4	RS	G	\$ANVENT, LOCA ANALYSIS DUKE POWER MCGUIRE UNITS	DUCCO	635			529
F4	RS	H	\$WATER, STEAM TABLES 14.5-14,500PSIA 32-472DEGF	BAPL	6600			R267
F4	RS	I	\$SORSD8, PRESSURE VESSEL STRESS AND FATIGUE	KAPL	6600			R391
F4	RS	T C	\$EXTERMINATOR2, 2-D MULTI-GP DIFFUSION PROGRAM	BC	625			156
F4	RS	T C	\$FOG, 1-D FEW-GP DIFFUSION SLAB CYLINDER SPHERE	BC	625			28
F4	RS	T G	\$GADOSE,DOSET, HTGR ACCIDENT ANALYSIS DOSE CALC	GGA	1108			261
F4	RS	T H	\$STEAM-67, 1967 ASME STEAM AND WATER PROPERTIES	BG&E	360C			487
F4	RS	T I	\$CYGRO2, STRESS ANALYSIS CYL FUEL ELEMENT	BAPL	6600			R266
F4	RS	T M	\$CHECKER,CRECT,DAMMET,PLOTFB,... ENDF/B V1 PROC	BNL	6600B			384
F4	RS	T M	\$CHECK3,RIGEL3, ENDF/B V3 PROCESSING CODES	BNL	6600			571
F4	RS	T M	\$CRECT,CHECKER,RIGEL,PLOTFB,... ENDF/B V2 PROC	BNL	6600B			475
F4	RS	T M	\$RIGEL, ENDF/B V3 DATA PROCESSING CODE	ANL	360			571
F4	RS	T M	\$RIGEL4,CHECK4,... ENDF/B V4 PROCESSING CODES	BNL	6600B			638
F4	RS	T O	\$GASSPAN, COMPLEX GAMMA-RAY SPECTRA ANALYSIS	KAPL	6600			R485
F4	RS	T P	\$MODEL, MODIFIED BETTIS ENVIRNMNTL LIB SCOPE2.0	CEND	7600B			478
F4	RS	L T B	\$GAMBIT, X-SEC GENERATION FOR TRANSPORT CODES	WANL	6600			547
F4	RS	L T B	\$GGC4, MULTI-GP X-SECTIONS FAST THERMAL SPECTRA	WANL	6600			298
F4	RS	L T C	\$FIRE5, 1-D AGE-DIFFUSION SLAB CYLINDER SPHERE	AEB	360			9
F4	RS P	A	\$AVERAGE, UNRESOLVED REGION AVERAGE X-SEC CALC	BNL	6600			376
F4	RS P	A	\$BESFIT, DIFFRACTION MODEL ELASTIC SCAT X-SEC	BNL	6600			524
F4	RS P	A	\$CLEM, ANGULAR DISTRIBUTION LEGENDRE FITTING	KAPL	6600			R531
F4	RS P	A	\$CODILL1, LEAST SQUARES ANALYSIS RESONANCE DATA	UICS	360			347
F4	RS P	A	\$GAKER, INELASTIC SCAT X-SECTION CALC MODERATOR	GGA	1108			289
F4	RS P	A	\$GANDY3, UNRESOLVED RESONANCE X-SECTION CALC	GGA	1108B			341
F4	RS P	A	\$GASKET, THERMAL SCATTERING LAW CALCULATION	GGA	1108			263
F4	RS P	A	\$GRAMP, R-M PARAMETERS OF UNRESOLVED RESONANCES	BAPL	6600			R470
F4	RS P	A	\$MULTI, MULTI-LEVEL RESONANCE THEORY XSEC CALC	KAPL	6600			R535
F4	RS P	A	\$PHASER, PHASE SHIFT X-SEC & POLARIZATION CALC	KAPL	6600			R507
F4	RS P	A	\$POLLA, CONVERTS R-MATRIX RESONANCE PARAMETERS	ORNL	360			639
F4	RS P	A	\$PSEUDO, STATISTICAL RESONANCE PARAMETER CALC	ENEA	360			292
F4	RS P	A	\$PSEUDO, STATISTICAL RESONANCE PARAMETER CALC	GGA	1108			292
F4	RS P	A	\$RAMP1, REICH-MOORE RESOLVED REGION X-SECTIONS	BNL	6600			492
F4	RS P	A	\$SIGPLOT, RESOLVED MULTILEVEL B-W X-SEC CALC	BNL	6600			377
F4	RS P	A	\$THRES2, STATISTICAL MODEL REACTION X-SECTION	ENEA	360			504
F4	RS P	A	\$THRES2, STATISTICAL MODEL REACTION X-SECTIONS	BNL	6600B			504
F4	RS P	B	\$AVID, ANNULAR VOID X-SECTION CALCULATION	GEC	625			276
F4	RS P	B	\$PART1, OPTIMAL GROUP OR MESH COLLAPSING	RW	6500			416
F4	RS P	B	\$WELWING, MATERIAL BUCKLING CYL FUEL ELEMENTS	AEB	360			362
F4	RS P	C	\$PERT, 1-D PERTURBATION FOR AIM AND FOG CODES	BHSC	360			30
F4	RS P	C	\$PERT4, 2-D PERTURBATION XY RZ RTHETA GEOMETRY	BNW	1108			304
F4	RS P	D	\$CINDER,M0102, POINT DEPLETION FISSION PRODUCT	BAPL	6600			313
F4	RS P	D	\$FREVP6, HTGR METALLIC FISSION PRODUCT RELEASE	GGA	1108			301
F4	RS P	D	\$NPRFCOP, FUEL CYCLE COSTS PERFORMANCE DATA	ANL	360			146
F4	RS P	D	\$NPRFCOP, FUEL CYCLE COSTS PERFORMANCE DATA	UEC	6600			146
F4	RS P	D	\$POWERCO, NUCLEAR STATION ELECTRICITY COSTS	UEC	6600			340
F4	RS P	D	\$PRP, PRODUCT PRICE CALCULATED BY DCF METHOD	ORNL	360			739
F4	RS P	D	\$RAPFU, FUEL CYCLE PARAMETERS FAST BREEDERS	NED	635			372
F4	RS P	D	\$WAMPUM, FUEL CYCLE COSTS PERFORMANCE STUDY	UEC	6600			224
F4	RS P	E	\$AIREK3, SPACE-INDEPENDENT KINETICS W/FEEDBACK	AEB	360			121
F4	RS P	E	\$BLAST, REACTOR KINETICS TEMPERATURE DIST STUDY	AEB	360			363
F4	RS P	E	\$GAPOTKIN, SPACE-INDEPENDENT REACTOR KINETICS	GGA	1108			317
F4	RS P	E	\$GASA, STABILITY ANALYSIS REACTOR KINETICS EQNS	GGA	1108			290
F4	RS P	E	\$R101, SPACE-INDEPENDENT KINETICS KEX OPTIONS	ANL	360			255
F4	RS P	E	\$R102, SPACE-INDEPENDENT INVERSE KINETICS CALC	ANL	360			168
F4	RS P	E	\$STRIFIDO, PULSED NEUTRON SOURCE DATA ANALYSIS	CNEA	360			489
F4	RS P	F	\$NOWIG, 1-D 2-GP KINETICS TEMPERATURE FEEDBACK	BAPL	6600			R371
F4	RS P	F	\$RAUMZEIT, 1-D TIME-DEPENDENT DIFFUSION CALC	KAPL	6600			R352
F4	RS P	F	\$STINT3, SINGLE-CHANNEL SPACE-TIME SYNTHESIS	KAPL	6600			R389
F4	RS P	G	\$BOIL1, BOILOFF ACCIDENT CORE HEATUP & MELTDOWN	BCL	6400			734
F4	RS P	G	\$CEBUG, STEAM GENERATOR SODIUM-WATER REACTION	CEND	7600			548
F4	RS P	G	\$CLOUD, GAMMA-RAY DOSE RATE FROM A CLOUD	DP	360			47
F4	RS P	G	\$DISPER1, AEROSOL PARTICLE TRANSPORT STUDY	ANL	370			554
F4	RS P	G	\$EGAD, CALC OF EXTERNAL GAMMA DOSE INTEGRALS	DP	360			600

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F4	RS	P	G	SFRCL2, LOCA FISSION PRODUCT RELEASE ANALYSIS	BCL	6400	500
F4	RS	P	G	SINTEG, INSPEC, MARKOV SIMULATION OF REACTOR OPN	DP	360	590
F4	RS	P	G	SNAHAMMER, FLUID HAMMER ANALYSIS PIPING SYSTEM	ANL	360	717
F4	RS	P	G	SNAHAMMER, FLUID HAMMER ANALYSIS PIPING SYSTEM	ANL	7600	717
F4	RS	P	G	SNATTRANSIENT, FLUID HAMMER ANALYSIS 1-D PIPING	ANL	360	718
F4	RS	P	G	SSAFTAC, MONTE CARLO FAULT TREE SIMULATION CODE	NEA	360	674
F4	RS	P	G	SSOCCOOL2, SODIUM-FUEL INTERACTION ANALYSIS	ANL	360	521
F4	RS	P	G	SSOCCOOL2, SODIUM-FUEL INTERACTION ANALYSIS	HEDL	1108	521
F4	RS	P	G	SSOFIRE2, SODIUM POOL FIRE 1- & 2-CELL ANALYSIS	AI	360	559
F4	RS	P	G	SSPRAY3, SODIUM SPRAY RELEASE SAFETY ANALYSIS	HEDL	CY74	716
F4	RS	P	H	SBETTY, ENTRAINED PARTICLES SAMPLING STUDY	BAPL	6600	R545
F4	RS	P	H	SDIFFUSER, 2D SUBSONIC MHD DIFFUSER PERFORMANCE	ANL	370	737
F4	RS	P	H	SFLOW-MODEL, MULTI-CHANNEL 2-D 2-PHASE FLOW	MSS	360	246
F4	RS	P	H	SHEATING2, TRANSIENT STEADY-STATE HEAT TRANSFER	SSDC	370	198
F4	RS	P	H	SMARGE/SLUMP, MAXIMUM TEMPERATURE LMFBR FUEL PIN	ANL	360	677
F4	RS	P	H	SM0899, HOH, STEAM TABLES 14.5-2538 PSIA	BAPL	6600	R294
F4	RS	P	H	SPLENUM, FLOW DIST. IN CYL COOLANT INLET PLENUM	DP	360	586
F4	RS	P	H	SRAPP, HIGH-VELOCITY FLOW STUDY STEAM-WATER MIX	KAPL	6600	R382
F4	RS	P	H	SSLGTR, SLAG TRANSPORT MODELS FOR DUCT SURFACES	ANL	370	783
F4	RS	P	H	SSOLA-ICE, TRANSIENT COMPRESSIBLE FLUID FLOW	LASL	7600	723
F4	RS	P	I	SBUBL1, FUEL SWELLING & GAS RELEASE SIMULATION	BAPL	6600	R468
F4	RS	P	I	SBUCKLE, CREEP BUCKLING OF INITIALLY OVAL TUBE	BNW	6600C	667
F4	RS	P	I	SFUGIT, DYNAMIC RESPONSE OF ELASTIC STRUCTURES	BAPL	6600	R537
F4	RS	P	I	SIMPAC2, B SHIPPING CONTAINER IMPACT ANALYSIS	LASL	7600	715
F4	RS	P	I	SLUGS, STRESS FOR INTEGRAL ATTACHMENTS TO PIPE	ORNL	360	648
F4	RS	P	I	SMANE1, RECTANGULAR MAGNETIC NETWORK SOLUTION	BAPL	6600B	R412
F4	RS	P	I	SM0266, LINEAR ELASTIC STRUCTURAL DYNAMICS	BAPL	6600	R383
F4	RS	P	I	SM0552, DYNAMIC ANALYSIS LINEAR ELASTIC SYSTEMS	BAPL	6600	R283
F4	RS	P	I	SNUBOW, STRUCTURAL ANALYSIS BOWED REACTOR CORES	ANL	360B	643
F4	RS	P	I	SNUBOW2D-INELASTIC, BOWED REACTOR CORE ANALYSIS	ANL	370	790
F4	RS	P	I	SSAFE-CREEP, VISCOELASTIC ANALYSIS CONCRETE	GGA	1108	300
F4	RS	P	I	SSAFE-PLANE, PLANE STRESS ANALYSIS, 2-D BODIES	GGA	1108	252
F4	RS	P	I	SSAFE-SHELL, STRESS ANALYSIS THIN SHELLS	GGA	1108	253
F4	RS	P	I	SSTEM, MATRIX GENERATION FOR A SYSTEM OF BEAMS	KAPL	6600	R337
F4	RS	P	I	SSTRIPE, FUEL ROD CLAD STRAIN & PELLET CRACKING	BAPL	6600	R570
F4	RS	P	I	STCB01, CREEP-BUCKLING OF TUBES UNDER PRESSURE	BAPL	6600	R604
F4	RS	P	I	STUBE, U-TUBE HEAT EXCHANGER STRESS ANALYSIS	KAPL	6600	R378
F4	RS	P	J	SDEMONR, UNBIASED MONTECARLO SLAB SHIELD CODE	LSU	360	754
F4	RS	P	L	SBL47, DRAFTING TOOL TO PLOT PLANE STRUCTURES	BAPL	6600	R373
F4	RS	P	L	SGENRD, FREE-FORMAT CARD INPUT PROCESSOR	LASL	360	530
F4	RS	P	L	SGENRD, FREE-FORMAT CARD INPUT PROCESSOR	LASL	6600	530
F4	RS	P	L	SGROWRK, GRID GENERATION FOR SAFE PROGRAMS	GGA	1108	296
F4	RS	P	N	SDAC1, SN PERTURBATION CODE USING DTF4 FLUXES	LASL	6600	455
F4	RS	P	N	SHEATMESH, GEOMETRICAL DATA HEAT TRANSFER STUDY	SLL	6600	434
F4	RS	P	N	SLARCA, FLUX-WEIGHTING OF DTF4 CROSS SECTIONS	LASL	6600	409
F4	RS	P	O	SALPHA-M, RESOLUTION OF GAMMA-RAY SPECTRA	ORNL	360	413
F4	RS	P	O	SCORGAM, UNFOLDING OF COMPLEX GAMMA-RAY SPECTRA	KSUN	360	390
F4	RS	P	O	SDYN01, PHOTOMULTIPLIER ELECTRON DISTRIBUTION	ANL	360	R464
F4	RS	P	O	SDYN01, PHOTOMULTIPLIER ELECTRON DISTRIBUTION	KAPL	6600	R464
F4	RS	P	O	SJITER, FLUCTUATION EXPERIMENT ANALYSIS	BAPL	6600	R394
F4	RS	P	O	SREDUX, REACTOR FLUCTUATION EXPERIMENT ANALYSIS	BAPL	6600	R425
F4	RS	P	P	SANOVA, THREE FACTOR ANALYSIS OF VARIANCE	BKC	6600	819
F4	RS	P	P	SARSTEC, NONLINEAR MIXED INTEGER OPTIMIZATION	EG&G	360	738
F4	RS	P	P	SBH99, EXTREME VALUE DISTRIBUTION DATA ANALYSIS	BAPL	6600	R621
F4	RS	P	P	SCOMQC, QUALITY CONTROL DATA ANALYSIS ROUTINES	BKC	360	649
F4	RS	P	P	SDAFT1, LEAST SQUARES FIT FISSILE NUCLIDE DATA	BAPL	6600	R327
F4	RS	P	P	SERF.ERFC, ERROR & COMPLEMENTARY ERROR FUNCTION	SLA	6600	601
F4	RS	P	P	SEXPALS, LEAST SQUARES EXPONENTIAL DECAY CURVES	LLL	7600	321
F4	RS	P	P	SFRANTIC, LEAST SQUARES FIT SUM OF EXPONENTIALS	ANL	370	324
F4	RS	P	P	SKEELE, LINEARLY-CONSTRAINED OPTIMIZATION	ORNL	360	556
F4	RS	P	P	SMOST, A MULTIDIMENSIONAL OPTIMIZATION SCHEME	KAPL	6600	R446
F4	RS	P	P	SNIXLIN, LEAST SQUARES FIT TO NONLINEAR FORMS	DP	360	709
F4	RS	P	P	SPCTEST, PRINCIPAL COMPONENT TEST FOR OUTLIERS	UCND	360	769
F4	RS	P	P	SPDEONE, SOLUTIONS OF PARTIAL DIFFERENTIAL EQNS	LLL	7600	777
F4	RS	P	P	SPLOTR, 2-D CONTOUR PLOTS & AREA CALCULATION	SLA	6600	R578
F4	RS	P	P	SREL01, RELIABILITY FOR A SINGLE FAILURE MODE	BAPL	6600	R497
F4	RS	P	P	SROPE, FINDING ROOTS OF A POLYNOMIAL	KAPL	6600	R444
F4	RS	P	P	SSOERP, SECOND-ORDER ERROR PROPAGATION CODE	EG&G	360	764
F4	RS	P	P	SSOERP, SECOND-ORDER ERROR PROPAGATION CODE	EG&G	7600	764
F4	RS	P	Q	SRESPOND, DISSIMILAR MEDIA TLD CORRECTION CALC	AI	360	566
F4	RS	P	R	SSULCAL, MODEL OF SULFUR CHEMISTRY IN A PLUME	ORNL	360	788
F4	RS	P	T	SF0355, SHAPER CUTTER CONTOUR GENERATOR	ANL	360	897

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F4	RS	P	T	SF0355, SHAPER CUTTER CONTOUR GENERATOR	BKC	6600	697
F4	RS	P	U	SDYNAMIC ANALYSIS OF GASES BY MASS SPECTROMETRY	RFD	360	645
F4	RS	P	U	SSOLVEX, SOLVENT EXTRACTION PROCESS SIMULATION	DP	360	662
F4	RS	P	W	SCONDYN, POLYA MODEL SECONDARY ELECTRON SPECTRA	KAPL	6600	786
F4	RS	P	W	SMMM3, COORDINATE ANALYSES SEMI-RIGID MOLECULES	EG&G	360	632
F4	RS	P	X	STOKMINA/TOKMINA2, TOKAMAK FUSION REACTOR STUDY	ANL	360	561
F4	RS	P	T	A SATHENA4, INELASTIC SCATTERING FORM FACTORS	ORNL	360	417
F4	RS	P	T	A SDOPSEL, SELF-SHIELDING IN THE RESONANCE REGION	RRC	370	805
F4	RS	P	T	A \$JP1XR, COUPLED-CHANNEL SCATTERING X-SEC CALC	KAPL	6600	R506
F4	RS	P	T	A \$PUN1, UNRESOLVED RESONANCE INTEGRALS X-SECS	BAPL	6600	R359
F4	RS	P	T	A \$RESEND, ADLER, ENDF/B RESONANCE XSECTION CODES	BNL	6600B	465
F4	RS	P	T	A \$SUMOR, S-WAVE NEUTRON X-SECTION CALCULATION	BAPL	6600	R399
F4	RS	P	T	A \$TACAS1, ANALYSIS OF RESONANCE MEASUREMENTS	GGA	1108	410
F4	RS	P	T	A \$TOR, THERMAL SCATTERING CRYSTALLINE MATERIALS	LASL	6600	360
F4	RS	P	T	B \$CLUP77, SQUARE CELL COLLISION PROBABILITY CALC	ANL	360	526
F4	RS	P	T	B \$CLUP77, SQUARE CELL COLLISION PROBABILITY CALC	JAER	230	526
F4	RS	P	T	B \$EPOCH, NEUTRON AGE CALCULATION OF ENDF/B DATA	BAPL	6600	R461
F4	RS	P	T	B \$ETOG3, ENDF/B TO MUFT, GAM, ANISN X-SEC FORMAT	WAPD	7600	538
F4	RS	P	T	B \$ETOM1, ENDF/B FORMAT TO MUFT FORMAT X-SECTIONS	WAPD	6600	436
F4	RS	P	T	B \$ETOT2, THERMAL LIBRARIES FROM ENDF/B DATA	WAPD	7600	509
F4	RS	P	T	B \$ETOT3, ENDF/B V3 DATA TO THERMAL LIBRARY FORM	WAPD	7600	628
F4	RS	P	T	B \$FCC4, FUNDAMENTAL MODE FAST REACTOR X-SEC CALC	BNW	1108	306
F4	RS	P	T	B \$GLEN, GROUP CONSTANT CALC FROM TOR OUTPUT DATA	LASL	6600	361
F4	RS	P	T	B \$LINEAR, SIGMA1, LINEARIZE & BROADEN ENDF/B DATA	LLL	7600	747
F4	RS	P	T	B \$REAX, RESOLVED RESONANCE EPITHERMAL X-SECTIONS	NED	635	257
F4	RS	P	T	B \$RICE, PRIMARY RECOIL ATOM SPECTRA ENDF/B DATA	ORNL	360	453
F4	RS	P	T	B \$SUPERTOG, ENDF/B FINE-GP CONSTANTS GENERATION	ORNL	360	431
F4	RS	P	T	C \$BE21, FEW-GP DISCRETE ORDINATES SLAB GEOMETRY	BAPL	6600	R398
F4	RS	P	T	C \$BISYN, 2-D MULTI-GP DIFFUSION SYNTHESIS CALC	NED	1108	287
F4	RS	P	T	C \$DOT2DB, 2-D MULTIGROUP DIFFUSION & SN THEORY	NED	635	459
F4	RS	P	T	C \$DTF4, 1-D MULTI-GP DISCRETE ORDINATE PROGRAM	LASL	6600	209
F4	RS	P	T	C \$SEXTERMINATOR2, 2-D MULTI-GP DIFFUSION PROGRAM	CEND	6600	156
F4	RS	P	T	C \$SEXTERMINATOR2, 2-D MULTI-GP DIFFUSION PROGRAM	ORNL	360	156
F4	RS	P	T	C \$FAIMOS, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	BHSC	360	120
F4	RS	P	T	C \$FLARE, 3-D REACTIVITY AND POWER DISTRIBUTION	AINS	7600	167
F4	RS	P	T	C \$FLARE, 3-D REACTIVITY AND POWER DISTRIBUTION	NED	635	167
F4	RS	P	T	C \$GASP7, 1-D BURNUP POWER DISTRIBUTION SEARCH	GGA	1108	319
F4	RS	P	T	C \$GATT, 3-D FEW-GP DIFFUSION CALC HEX-Z MESH	GGA	1108	380
F4	RS	P	T	C \$HFN, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	BNW	1107	241
F4	RS	P	T	C \$KEFF, MGBS, TGAN, NUCLEAR CRITICALITY SAFETY	DP	360	617
F4	RS	P	T	C \$TEMCO7, TEMPERATURE COEFFICIENT CALCULATION	GGA	1108	320
F4	RS	P	T	C \$TRIDENT, 2D MULTIGP TRANSPORT TRIANGULAR MESH	LASL	7600	741
F4	RS	P	T	C \$TRIPLT, 2-D TRIANGULAR MESH TRANSPORT PROGRAM	LASL	6600	608
F4	RS	P	T	C \$TRIPLT, 2-D TRIANGULAR MESH TRANSPORT PROGRAM	LASL	7600	608
F4	RS	P	T	C \$TWOTRAN-PNVW, 2-D PARTICLE TRANSPORT XY RZ RTH	LASL	7600	573
F4	RS	P	T	C \$TWOTRAN2, 2-D MULTI-GP TRANSPORT XY RZ RTHETA	LASL	6600D	358
F4	RS	P	T	C \$TWOTRAN2, 2-D MULTI-GP TRANSPORT XY RZ RTHETA	LASL	7600D	358
F4	RS	P	T	C \$SVARI-QUIR, TIME-DEP 2-D MULTI-GP DIFFUSION	UMCC	360	212
F4	RS	P	T	C \$SVARI-QUIR, TIME-DEP 2-D MULTI-GP DIFFUSION	WANL	6600	212
F4	RS	P	T	D \$CINCAS, NUCLEAR FUEL CYCLE COST AND ECONOMICS	CWE	360	354
F4	RS	P	T	D \$CINCAS, NUCLEAR FUEL CYCLE COST AND ECONOMICS	WAPD	6670	354
F4	RS	P	T	D \$SCOROPT, OPTIMIZING LMFBR MIXED-OXIDE CORES	FBRD	6000	S752
F4	RS	P	T	D \$FEVER7, 1-D MULTIGROUP DIFFUSION AND DEPLETION	GGA	1108	318
F4	RS	P	T	D \$FUMBLE, FAST REACTOR FUEL BURNUP & MANAGEMENT	NED	635	480
F4	RS	P	T	D \$GAUGE, 2-D FEW-GP HEX GEOM DIFFUSION DEPLETION	GGA	1108	339
F4	RS	P	T	D \$GEOCOST-BC, BINARY CYCLE GEOTHERMAL COST STUDY	BNW	6600	711
F4	RS	P	T	D \$GEOCOST, GEOTHERMAL ENERGY COST ANALYSIS	BNW	6600	684
F4	RS	P	T	D \$PHENIX, 2-D DIFFUSION BURNUP REFUELING HISTORY	LASL	6600	454
F4	RS	P	T	D \$PWOCST, REACTOR FUEL CYCLE COST CALCULATION	GGA	1108	441
F4	RS	P	T	D \$2DB, 2-D MULTIGROUP DIFFUSION AND DEPLETION	BNW	1108	325
F4	RS	P	T	D \$2DB, 2-D MULTIGROUP DIFFUSION AND DEPLETION	LASL	6600	325
F4	RS	P	T	D \$3DB, 3-D MULTIGROUP DIFFUSION BURNUP ANALYSIS	HEDL	1108	567
F4	RS	P	T	D \$3DDT, 3-D MULTIGROUP DIFFUSION XYZ R-THETA-Z	LASL	6600	463
F4	RS	P	T	D \$3DXT, DEP3, 3-D XENON TRANSIENT & DEPLETION	KAPL	6600	R477
F4	RS	P	T	E \$ANCON, SPACE-INDEPENDENT REACTOR KINETICS CODE	ANL	360	486
F4	RS	P	T	E \$ANCON, SPACE-INDEPENDENT REACTOR KINETICS CODE	LASL	6600	486
F4	RS	P	T	F \$ADEP, 1-D & 2-D FEW-GROUP SPACE-TIME KINETICS	BCL	6400	494
F4	RS	P	T	F \$GAKIN2, 10 MULTIGROUP TIME-DEPENDENT DIFFUSION	UFCC	370B	310
F4	RS	P	T	F \$GAKIT, 1-D MULTIGP KINETICS WITH TEMP FEEDBACK	GGA	1108	370
F4	RS	P	T	F \$HEMP, HYDRODYNAMIC ELASTIC MAGNETO PLASTIC	LLL	7600	775
F4	RS	P	T	F \$NOAH, 1-D ONE-GP SPACE-TIME DIFFUSION FEEDBACK	BNL	6600	405
F4	RS	P	T	F \$SAS1A, FAST REACTOR POWER AND FLOW TRANSIENTS	ANL	360	400

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F4	RS	P	T	F	SSAS1A, FAST REACTOR POWER AND FLOW TRANSIENTS	ANL	6600	400
F4	RS	P	T	F	STIMEX, 1-D TIME-DEP MULTIGP DISCRETE ORDINATES	LASL	360	756
F4	RS	P	T	F	STIMEX, 1-D TIME-DEP MULTIGP DISCRETE ORDINATES	LASL	7600	756
F4	RS	P	T	F	STSN, SPATIALLY-DEPENDENT REACTOR KINETICS	AI	360	309
F4	RS	P	T	F	STWIGGLE, 2-D 2-GP SPACE-TIME DIFFUSION	ANL	360	R338
F4	RS	P	T	F	STWIGL, 2-D 2-GP SPACE-TIME DIFFUSION FEEDBACK	BAPL	6600	R338
F4	RS	P	T	F	\$WIGL2, 1-D 2-GP SPACE-TIME DIFFUSION 3-GEOM	BAPL	6600	R274
F4	RS	P	T	F	\$WIGL2, 1-D 2-GP SPACE-TIME DIFFUSION 3-GEOM	GGA	1108	R274
F4	RS	P	T	F	\$WIGL2, 1-D 2-GP SPACE-TIME DIFFUSION 3-GEOM	UFCC	370	R274
F4	RS	P	T	F	\$WIGL3, 1-D SPACE-TIME DIFFUSION W/FEEDBACK	BAPL	6600	R708
F4	RS	P	T	G	\$AISITE2, PARAMETRIC SITE REQUIREMENT STUDY	AI	360	172
F4	RS	P	T	G	\$CACECO, LMFBR CONTAINMENT ACCIDENT ANALYSIS	HEDL	6600	R762
F4	RS	P	T	G	\$CHART, IODINE DECAY HEAT ON CHARCOAL ADSORBERS	ORNL	360	804
F4	RS	P	T	G	\$COMRADEX4, ACCIDENT RELEASED RADIOLOGICAL DOSE	AI	370	663
F4	RS	P	T	G	\$CORRAL2, RADIONUCLIDE CONTAINMENT AFTER LOCA	BCL	6400	745
F4	RS	P	T	G	\$ECCSA4, LOSS-OF-COOLANT & EMERGENCY COOLING	BCL	6400	330
F4	RS	P	T	G	\$EMERALD REV. 1, PWR ACCIDENT ACTIVITY RELEASE	PGE	360	546
F4	RS	P	T	G	\$EMERALD-NORMAL, PWR ACTIVITY RELEASE AND DOSE	PGE	360	685
F4	RS	P	T	G	\$FLASH3, LOSS-OF-COOLANT ACCIDENT ANALYSIS	BAPL	6600	R295
F4	RS	P	T	G	\$FLASH6, FULLY-IMPLICIT TRANSIENT SIMULATION	BAPL	7600	R448
F4	RS	P	T	G	\$FREADM1, FAST REACTOR CORE ACCIDENT ANALYSIS	NED	635	479
F4	RS	P	T	G	\$SHAARM3, AEROSOL BEHAVIOR LOG-NORMAL DIST MODEL	BCL	6400	797
F4	RS	P	T	G	\$HAMOC, FLUID HAMMER ANALYSIS OF PIPING SYSTEM	HEDL	6600	710
F4	RS	P	T	G	\$IMPORTANCE, FTA BASIC EVENT & CUT SET RANKING	ANL	370	779
F4	RS	P	T	G	\$M0555,ACT1, LOSS-OF-COOLANT ACCIDENT ANALYSIS	BAPL	6600	R284
F4	RS	P	T	G	\$NATHAN, FLUID HAMMER ANALYSIS 1D & 2D SYSTEMS	ANL	360	719
F4	RS	P	T	G	\$SNURLOC-1.0, LOSS-OF-COOLANT THERMAL ANALYSIS	BCL	6400	328
F4	RS	P	T	G	\$PREP,KITT, SYSTEM FAULT TREE EVALUATION CODES	EG&G	1108	528
F4	RS	P	T	G	\$PTA1, PIPE SYSTEM PRESSURE ANALYSIS	ANL	370	R761
F4	RS	P	T	G	\$RELAP3B/MOD110, REACTOR SYSTEM TRANSIENT CODE	BNL	7600	733
F4	RS	P	T	G	\$SOMIX1, SODIUM SPRAY FIRES IN CYLINDRICAL CELL	AI	370	R751
F4	RS	P	T	G	\$SWHAM6, LIQUID-FILLED PIPING SYSTEM ANALYSIS	ANL	7600B	278
F4	RS	P	T	H	\$ASTEM, THERMODYNAMIC PROPERTIES WATER & STEAM	BCAC	6600	580
F4	RS	P	T	H	\$BEHAVE-SST, OVERPOWER TRANSIENT FUEL MECHANICS	FBRD	7600	768
F4	RS	P	T	H	\$CHIC-KIN, FAST + INTERMEDIATE POWER TRANSIENTS	BAPL	6600	R473
F4	RS	P	T	H	\$COMPARE-MOD1, TRANSIENT FLOW W/SIKKS & DOORS	LASL	7600	776
F4	RS	P	T	H	\$COMPARE, TRANSIENT FLOW IN VENTED FLUID SYSTEM	LASL	7600	702
F4	RS	P	T	H	\$COMPARE, TRANSIENT FLOW IN VENTED FLUID SYSTEM	NRC	370	702
F4	RS	P	T	H	\$SDYNAM, DYNAMIC ANALYSIS BOILING FLOW STEAM	GGA	1108	440
F4	RS	P	T	H	\$ENERGY, LMFBR COOLANT TEMPERATURE PREDICTION	MIT	370	696
F4	RS	P	T	H	\$EVITS, STEADY STATE TWO-DIMENSIONAL FLUID FLOW	ANL	360	792
F4	RS	P	T	H	\$FIGRO, LWBR FUEL SWELLING TEMPERATURE STUDY	BAPL	6600	R272
F4	RS	P	T	H	\$FLOT1,M0219, PWR FLOW TRANSIENT ANALYSIS	BAPL	6600	R331
F4	RS	P	T	H	\$FLOW3, NETWORK ANALYSIS OF 3-D TWO-PHASE FLOW	BAPL	7600B	R664
F4	RS	P	T	H	\$FRAP-S3, STEADY STATE ANALYSIS OXIDE FUEL RODS	EG&G	7600	694
F4	RS	P	T	H	\$GLUB1, WATER-LOGGED FUEL ELEMENT ANALYSIS	BAPL	6600	R424
F4	RS	P	T	H	\$SHAFMAT, SYSTEM STEADY-STATE FLOW DISTRIBUTION	KAPL	6600	R616
F4	RS	P	T	H	\$SHEATING5, 1, 2, OR 3-D HEAT CONDUCTION PROGRAM	ORNL	360	517
F4	RS	P	T	H	\$SHETRAP, FUEL ROD RESPONSE LOCA EXPERIMENTS	ORNL	360	730
F4	RS	P	T	H	\$SHOT2, 2-D TRANSIENT HEAT CONDUCTION PROGRAM	BAPL	6600	R286
F4	RS	P	T	H	\$SLION4, 3-D TEMPERATURE DISTRIBUTION PROGRAM	CHI	1108A	R299
F4	RS	P	T	H	\$SLION4, 3-D TEMPERATURE DISTRIBUTION PROGRAM	FW	1108B	R299
F4	RS	P	T	H	\$SLOCK, FEW-CHANNEL COOLANT-FLOW BLOCKAGE STUDY	PNC	360	732
F4	RS	P	T	H	\$SMANTA, STEADY-STATE THERMAL-HYDRAULIC ANALYSIS	NED	635	256
F4	RS	P	T	H	\$SMANTA, STEADY-STATE THERMAL-HYDRAULIC ANALYSIS	WARD	6600	256
F4	RS	P	T	H	\$SORCENT, NUCLEAR STEAM TURBINE CYCLE ANALYSIS	ORNL	360B	703
F4	RS	P	T	H	\$SORRIBLE, ROD BUNDLE FLOW & TEMPERATURE DIST.	ORNL	360	629
F4	RS	P	T	H	\$SPACT2, COOLANT & CLADDING TEMPERATURE ANALYSIS	FBRD	7600	S796
F4	RS	P	T	H	\$SREFLUX, LWR REFLOOD HEAT TRANSFER PREDICTION	MIT	360	763
F4	RS	P	T	H	\$SSCHAFF, HEAT & WATER TRANSFER IN POROUS MEDIA	BKY	7600	802
F4	RS	P	T	H	\$STOPS, TRANSIENT THERMODYNAMICS OF PRESSURIZERS	BAPL	6600	R348
F4	RS	P	T	H	\$STVENT, VENTILATION SYSTEM TRANSIENT ANALYSIS	LASL	7600	809
F4	RS	P	T	H	\$SVELVET2, TURBULENT FLOW IN LMFBR ROD BUNDLE	NED	635	458
F4	RS	P	T	H	\$SWASP2, WATER PROPERTIES FOR SAFETY ANALYSIS	BAPL	7600	R396
F4	RS	P	T	I	\$BEAMCRP, FINITE-ELEMENT BEAM CREEP ANALYSIS	HEDL	6600	R701
F4	RS	P	T	I	\$SBUSHL, CYL SHELL BUCKLING COLLAPSE ANALYSIS	BAPL	6600	R481
F4	RS	P	T	I	\$SCOVE1, CREEP COLLAPSE FOR OVAL FUEL PIN TUBE	BNW	6600	817
F4	RS	P	T	I	\$SCYGR03, OXIDE FUEL ROD STRESS & DEFORMATION	BAPL	6600	R449
F4	RS	P	T	I	\$FLANGE-ORNL, ANALYSIS OF FLANGED JOINTS	ORNL	360B	689
F4	RS	P	T	I	\$GAPCON-THERMAL2, FUEL PIN GAP CONDUCTANCE CALC	BNW	6600	618
F4	RS	P	T	I	\$HONDO, A DYNAMIC RESPONSE FINITE-ELEMENT CODE	SLA	6600B	672
F4	RS	P	T	I	\$LIFE3, MIXED-OXIDE FUEL ELEMENT PERFORMANCE	ANL	7600	R460

F4

F4	RS	P	T	I	\$M0457, PIPE, ELASTIC STRESS OF PIPING SYSTEM	BAPL	6600	R329
F4	RS	P	T	I	\$PELEN, FUEL PELLET TEMPERATURE & DEFORMATION	BAPL	6600	R598
F4	RS	P	T	I	\$PIRAX2, SIMPLIFIED INELASTIC PIPING ANALYSIS	BCL	6400	R735
F4	RS	P	T	I	\$SABOR4, DISCRETE-ELEMENT ANALYSIS THIN SHELLS	MIT	360	R402
F4	RS	P	T	I	\$SAFE-PLANE, PLANE STRESS ANALYSIS, 2-D BODIES	BNL	6600	252
F4	RS	P	T	I	\$SAFE-2D, PLANE & AXISYMMETRIC STRESS ANALYSIS	GGA	1108	379
F4	RS	P	T	I	\$SAFE-3D, 3-D COMPOSITE STRUCTURE STRESS STUDY	GGA	1108	332
F4	RS	P	T	I	\$SEALSHL2, SHELL STRESS ANALYSIS AXISYM LOAD	BAPL	6600	R282
F4	RS	P	T	I	\$SEALSHL2, SHELL STRESS ANALYSIS AXISYM LOAD	SR	360	R282
F4	RS	P	T	I	\$SEALSHL2, SHELL STRESS ANALYSIS AXISYM LOAD	WTSC	7600	R282
F4	RS	P	T	I	\$SHOCK, DYNAMIC RESPONSE OF LUMPED-MASS SYSTEMS	SLL	6600	795
F4	RS	P	T	I	\$SLADE-D, DYNAMIC ANALYSIS OF THIN SHELLS	SLA	6600	581
F4	RS	P	T	I	\$SOR3, STRESS ANALYSIS SHELLS OF REVOLUTION	KAPL	6600C	R 80
F4	RS	P	T	J	\$MUSCAT, VIEW FACTOR SHIELDING CODE CAVITY GEOM	GGA	1108	259
F4	RS	P	T	J	\$M0756, LETO, 1-D SLAB GAMMA-RAY TRANSPORT	BAPL	6600	R343
F4	RS	P	T	K	\$CITATION, 1,2,3-D DIFFUSION DEPLETION MULTI-GP	ORNL	3601	387
F4	RS	P	T	K	\$DEMO4, CRBR REACTOR & PLANT TRANSIENT ANALYSIS	WARD	7600	R676
F4	RS	P	T	K	\$SPARK1, NUCLEAR REACTOR POWER PLANT ANALYSIS	BAPL	6600	R743
F4	RS	P	T	K	\$SPARK1, NUCLEAR REACTOR POWER PLANT ANALYSIS	BAPL	7600	R743
F4	RS	P	T	L	\$EURCYL1, CYL-CYL INTERSECTION MESH GENERATOR	WARD	7600	R746
F4	RS	P	T	L	\$QMESH, RENUM, SELF-ORGANIZING MESH GENERATION	SLA	6600	612
F4	RS	P	T	M	\$CRECT, CHECKER, ENDF/B V2 PROCESSING CODES	ANL	360	475
F4	RS	P	T	M	\$SSHLOG, DATA MANAGEMENT, EDITING, & ANALYSIS	BAPL	6600	R557
F4	RS	P	T	M	\$STROUT, MUG MULTIGROUP XSEC LIBRARY MAINTENANCE	NED	635	493
F4	RS	P	T	N	\$PLOT-3D, 3-D PLOTS ON IBM2280 OR CALCOMP780	ANL	360	544
F4	RS	P	T	O	\$BURNUP, HEAVY ELEMENT ISOTOPIC BURNUP ANALYSIS	NED	635	311
F4	RS	P	T	O	\$SEXP, ANALYSIS OF PULSED NEUTRON SOURCE DATA	NED	635	258
F4	RS	P	T	P	\$BESSEL FUNCTIONS, AIRY & LOG GAMMA SUBROUTINES	SLA	6600	656
F4	RS	P	T	P	\$DPOLE, HELMHOLTZ EQUATION ON GENERAL 3D REGION	NYU	6600	816
F4	RS	P	T	P	\$METRICATION, CONVERSION TO OR FROM SI UNITS	RDYN	370B	G668
F4	RS	P	T	P	\$M0661, M0657, M0626, POLYNOMIAL CURVE FITTING	BAPL	6600	R411
F4	RS	P	T	P	\$OCOPTH, DRVOCR, UNCONSTRAINED OPTIMIZATION	ANL	360	753
F4	RS	P	T	P	\$SPEKEN, PEARSON SPEARMAN & KENDALL CORRELATION	ORNL	360	781
F4	RS	P	T	P	\$SUPPORT, SOLUTION OF BOUNDARY-VALUE PROBLEMS	ANL	370B	731
F4	RS	P	T	P	\$SUPPORT, SOLUTION OF BOUNDARY-VALUE PROBLEMS	SLA	6600	731
F4	RS	P	T	Q	\$COREL, RASE4, DAMG2, ION IMPLANTATION DEPOSITION	SLA	6600	758
F4	RS	P	T	Q	\$GROUP2, GROUP THEORY OF LATTICE DYNAMICS	ANL	360	620
F4	RS	P	T	Q	\$GROUP2, GROUP THEORY OF LATTICE DYNAMICS	LASL	6600	620
F4	RS	P	T	R	\$SITE2, ENERGY FACILITY SITING ASSESSMENT	ANL	360	687
F4	RS	P	T	T	\$FFEARS, LAPLACE EQUATION ISOTROPIC DIELECTRICS	SLA	6600B	577
F4	RS	P	T	T	\$TDIST2, COMMUNITY ENERGY CONSUMPTION ANALYSIS	MIT	370	799
F4	RS	P	T	T	\$WFLLL2B, WIRE CONFIGURATION FREQUENCY DOMAIN	LLL	7600	721
F4	RS	P	T	U	\$SEPHIS/MOD4, SOLVENT EXTRACTION SIMULATION	ORNL	360	R690
F4	RS	P	T	V	\$SLACKLY, 1D MULTICAVITY KLYSTRON TUBE ANALYSIS	SLAC	360	807
F4	RS	P	T	V	\$TRANSPORT, DESIGN OF CHARGED PARTICLE BEAMS	SLAC	370	791
F4	RS	P	T	X	\$STEPE4, THERMONUCLEAR REACTION RATES	LASL	7600	749
F4	RS	P	C	C	\$TRIAL, 3-D REACTION RATES FROM 2-D FLUX SETS	FBRD	6000	585
F4	RS	P	C	G	\$STEFEG, ANALYSIS OF PWR & BWR GASEOUS RELEASE	ORNL	360	583
F4	RS	P	C	H	\$FLAC, STEADY-STATE FLOW, PRESSURE DISTRIBUTION	A&TS	370	395
F4	RS	P	C	I	\$PSA2, STRESS ANALYSIS MULTIANCHOR PIPE SYSTEM	AI	360	542
F4	RS	P	C	P	\$SLIDES, FOR DISSPLA-LETTERED SLIDES & POSTERS	ANL	370	728
F4	RS	P	C	Q	\$ISOTAB, PU POWER OUTPUT FROM MIXED ISOTOPES	MLMO	360B	R619
F4	RS	P	CT	A	\$ALVIN, DIFFERENTIAL-INTEGRAL DATA CONSISTENCY	LASL	7600	815
F4	RS	P	CT	A	\$JUPITOR1, COUPLED CHANNEL X-SEC EVALUATION	ENEA	360	308
F4	RS	P	CT	C	\$FLARE, 3-D REACTIVITY AND POWER DISTRIBUTION	MSS	360	167
F4	RS	P	CT	D	\$GEM, ANALYSIS OF NUCLEAR FUEL CYCLE ECONOMICS	UICS	360	576
F4	RS	P	CT	D	\$NUFUEL, NUCLEAR FUEL CYCLE REQUIREMENTS	ERDA	370C	683
F4	RS	P	CT	D	\$OPUS, POWER PLANT PERFORMANCE AND PRICE STUDY	GGA	1108	226
F4	RS	P	CT	D	\$SAGE-WASP, OPTIMAL ELECTRIC UTILITY EXPANSION	TVA	370	S744
F4	RS	P	CT	D	\$3DB, 3-D MULTIGROUP DIFFUSION BURNUP ANALYSIS	ANL	360	567
F4	RS	P	CT	F	\$MELT3, FAST REACTOR TRANSIENT OVERPOWER STUDY	HEDL	6600	700
F4	RS	P	CT	F	\$REXCO-H, 2-D HYDRODYNAM RESPONSE TO EXCURSION	ANL	360	550
F4	RS	P	CT	F	\$REXCO-H2, 2-D HYDRODYNAM RESPONSE TO EXCURSION	ANL	360	R615
F4	RS	P	CT	H	\$LION4, 3-D TEMPERATURE DISTRIBUTION PROGRAM	FW	360	R299
F4	RS	P	CT	H	\$THI3D, THERMAL-HYDRAULIC MULTICHANNEL ANALYSIS	ANL	370	706
F4	RS	P	CT	I	\$SAXICRP, FINITE ELEMENT CODE FOR CREEP ANALYSIS	HEDL	6600	785
F4	RS	P	CT	I	\$BEHAVE2, OXIDE FUEL PERFORMANCE FINITE-ELEMENT	FBRD	635	R568
F4	RS	P	CT	I	\$CORTES, THERMAL & MECHANICAL ANALYSIS OF TEES	ORNL	360B	759
F4	RS	P	CT	I	\$LIFE3, MIXED-OXIDE FUEL ELEMENT PERFORMANCE	ANL	370	R460
F4	RS	P	CT	I	\$PLACRE, FEM INELASTIC STRUCTURAL ANALYSIS	ORNL	360	R740
F4	RS	P	CT	I	\$SAP4, STRUCTURAL ANALYSIS OF LINEAR SYSTEMS	ANL	370D	641
F4	RS	P	CT	L	\$QMESH, RENUM, SELF-ORGANIZING MESH GENERATION	ANL	360	612

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F4	RS P CT M	SLASIP3, CCCC STANDARD INTERFACE FILE PROCESSOR	LASL	360	691
F4	RS P CT M	SSKILLS INVENTORY, PERSONNEL INFORMATION SYSTEM	H&N	6400	801
F4	RS P CT N	SGRPAK, PLOT PACKAGE FOR CORTES FEM PROGRAMS	ORNL	360	760
F4	RS P CT N	SPRPLOT, LINE PRINTER PLOT SUBROUTINE PACKAGE	ACRC	370	773
F4	RS P CT P	SDRAFTMAN, DRAW FIGURES & GRAPHS WITH DISSPLA	ANL	360	748
F4	RS P CT P	SFORSIM, SOLN OF PARTIAL OR ORDINARY DIFF EQNS	CRNL	6600B	514
F4	RS P CT P	\$2DEPEP, ELLIPTIC PARABOLIC & EIGENVALUE SOLNS.	PURD	6500	806
F4	RS P CT T	SFFEARS, LAPLACE EQUATION ISOTROPIC DIELECTRICS	ANL	360	577
F4	RS P CT W	SMACS LATTICE VIBRATION NEUTRON SCATTERING CODES	EG&G	360	574
F4	RS P CT W	SMSCAT, SLOW NEUTRON MULTIPLE SCATTERING CALC	ANL	360	575
F4	RS P X A	SCOHBE, COHERENT INELASTIC SCATTERING LAW CALC	GGA	1108	385
F4	RS P X G	\$BUKST1, HYDRODYNAMIC ANALYSIS DURING BLOWDOWN	PPCO	360	435
F4	RS P X I	SFINE_, FINITE-ELEMENT STUDY 2,3-D STRUCTURES	KAPL	6600	R404
F4	RS P X P	SGEAR, ORDINARY DIFFERENTIAL EQN SYSTEM SOLVER	ANL	360C	592
F4	RS P X P	SGEAR, ORDINARY DIFFERENTIAL EQN SYSTEM SOLVER	LLL	6600C	592
F4	RS P X R	SMOBY, MOBILE HOME HEATING & COOLING ENERGY USE	ORNL	360	724
F4	RS P X T B	\$ETOX3, MULTI-GP CONSTANTS FROM ENDF/B FOR 1DX	HEDL	1108B	388
F4	RS P X T B	\$GAF, GAR, SPECTRA AND GROUP-AVERAGED X-SEC CALC	GGA	1108	316
F4	RS P X T B	\$1DX, 1-D DIFFUSION FAST X-SECTION GENERATION	BNW	1108	374
F4	RS P X T C	\$HFN, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	BNW	6600	241
F4	RS P X T E	\$MOD5, STOCHASTIC MODEL OF NEUTRON SLOWING-DOWN	NPGS	360	491
F4	RS P X T F	\$CEXE, INCEXE, 1-GP 3-D XYZ XENON OSCILLATION	CEND	360	415
F4	RS P X T F	\$FORE2, FAST REACTOR EXCURSION CALCULATIONS	ANL	360	174
F4	RS P X T F	\$FORE2, FAST REACTOR EXCURSION CALCULATIONS	NED	635	174
F4	RS P X T G	\$MIRAB, MIRAP, CONTAINMENT SYSTEM IODINE REMOVAL	BCL	6400B	499
F4	RS P X T G	\$MUCHA1, MUCHA2, MULTIPLE CHANNEL ANALYSIS ECC	BCL	6400	508
F4	RS P X T H	\$ASTEM, THERMODYNAMIC PROPERTIES WATER & STEAM	EG-D	360B	580
F4	RS P X T H	\$K-FIX, TRANSIENT 2-DIMENSIONAL 2-FLUID FLOW	LASL	7600	727
F4	RS P X T H	\$ORTHIS, ORTHAT, 2-DIMENSIONAL HEAT CONDUCTION	ORNL	360	525
F4	RS P X T I	\$GAPCON-THERMAL3, FUEL SS & TRANSIENT BEHAVIOR	BNW	6600	770
F4	RS P X T K	\$DSNP, DYNAMIC SIMULATION NUCLEAR POWER PLANTS	ANL	370	784
F4	RS P X T L	\$GAND, GAFGAR X-SECTION LIBRARY PREPARATION	GGA	1108	345
F4	RS P X T P	\$DE/STEP, INTRP, SOLN OF ORDINARY DIFF EQUATIONS	SLA	360D	640
F4	RS P X T P	\$DE/STEP, INTRP, SOLN OF ORDINARY DIFF EQUATIONS	SLA	6600D	640
F4	RS P X T P	\$EISPACK2, MATRIX EIGENVALUE/VECTOR PACKAGE	ANL	PD10B	534
F4	RS P X T P	\$EISPACK2, MATRIX EIGENVALUE/VECTOR PACKAGE	ANL	1110B	534
F4	RS P X T P	\$EISPACK2, MATRIX EIGENVALUE/VECTOR PACKAGE	ANL	6600B	534
F4	RS P X T P	\$EISPACK2, MATRIX EIGENVALUE/VECTOR PACKAGE	ANL	6700B	534
F4	RS P X T P	\$EPIODE, ORDINARY DIFF EQUATION SYSTEM SOLVER	LLL	360	675
F4	RS P X T P	\$EPIODEB, SOLVE ODE SYST WITH BANDED JACOBIAN	LLL	360	705
F4	RS P X T P	\$GEARB, SOLVE ODE SYSTEM WITH BANDED JACOBIAN	LLL	360C	661
F4	RS P X T P	\$GEARB, SOLVE ODE SYSTEM WITH BANDED JACOBIAN	LLL	6600C	661
F4	RS P X T P	\$LINPACK, SIMULTANEOUS LINEAR ALGEBRAIC EQUATNS	ANL	370	800
F4	RS P X T U	\$RICE-LASL, CHEMICALLY REACTIVE MIXTURE FLOW	LASL	6600	720
F4	RS P XC P	\$MTRC0001, SI METRIC TO U.S. CUSTOMARY UNITS	MLMO	360	812
F4	RS P XCT B	\$FLANGE2(71-1), ENDF/B THERMAL SCATTERING DATA	DP	360B	368
F4	RS P XCT C	\$GAPER1D, 1-D TRANSPORT PERTURBATION THEORY	GGA	1108	606
F4	RS P XCT D	\$CONCEPT3, POWER PLANT CONCEPTUAL COST ESTIMATE	GGA	1108	498
F4	RS P XCT E	\$TASK, 1-D MULTIGROUP REACTOR KINETICS PROGRAM	ORNL	360	558
F4	RS P XCT F	\$VENUS, 2-D LMFBR POWER EXCURSION DISASSEMBLY	ANL	360	511
F4	RS P XCT G	\$FRANTIC-NRC, TIME SYSTEM UNAVAILABILITY	NRC	370	766
F4	RS P XCT H	\$COBRA41, ROD BUNDLE & CORE THERMAL-HYDRAULICS	BNW	7600D	432
F4	RS PL T B	\$ETOG1, ENDF/B TO MUFT, GAM, ANISN X-SEC FORMAT	WAPD	6600	437
F4	RS PL T B	\$GAMTEC2, MULTI-GP CONSTANT CALC 0 TO 10 MEV	BNW	1107	185
F4	RS PL T B	\$STEMPEST2, THERMAL NEUTRON SPECTRUM X-SECTIONS	BHSC	360	50
F4	RS PL T C	\$BISYN, 2-D MULTI-GP DIFFUSION SYNTHESIS CALC	NED	635	287
F4	RS PL T M	\$EDITOR, ENDF/B TAPE PROCESSING AND EDITING	ORNL	6600	502
F4	RS PL T R	\$SOLSYS, SOLAR ENERGY SYSTEM SIMULATION PROGRAM	SLA	6600B	692
F4	RS PL C G	\$CURIE, FISSION PRODUCT INVENTORY DECAY HISTORY	ANL	370	196
F4	RS PL CT B	\$INCITE, THERMAL SPECTRA & MULTI-GP CONSTANTS	EG&G	360	565
F4	RS PL CT C	\$AIM6, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	OSUC	370	29
F4	RS PL CT F	\$QX1, QUASISTATIC SPATIAL REACTOR KINETICS CODE	ANL	360	474
F4	RS PL CT M	\$EDITOR, ENDF/B TAPE PROCESSING AND EDITING	ORNL	360B	502
F4	RS PL CT P	\$ERRST, LOCA ROD BUNDLE CHF DATA ANALYSIS	EG&G	360	518
F4	RS PLX T B	\$AILMOE, X-SECTION CALC ELASTIC SCAT RESONANCES	AI	360	147
F4	RS PLX T B	\$GAMTEC2, MULTI-GP CONSTANT CALC 0 TO 10 MEV	BC	625	185
F4	RS PLX T B	\$GAMTEC2, MULTI-GP CONSTANT CALC 0 TO 10 MEV	UVAC	6400	185
F4	RS PLX T B	\$HRG3, SLOWING-DOWN SPECTRUM, MULTIGP CONSTANTS	BNW	1108	467
F4	RS PLX T B	\$HRG3, SLOWING-DOWN SPECTRUM, MULTIGP CONSTANTS	TVA	360	467
F4	RS PLX T C	\$MACH1, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	PURD	6500	262
F4	RS PLX T C	\$VIM1, MONTE CARLO CRITICAL ASSEMBLY ANALYSIS	AI	7600	510
F4	RS PLX T G	\$CRAC, CALC OF REACTOR ACCIDENT CONSEQUENCES	NRC	370	722

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F4	RS	PLXCT	B	SFORM, FAST NEUTRON SPECTRUM X-SECTION CALC	OSUC	370	51
F4	RS	PLXCT	B	\$GGC4, MULTI-GP X-SECTIONS FAST THERMAL SPECTRA	GGA	1108B	298
F4	RS	PLXCT	B	\$LEOPARD, SPOTS, SPECTRUM CALC WITH DEPLETION	WAPD	360C	279
F4	RS	PLXCT	B	\$PHROG, MULTI-GP CONSTANT & FAST SPECTRA CALC	EG&G	360	520
F4	RSB	L	T	\$CLIP, FORM OR THREDES LIBRARY UTILITY ROUTINE	AI	360	271
F4	RSBP		D	\$CHAINS, ANALYSIS OF RADIOACTIVE DECAY CHAINS	GEC	635	418
F4	RSBP		D	\$DOS, NEUTRON FLUX-DOSIMETER ACTIVITY RELATION	GEC	635	423
F4	RSBF		O	\$MICHROD, MICROHARDNESS MEASUREMENT ANALYSIS	GEC	635	421
F4	RSBP		P	\$GRAPH, LINEAR REGRESSION W/CONFIDENCE LIMITS	BKC	360	624
F4	RSBP		P	\$HISTOGRAMS, QUALITY CONTROL SAMPLE STATISTICS	BKG	360	614
F4	RSBP		Q	\$XDTRAP, HYDROGEN PERMEATION WITH TRAPPING	DP	360	655
F4	RSBP	T	B	\$GROUSE, SPACE-DEPENDENT X-SECTION GENERATION	GEC	635	420
F4	RSBP	T	K	\$THREDES, 1-D FEW-GP DIFFUSION DESIGN SYSTEM	AI	360	273
F4	RSBP	C	P	\$LATIN SQ, NXN LATIN SQUARE EXPERIMENTAL DESIGN	MLMO	360	630
F4	RSBP	CT	C	\$ARC-DIF1D, 1-D MULTI-GP DIFFUSION & INVENTORY	ANL	360	626
F4	RSBP	CT	C	\$HERESY3, 2-D HETEROGENEOUS REACTOR CALCULATION	DP	360B	136
F4	RSBP	CT	C	\$MONA, 1-D MULTIGROUP DIFFUSION SLAB, CYL, SPH	EG&G	360	582
F4	RSBP	CT	C	\$TRIPLT, 2-D TRIANGULAR MESH TRANSPORT PROGRAM	LASL	360	608
F4	RSBP	CT	C	\$TWOTRAN2, 2-D MULTI-GP TRANSPORT XY RZ RTHETA	LASL	360D	358
F4	RSBP	CT	D	\$DWARF, 1-D FEW-GP DIFFUSION DEPLETION PROGRAM	EG&G	360	579
F4	RSBP	CT	G	\$FLASH4, FULLY-IMPLICIT TRANSIENT SIMULATION	MA-G	360	R448
F4	RSBP	CT	G	\$PPFM, STEADY-STATE FISSION PRODUCT FUEL MODEL	EG&G	360	584
F4	RSBP	CT	G	\$MOCUS, MINIMAL SETS FROM FAULT TREES	EG&G	360	653
F4	RSBP	CT	G	\$PREP,KITT, SYSTEM FAULT TREE EVALUATION CODES	EG&G	360	528
F4	RSBP	CT	G	\$RSAC, RADIOLOGICAL SAFETY ANALYSIS PROGRAM	EG&G	360B	265
F4	RSBP	CT	G	\$WREM-TOODEE2/MOD3, 2D TIME-DEP FUEL ELEM STUDY	NRC	370	712
F4	RSBP	CT	H	\$COBRA3M, FUEL PIN THERMAL-HYDRAULIC ANALYSIS	ANL	360B	659
F4	RSBP	CT	I	\$CYGR03, OXIDE FUEL ROD STRESS & DEFORMATION	AN-T	360B	R449
F4	RSBP	CT	I	\$STRAP, STATIC & DYNAMIC STRUCTURAL ANALYSIS	EG&G	360	539
F4	RSBP	CT	J	\$VIEWPIN, VIEW FACTOR CALC FOR CYLINDRICAL PINS	EG&G	360	569
F4	RSBP	CT	L	\$ARC-NUI002, BCD INPUT DATA PROCESSING MODULE	ANL	360	533
F4	RSBP	X	T	\$SIZZLE, 1-D MULTIGROUP DIFFUSION DEPLETION	AI	360	58
F4	RSBP	X	T	\$THETA1-B, FUEL ROD THERMAL RESPONSE LOCA	EG&G	360	512
F4	RSBP	XCT	B	\$ETOX3, MULTI-GP CONSTANTS FROM ENDF/B FOR 1DX	HEDL	360	388
F4	RSBP	XCT	G	\$FRAP-T3, TRANSIENT ANALYSIS OF OXIDE FUEL RODS	EG&G	7600	658
F4	RSBP	XCT	H	\$MOXY/MOD032, BWR CORE HEAT TRANSFER CODE	EG&G	360B	551
F4	RSBP	XCT	P	\$EISPACK2, MATRIX EIGENVALUE/VECTOR PACKAGE	ANL	360B	534
F4	RSBP	XCT	P	\$MORTRAN2, MACRO-BASED STRUCTURED FORTRAN	SLAC	360	678
F4	RSBP	XCT	U	\$GAUSS5, ANALYSIS OF GAMMA-RAY SPECTRA GE(LI)	EG&G	360	605
F4	RSBPL	CT	C	\$VARI-1D, 1-D VARIATIONAL SENSITIVITY	ANL	360	625
F4	RSBPL	CT	L	\$ARC-XSEC1, MICROSCOPIC X-SECTION MANIPULATION	ANL	360	594
F4	RSBPLX	T	C	\$CAESAR4,LIBLST, 1-D MULTI-GP DIFFUSION & LIB.	AI	360	270
F4	RSBPLXCT	B		\$LASER, SPECTRUM CALC WITH BURNUP CYL LATTICE	TVA	360B	249
F4	RSBPLXCT	C		\$MACHI, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	MTS	360	262
F4	RSBPLXCT	C		\$VIMIX, MONTE CARLO CRITICAL ASSEMBLY ANALYSIS	AI-A	360	510
F5	S	P	X	\$FUNPACK2, SPECIAL FUNCTION ROUTINES	ANL	1108B	610
F5	RS	P	A	\$FLANGE1, SCATTERING LAW X-SECTION CALCULATION	GGA	1108	247
F5	RS	P	D	\$ISOTOPES, MAXIMUM YIELD FROM REACTION OR DECAY	LMSC	1100	179
F5	RS	P	H	\$FLAC, STEADY-STATE FLOW, PRESSURE DISTRIBUTION	GGA	1108	395
F5	RS	P	T	\$ENDFB2,GAND2,GFE2, ENDF/B TO GAFGAR X-SECTIONS	GGA	1108	596
F5	RS	P	T	\$2DF, 2-D MULTI-GP DISCRETE ORDINATE CODE	GGA	1108	173
F5	RS	P	T	\$DBUFIT1, LEAST SQUARES TRANSMUTATION ANALYSIS	BNW	1108	456
F5	RS	P	T	\$TAC2D, STEADY-STATE AND TRANSIENT TEMP CALC	GGA	1108	408
F5	RS	P	T	\$TAC3D, TRANSIENT 3-D HEAT TRANSFER PROGRAM	GGA	1108	414
F5	RS	P	T	\$SAFE-CRACK, VISCOELASTIC ANALYSIS OF CONCRETE	GGA	1108	451
F5	RS	P	T	\$SHELL5, THIN SHELL 3-D STRUCTURAL ANALYSIS	GGA	1108	452
F5	RS	P	T	\$TROUT, MUG MULTIGROUP XSEC LIBRARY MAINTENANCE	NED	1108	493
F5	RS	P	T	\$GAPER2D, 2-D PERTURBATION CALC FROM 2DF OUTPUT	GGA	1108	471
F5	RS	P	T	\$SCAGE,BIRD,SPEC, TIME-OF-FLIGHT DATA ANALYSIS	GGA	1108	476
F5	RS	P	T	\$STOPLYR2, POWER PLANT THERMAL DISCHARGE STUDY	HEDL	1108	599
F5	RS	P	CT	\$FSDP3, POINTWISE XSECS. FROM B-W PARAMETERS	GGA	1108	216
F5	RS	P	CT	\$REPP, THERMAL-HYDRAULIC WATER REACTOR DESIGN	BNW	1108	483
F5	RS	P	X	\$PACTOLUS,CLOTHO, NUCLEAR POWER PLANT COST CODE	HEDL	1108	540
F5	RS	P	X	\$NOISY1, AUTO- AND CROSS-SPECTRAL DENSITIES	BNW	1108	488
F5	RS	PLX	T	\$SBRT1, THERMAL SPECTRUM X-SECTION CALC	BNW	1108	184
F5	RS	PLX	T	\$LEOPARD, SPOTS, SPECTRUM CALC WITH DEPLETION	JNC	1108B	279
F5	RSBPL	T	D	\$ISOGEN, RADIONUCLIDE GENERATION AND DECAY	BNW	1108	367
G-Z	ANL	360B	F+P+A	RS T P \$AMDLIBGZ, ARGONNE SUBROUTINE LIBRARY CAT.			544
GADOSE,DOSET, HTGR ACCIDENT ANALYSIS DOSE CALC	GGA	1108	F4	RS T G \$			261
GAF,GAR, SPECTRA AND GROUP-AVERAGED X-SEC CALC	GGA	1108	F4	RS P X T B \$			316
GAFFE, EQUILIBRIUM FUEL CYCLE CALCULATION	GGA	1108	F4	S T D \$			302
GAFGAR ENDF/B DATA TAPES	GGA	1108	81N	R L T Z \$ZPR-III ASSEMBLY 48			356

GAFGAR

GEOCOST-BC

GAFGAR X-SECTION LIBRARY PREPARATION	GGA	1108	F4	RS P X T L	\$GAND,	345
GAFGAR X-SECTIONS	GGA	1108	F5	RS P T B	\$ENDFB2, GAND2, GFE2, ENDF/B TO	596
GAKER, INELASTIC SCAT X-SECTION CALC MODERATOR	GGA	1108	F4	RS P	A \$	289
GAKIN2, 10 MULTIGROUP TIME-DEPENDENT DIFFUSION	UFCC	370B	F4	RS P T F	\$	310
GAKIT, 1-D MULTIGP KINETICS WITH TEMP FEEDBACK	GGA	1108	F4	RS P T F	\$	370
GAM, ANISN X-SEC FORMAT WAPD 6600	F4	RS	PL T B	\$ETOG1, ENDF/B TO MUFT,	437	
GAM, ANISN X-SEC FORMAT WAPD 7600	F4	RS	P T B	\$ETOG3, ENDF/B TO MUFT,	338	
GAMBLE5, 2-D MULTI-GP DIFFUSION XY RZ GEOMETRY	GGA	1108	F+BAL	RS P T C	\$	222
GAMBIT, X-SEC GENERATION FOR TRANSPORT CODES	WANL	6600	F4	RS L T B	\$	547
GAMMA DOSE INTEGRALS	DP	360	F4	RS P	G \$EGAD, CALC OF EXTERNAL	600
GAMMA SUBROUTINES	SLA	6600	F4	RS P T P	\$BESSEL FUNCTIONS, AIRY & LOG	656
GAMMA-RAY CATALOG	DP	360B	EBCDC	R L T Z	\$GAMTAB, RADIOACTIVE-DECAY	637
GAMMA-RAY DOSE RATE FROM A CLOUD	DP	360	F4	RS P	G \$CLOUD,	47
GAMMA-RAY SOURCE BUILDUP FACTOR CALC	BAPL	6600	F+ASC	RS P T J	\$ASPI5,	R429
GAMMA-RAY SPECTRA	ORNL	360	F4	RS P	O \$ALPHA-M, RESOLUTION OF	413
GAMMA-RAY SPECTRA	EG&G	360	F+P+A	RSBP XCT W	\$GAUSS6, BATCH ANALYSIS OF	622
GAMMA-RAY SPECTRA	GGA	1108	F+BAL	RS P T O	\$TOAD, PROCESSING OF ANALYZER	333
GAMMA-RAY SPECTRA	KSUN	360	F4	RS P	O \$CORGM, UNFOLDING OF COMPLEX	390
GAMMA-RAY SPECTRA ANALYSIS	KAPL	6600	F4	RS T O	\$GASPAN, COMPLEX	R485
GAMMA-RAY SPECTRA GE(LI)	EG&G	360	F4	RSBP XCT U	\$GAUSS5, ANALYSIS OF	605
GAMMA-RAY TRANSPORT	BAPL	6600	F4	RS P T J	\$M0756, LETO, 1-D SLAB	R343
GAMTAB, RADIOACTIVE-DECAY GAMMA-RAY CATALOG	DP	360B	EBCDC	R L T Z	\$	637
GAMTEC2, MULTI-GP CONSTANT CALC 0 TO 10 MEV	BC	525	F4	RS PLX T B	\$	185
GAMTEC2, MULTI-GP CONSTANT CALC 0 TO 10 MEV	BNW	1107	F4	RS PL T B	\$	185
GAMTEC2, MULTI-GP CONSTANT CALC 0 TO 10 MEV	UVAC	6400	F4	RS PLX T B	\$	185
GAMTRI, 2-D MULTI-GP DIFFUSION TRIANGULAR MESH	GGA	1108	F+BAL	RS P T C	\$	401
GAM1 OR 2	WAPD	6600	BCD	R L T Z	\$ETOG1 DATA LIBRARIES, MUFT4 OR 5,	447
GAND, GAFGAR X-SECTION LIBRARY PREPARATION	GGA	1108	F4	RS P X T L	\$	345
GANDY3, UNRESOLVED RESONANCE X-SECTION CALC	GGA	1108B	F4	RS P	A \$	341
GAND2, GFE2, ENDF/B TO GAFGAR X-SECTIONS	GGA	1108	F5	RS P T B	\$ENDFB2,	596
GAP CONDUCTANCE CALC	BNW	6600	F4	RS P T I	\$GAPCON-THERMAL2, FUELPIN	618
GAPCON-THERMAL2, FUELPIN GAP CONDUCTANCE CALC	BNW	6600	F4	RS P T I	\$	618
GAPCON-THERMAL3, FUEL SS & TRANSIENT BEHAVIOR	BNW	6600	F4	RS P X T I	\$	770
GAPER1D, 1-D TRANSPORT PERTURBATION THEORY	GGA	1108	F4	RS P XCT C	\$	606
GAPER2D, 2-D PERTURBATION CALC FROM 2DF OUTPUT	GGA	1108	F5	RS P T N	\$	471
GAPL3, INELASTIC LARGE DEFLECTION STRESS STUDY	BAPL	6600	F+CCM	RS P T I	\$	R397
GAPOTKIN, SPACE-INDEPENDENT REACTOR KINETICS	GGA	1108	F4	RS P	E \$	317
GAR, SPECTRA AND GROUP-AVERAGED X-SEC CALC	GGA	1108	F4	RS P X T B	\$GAF,	316
GAS RELEASE SIMULATION	BAPL	6600	F4	RS P	I \$BUBL1, FUEL SWELLING &	R468
GASA, STABILITY ANALYSIS REACTOR KINETICS EQNS	GGA	1108	F4	RS P	E \$	290
GASEOUS RELEASE	ORNL	360	F4	RS P C	G \$STEFEG, ANALYSIS OF PWR & BWR	583
GASES BY MASS SPECTROMETRY RFD	360	F4	RS P	U	\$DYNAMIC ANALYSIS OF	645
GASKET, THERMAL SCATTERING LAW CALCULATION	GGA	1108	F4	RS P	A \$	263
GASPAN, COMPLEX GAMMA-RAY SPECTRA ANALYSIS	KAPL	6600	F4	RS	T O \$	R485
GASP7, 1-D BURNUP POWER DISTRIBUTION SEARCH	GGA	1108	F4	RS P T C	\$	319
GATT, 3-D FEW-GP DIFFUSION CALC HEX-Z MESH	GGA	1108	F4	RS P T C	\$	380
GAUGE, 2-D FEW-GP HEX GEOM DIFFUSION DEPLETION	GGA	1108	F4	RS P T D	\$	339
GAUSS5, ANALYSIS OF GAMMA-RAY SPECTRA GE(LI)	EG&G	360	F4	RSBP XCT U	\$	605
GAUSS6, BATCH ANALYSIS OF GAMMA-RAY SPECTRA	EG&G	360	F+P+A	RSBP XCT W	\$	622
GAZE2, 1-D MULTIGROUP DIFFUSION SLAB, SPH, CYL	GGA	1108	F+BAL	RS P T C	\$	430
GE(LI)	EG&G	360	F4	RSBP XCT U	\$GAUSS5, ANALYSIS OF GAMMA-RAY SPECTRA	605
GEAR, ORDINARY DIFFERENTIAL EQN SYSTEM SOLVER	ANL	360C	F4	RS P X	P \$	592
GEAR, ORDINARY DIFFERENTIAL EQN SYSTEM SOLVER	LLL	6600C	F4	RS P X	P \$	592
GEARB, SOLVE ODE SYSTEM WITH BANDED JACOBIAN	LLL	360C	F4	RS P X T P	\$	661
GEARB, SOLVE ODE SYSTEM WITH BANDED JACOBIAN	LLL	6600C	F4	RS P X T P	\$	661
GEC 625	F4	RS P	B	\$AVOID, ANNULAR VOID X-SECTION CALCULATION	276	
GEC 635	F4	RSBP	D	\$CHAINS, ANALYSIS OF RADIOACTIVE DECAY CHAINS	418	
GEC 635	F4	RSBP	D	\$DOS, NEUTRON FLUX-DOSIMETER ACTIVITY RELATION	423	
GEC 635	F4	RSBP	O	\$MICHRD, MICROHARDNESS MEASUREMENT ANALYSIS	421	
GEC 635	F4	RSBP	T B	\$GROUSE, SPACE-DEPENDENT X-SECTION GENERATION	420	
GEM, ANALYSIS OF NUCLEAR FUEL CYCLE ECONOMICS	UICS	360	F4	RS P CT D	\$	576
GEM, EIGENVALUE PROBLEM FOR VIBRATING SYSTEMS	KAPL	6600	F+ASC	RS P T I	\$	R344
GEN KAPL 6600B	F+C	RS P	T L	\$DATATRAN2, RADI GEOMETRY MODULES 2-D INPUT	406	
GENED ENVIRONMENTAL ROUTINES, SUBROUTINE LIB.	NED	635	F+GMP	RS T P	\$	515
GENERATOR	ANL	360	F4	RS P	T \$F0355, SHAPER CUTTER CONTOUR	697
GENERATOR	BKC	6600	F4	RS P	T \$F0355, SHAPER CUTTER CONTOUR	697
GENERATOR	LLL	7600	F	RS P T N	\$ZONE, 2-D FINITE ELEMENT MESH	765
GENERATOR	WARD	7600	F4	RS P T L	\$EURCYL1, CYL-CYL INTERSECTION MESH	R746
GENERATOR SODIUM-WATER REACTION	CEND	7600	F4	RS P	G \$CEBUG, STEAM	548
GENRD, FREE-FORMAT CARD INPUT PROCESSOR	LASL	360	F4	RS P	L \$	530
GENRD, FREE-FORMAT CARD INPUT PROCESSOR	LASL	6600	F4	RS P	L \$	530
GEOCOST-BC, BINARY CYCLE GEOTHERMAL COST STUDY	BNW	6600	F4	RS P T D	\$	711

GEOCOST

GRAMP

GEOCOST, GEOTHERMAL ENERGY COST ANALYSIS	BNW	6600	F4	RS P	T D	\$	684
GEOMETRICAL DATA HEAT TRANSFER STUDY SLL	6600	F4	RS P	N	SHEATMESH,		434
GEOTHERMAL COST STUDY BNW	6600	F4	RS P	T D	\$GEOCOST-BC, BINARY CYCLE		711
GEOTHERMAL ENERGY COST ANALYSIS	BNW	6600	F4	RS P	T D	\$GEOCOST,	684
GEPI GETS BASIC R	M	SMAPPER, PREDICTING MANUFACTURING REQUIREMENTS					595
GETCOR,FRECOR, FORTRAN DYNAMIC STORAGE ALLOC	ORNL	360	BAL+F	RS P	C P	\$	644
GETS BASIC R	M	SMAPPER, PREDICTING MANUFACTURING REQUIREMENTS	GEPI				595
GETS F R	R	\$PLETHS, ISOPLETH-AREA CALC FROM SINGLE SOURCE	ANL				591
GFE2, ENDF/B TO GAFGAR X-SECTIONS	GGA	1108	F5	RS P	T B	\$ENDFB2,GAND2,	596
GGA 1108 BIN R L T Z	\$ZPR-III ASSEMBLY 48 GAFGAR ENDF/B DATA TAPES						356
GGA 1108 F+BAL RS P T C	\$GAMBLES, 2-D MULTI-GP DIFFUSION XY RZ GEOMETRY						222
GGA 1108 F+BAL RS P T C	\$GAMTRI, 2-D MULTI-GP DIFFUSION TRIANGULAR MESH						401
GGA 1108 F+BAL RS P T C	\$GAZE2, 1-D MULTIGROUP DIFFUSION SLAB, SPH, CYL						430
GGA 1108 F+BAL RS P T D	\$BUGTRI, 2D MULTIGP DIFFUSION & BURNUP TRI-MESH						439
GGA 1108 F+BAL RS P T D	\$BUG2, 2-D MULTIGROUP DIFFUSION & BURNUP XY, RZ						438
GGA 1108 F+BAL RS P T E	\$BLOOST6, COMBINED KINETICS 2-D HEAT TRANSFER						303
GGA 1108 F+BAL RS P T O	\$TOAD, PROCESSING OF ANALYZER GAMMA-RAY SPECTRA						333
GGA 1108 F4 S T D	\$GAFFE, EQUILIBRIUM FUEL CYCLE CALCULATION						302
GGA 1108 F4 RS B	\$HEXSCAT, ELASTIC SCAT X-SECTIONS HEX LATTICE						291
GGA 1108 F4 RS T G	\$GADOSE,DOSET, HTGR ACCIDENT ANALYSIS DOSE CALC						261
GGA 1108 F4 RS P A	\$GAKER, INELASTIC SCAT X-SECTION CALC MODERATOR						289
GGA 1108 F4 RS P A	\$GASKET, THERMAL SCATTERING LAW CALCULATION						263
GGA 1108 F4 RS P A	\$PSEUDO, STATISTICAL RESONANCE PARAMETER CALC						292
GGA 1108 F4 RS P D	\$FREVP6, HTGR METALLIC FISSION PRODUCT RELEASE						301
GGA 1108 F4 RS P E	\$GAPOTKIN, SPACE-INDEPENDENT REACTOR KINETICS						317
GGA 1108 F4 RS P E	\$GASA, STABILITY ANALYSIS REACTOR KINETICS EQNS						290
GGA 1108 F4 RS P I	\$SAFE-CREEP, VISCOELASTIC ANALYSIS CONCRETE						300
GGA 1108 F4 RS P I	\$SAFE-PLANE, PLANE STRESS ANALYSIS, 2-D BODIES						252
GGA 1108 F4 RS P I	\$SAFE-SHELL, STRESS ANALYSIS THIN SHELLS						253
GGA 1108 F4 RS P L	\$GRDWRK, GRID GENERATION FOR SAFE PROGRAMS						296
GGA 1108 F4 RS P T A	\$TACASI, ANALYSIS OF RESONANCE MEASUREMENTS						410
GGA 1108 F4 RS P T C	\$GASP7, 1-D BURNUP POWER DISTRIBUTION SEARCH						319
GGA 1108 F4 RS P T C	\$GATT, 3-D FEW-GP DIFFUSION CALC HEX-Z MESH						380
GGA 1108 F4 RS P T C	\$STEMC07, TEMPERATURE COEFFICIENT CALCULATION						320
GGA 1108 F4 RS P T D	\$FEVER7, 1-D MULTIGROUP DIFFUSION AND DEPLETION						318
GGA 1108 F4 RS P T D	\$GAUGE, 2-D FEW-GP HEX GEOM DIFFUSION DEPLETION						339
GGA 1108 F4 RS P T D	\$PWOCOST, REACTOR FUEL CYCLE COST CALCULATION						441
GGA 1108 F4 RS P T F	\$GAKIT, 1-D MULTIGP KINETICS WITH TEMP FEEDBACK						370
GGA 1108 F4 RS P T F	\$WIGL2, 1-D 2-GP SPACE-TIME DIFFUSION 3-GEOM						R274
GGA 1108 F4 RS P T H	\$SDYNAM, DYNAMIC ANALYSIS BOILING FLOW STEAM						440
GGA 1108 F4 RS P T I	\$SAFE-2D, PLANE & AXISYMMETRIC STRESS ANALYSIS						379
GGA 1108 F4 RS P T I	\$SAFE-3D, 3-D COMPOSITE STRUCTURE STRESS STUDY						332
GGA 1108 F4 RS P T J	\$MUSCAT, VIEW FACTOR SHIELDING CODE CAVITY GEOM						259
GGA 1108 F4 RS P CT D	\$OPUS, POWER PLANT PERFORMANCE AND PRICE STUDY						226
GGA 1108 F4 RS P X A	\$COHBE, COHERENT INELASTIC SCATTERING LAW CALC						385
GGA 1108 F4 RS P X T B	\$GAF,GAR, SPECTRA AND GROUP-AVERAGED X-SEC CALC						316
GGA 1108 F4 RS P X T L	\$GAND, GAFGAR X-SECTION LIBRARY PREPARATION						345
GGA 1108 F4 RS P XCT C	\$GAPER1D, 1-D TRANSPORT PERTURBATION THEORY						606
GGA 1108 F4 RS P XCT D	\$CONCEPT3, POWER PLANT CONCEPTUAL COST ESTIMATE						498
GGA 1108 F5 RS P A	\$FLANGE1, SCATTERING LAW X-SECTION CALCULATION						247
GGA 1108 F5 RS P B	\$FLAC, STEADY-STATE FLOW, PRESSURE DISTRIBUTION						395
GGA 1108 F5 RS P T B	\$ENDFB2,GAND2,GFE2, ENDF/B TO GAFGAR X-SECTIONS						596
GGA 1108 F5 RS P T C	\$2DF, 2-D MULTI-GP DISCRETE ORDINATE CODE						173
GGA 1108 F5 RS P T H	\$TAC2D, STEADY-STATE AND TRANSIENT TEMP CALC						408
GGA 1108 F5 RS P T H	\$TAC3D, TRANSIENT 3-D HEAT TRANSFER PROGRAM						414
GGA 1108 F5 RS P T I	\$SAFE-CRACK, VISCOELASTIC ANALYSIS OF CONCRETE						451
GGA 1108 F5 RS P T I	\$SHELL5, THIN SHELL 3-D STRUCTURAL ANALYSIS						452
GGA 1108 F5 RS P T N	\$GAPER2D, 2-D PERTURBATION CALC FROM 2DF OUTPUT						471
GGA 1108 F5 RS P T O	\$CAGE,BIRD,SPEC, TIME-OF-FLIGHT DATA ANALYSIS						476
GGA 1108 F5 RS P CT A	\$FSDP3, POINTWISE XSECS. FROM B-W PARAMETERS						216
GGA 1108B F4 RS P A	\$GANDY3, UNRESOLVED RESONANCE X-SECTION CALC						341
GGA 1108B F4 RS PLXCT B	\$GGC4, MULTI-GP X-SECTIONS FAST THERMAL SPECTRA						298
GGC4, MULTI-GP X-SECTIONS FAST THERMAL SPECTRA	GGA	1108B	F4	RS PLXCT	B	\$	298
GGC4, MULTI-GP X-SECTIONS FAST THERMAL SPECTRA	WANL	6600	F4	RS L	T B	\$	298
GLEN, GROUP CONSTANT CALC FROM TOR OUTPUT DATA	LASL	6600	F4	RS P	T B	\$	361
GLOVE CHANGE ANALYSIS SYSTEM, GLOVE DATA BASE	RFD	360	COBOL	RS P	T M	\$	813
GLOVE DATA BASE RFD	360	COBOL	RS P	T M	\$		813
GLOVE CHANGE ANALYSIS SYSTEM,							
GLUB1, WATER-LOGGED FUEL ELEMENT ANALYSIS	BAPL	6600	F4	RS P	T H	\$	R424
GNASH, PARTICLE INDUCED X-SECTIONS & SPECTRA	LASL	7600B	F+COM	RS PL	T A	\$	757
GNATS,MESH2,GPRINT, 2-D NONLINEAR ANALYSIS	SLL	6600	F+COM	RS P	T I	\$	682
GPRINT, 2-D NONLINEAR ANALYSIS	SLL	6600	F+COM	RS P	T I	\$	682
GRAMP, R-M PARAMETERS OF UNRESOLVED RESONANCES	BAPL	6600	F4	RS P	A	\$	R470

GRAPH

HEX

GRAPH, LINEAR REGRESSION W/CONFIDENCE LIMITS	BKC	360	F4	RSBP	P	\$	624	
GRAPHIC X-SEC EVALUATION	AI	360	F+BAL	RSB L CT M	\$SCORE3, SCISRS	ENDF/B	375	
GRAPHICS SUBROUTINES	AI	360	F+BAL	RS	T P	\$FIGS, IBM360&2250	FORTRAN	484
GRAPHS WITH DISSPLA	ANL	360	F4	RS P CT P	\$DRAFTMAN, DRAW	FIGURES &	748	
GRDWRK, GRID GENERATION FOR SAFE PROGRAMS	GGA	1108	F4	RS P	L	\$	296	
GRFPAK, PLOT PACKAGE FOR CORTES-FEM PROGRAMS	ORNL	360	F4	RS P CT N	\$		760	
GRID GENERATION FOR SAFE-PROGRAMS	GGA	1108	F4	RS P	L	\$GRDWRK,	296	
GROUP CONSTANT CALC FROM TOR OUTPUT DATA	LASL	6600	F4	RS P	T B	\$GLEN,	361	
GROUP OR MESH COLLAPSING	RW	6500	F4	RS P	B	\$PARTI, OPTIMAL	416	
GROUP THEORY OF LATTICE DYNAMICS	ANL	360	F4	RS P	T Q	\$GROUP2,	620	
GROUP THEORY OF LATTICE DYNAMICS	LASL	6600	F4	RS P	T Q	\$GROUP2,	620	
GROUP-AVERAGED X-SEC CALC	GGA	1108	F4	RS P X T B	\$GAF, GAR, SPECTRA	AND	316	
GROUP-COLLAPSING	APG	6600	F4	RS	B	\$APRFX1, 99-GP	DLC-2B LIBRARY	466
GROUP2, GROUP THEORY OF LATTICE DYNAMICS	ANL	360	F4	RS P	T Q	\$	620	
GROUP2, GROUP THEORY OF LATTICE DYNAMICS	LASL	6600	F4	RS P	T Q	\$	620	
GROUSE, SPACE-DEPENDENT X-SECTION GENERATION	GEC	635	F4	RSBP	T B	\$	420	
GSSLRN1B, LEAST SQUARES PHOTOPEAK SPECTRA CODE	BNW	1108	F+BAL	RS P	T O	\$	457	
H&N	6400	F4	RS P CT M	\$SKILLS INVENTORY, PERSONNEL	INFORMATION SYSTEM		801	
HAARM3, AEROSOL BEHAVIOR LOG-NORMAL DIST MODEL	BCL	6400	F4	RS P	T G	\$	797	
HAA3B, AEROSOL BEHAVIOR LOGNORMAL MODEL	AI	370	F	RS P	T G	\$	443	
HADRONIC CASCADE TRANSPORT	FNAL	370	F+BAL	RS P T W	\$CASIM, SIMULATES		742	
HAFMAT, SYSTEM STEADY-STATE FLOW DISTRIBUTION	KAPL	6600	F4	RS P	T H	\$	R616	
HAMMER ANALYSIS OF PIPING SYSTEM	HEDL	6600	F4	RS P	T G	\$HAMOC, FLUID	710	
HAMMER ANALYSIS PIPING SYSTEM	ANL	360	F4	RS P	G	\$NAHAMMER, FLUID	717	
HAMMER ANALYSIS PIPING SYSTEM	ANL	7600	F4	RS P	G	\$NAHAMMER, FLUID	717	
HAMMER ANALYSIS 1-D PIPING	ANL	360	F4	RS P	G	\$NATRANSIENT, FLUID	718	
HAMMER ANALYSIS 1D & 2D SYSTEMS	ANL	360	F4	RS P	T G	\$NATRAN2, FLUID	719	
HAMMER, LITHE, HELP, CRITICAL ANALYSIS SYSTEM	DP	360	F+BAL	RS P XCT B	\$		277	
HAMOC, FLUID HAMMER ANALYSIS OF PIPING SYSTEM	HEDL	6600	F4	RS P	T G	\$	710	
HARMONY-PDQ X-SECTION GENERATION CODE	BAPL	6600	F+COM	RS P X T B	\$PAX03,		R426	
HCI	370	F+C+A	RS XC P	\$JCLCROSS, DSN CROSS-REF	LIST FROM JCL PROCLIBS		725	
HEAT & WATER TRANSFER IN POROUS MEDIA	BKY	7600	F4	RS P	T H	\$SCHAF,	802	
HEAT CONDUCTION	ORNL	360	F4	RS P X T H	SORTHIS, ORTHAT, 2-DIMENSIONAL		525	
HEAT CONDUCTION PROGRAM	BAPL	6600	F4	RS P	T H	\$SHOT2, 2-D TRANSIENT	R286	
HEAT CONDUCTION PROGRAM	ORNL	360	F4	RS P	T H	\$SHEATING5, 1,2, OR 3-D	517	
HEAT EXCHANGER STRESS ANALYSIS	KAPL	6600	F4	RS P	J	\$TUBE, U-TUBE	R378	
HEAT ON CHARCOAL ADSORBERS	ORNL	360	F4	RS P	T G	\$CHART, IODINE DECAY	804	
HEAT TRANSFER	GGA	1108	F+BAL	RS P T E	\$BLOOST6, COMBINED KINETICS 2-D		303	
HEAT TRANSFER SSDC	370	F4	RS P	H	\$HEATING2, TRANSIENT STEADY-STATE		198	
HEAT TRANSFER CODE	EG&G	360B	F4	RSBP	XCT H	\$SMOXY/MOD032, BWR CORE	551	
HEAT TRANSFER PREDICTION	MIT	360	F4	RS P	T H	\$REFLUX, LWR REFLOOD	763	
HEAT TRANSFER PROGRAM	GGA	1108	F5	RS P	T H	\$TAC3D, TRANSIENT 3-D	414	
HEAT TRANSFER STUDY	SLL	6600	F4	RS P	N	\$HEATMESH, GEOMETRICAL DATA	434	
HEATING & COOLING ENERGY USE	ORNL	360	F4	RS P X	R	\$MOBY, MOBILE HOME	724	
HEATING2, TRANSIENT STEADY-STATE HEAT TRANSFER	SSDC	370	F4	RS P	H	\$	198	
HEATING5, 1,2, OR 3-D HEAT CONDUCTION PROGRAM	ORNL	360	F4	RS P	T H	\$	517	
HEATMESH, GEOMETRICAL DATA HEAT TRANSFER STUDY	SLL	6600	F4	RS P	N	\$	434	
HEATUP & MELTDOWN	BCL	6400	F4	RS P	G	\$BOIL1, BOILOFF ACCIDENT CORE	734	
HEATUP CODE FOR BWR/6 ANALYSIS	EI	360	F+BAL	RS P CT H	\$6KILER, CORE		636	
HEAVY ELEMENT ISOTOPIC BURNUP ANALYSIS	NED	635	F4	RS P	T O	\$BURNUP,	311	
HEDL	360	F4	RSBP	XCT B	\$ETOX3, MULTI-GP CONSTANTS FROM	ENDF/B FOR 1DX	388	
HEDL	CY74	F4	RS P	G	\$SPRAY3, SODIUM SPRAY RELEASE	SAFETY ANALYSIS	716	
HEDL	1108	F+SLE	RS P XCT R	\$HERMES, REGIONAL RADIOLOGICAL	EFFECTS ANALYSIS		527	
HEDL	1108	F4	RS P	G	\$SOCOOL2, SODIUM-FUEL INTERACTION	ANALYSIS	521	
HEDL	1108	F4	RS P T D	\$3DB, 3-D MULTIGROUP DIFFUSION	BURNUP ANALYSIS		567	
HEDL	1108	F5	RS P T R	\$STOPLYR2, POWER PLANT THERMAL	DISCHARGE STUDY		599	
HEDL	1108	F5	RS P X T D	\$PACTOLUS, CLOTHO, NUCLEAR POWER	PLANT COST CODE		540	
HEDL	1108B	F4	RS P X T B	\$ETOX3, MULTI-GP CONSTANTS FROM	ENDF/B FOR 1DX		388	
HEDL	6600	F	RS P T H	\$SIEX, LMFBR FUEL PIN THERMAL	PERFORMANCE MODEL		673	
HEDL	6600	F4	RS P T G	\$SCACECO, LMFBR CONTAINMENT	ACCIDENT ANALYSIS		R762	
HEDL	6600	F4	RS P T G	\$HAMOC, FLUID HAMMER ANALYSIS	OF PIPING SYSTEM		710	
HEDL	6600	F4	RS P T I	\$BEAMCRP, FINITE-ELEMENT BEAM	CREEP ANALYSIS		R701	
HEDL	6600	F4	RS P CT F	\$MELT3, FAST REACTOR TRANSIENT	OVERPOWER STUDY		700	
HEDL	6600	F4	RS P CT I	\$SAXICRP, FINITE ELEMENT CODE	FOR CREEP ANALYSIS		785	
HELMHOLTZ EQUATION ON GENERAL 3D REGION	NYU	6600	F4	RS P	T P	\$DPOLE,	816	
HELP, CRITICAL ANALYSIS SYSTEM	DP	360	F+BAL	RS P XCT B	\$HAMMER, LITHE,		277	
HEMP, HYDRODYNAMIC ELASTICMAGNETO PLASTIC	LLL	7600	F4	RS P	T F	\$	775	
HERESY3, 2-D HETEROGENEOUS REACTOR CALCULATION	DP	360B	F4	RSBP	CT C	\$	136	
HERMES, REGIONAL RADIOLOGICAL EFFECTS ANALYSIS	HEDL	1108	F+SLE	RS P XCT R	\$		527	
HETEROGENEOUS REACTOR CALCULATION	DP	360B	F4	RSBP	CT C	\$HERESY3, 2-D	136	
HETRAP, FUEL ROD RESPONSE LOCA EXPERIMENTS	ORNL	360	F4	RS P	T H	\$	730	
HEX CELL	BAPL	6600	F+ASC	RS P X T B	\$RESQ2, RESQ0, DBF1, RESONANCE	INTEGRAL	R285	

HEX

INVENTORY

HEX GEOM DIFFUSION DEPLETION	GGA	1108	F4	RS P T D	SGAUGE, 2-D FEW-GP	339
HEX LATTICE	GGA	1108	F4	RS B	SHEXSCAT, ELASTIC SCAT X-SECTIONS	291
HEX-Z MESH	GGA	1108	F4	RS P T C	SGATT, 3-D FEW-GP DIFFUSION CALC	380
HEXSCAT, ELASTIC SCAT X-SECTIONS	HEX LATTICE	GGA	1108	F4	RS B	\$ 291
HFN, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	BNW	1107	F4	RS P T C	\$	241
HFN, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	BNW	6600	F4	RS P X T C	\$	241
HIGH-TEMPERATURE COAL COMBUSTOR MODEL	ANL	370	PL1	RS P T R	SCOMB, 1D	811
HIGH-VELOCITY FLOW STUDY STEAM-WATER MIX	KAPL	6600	F4	RS P	H SRAPP,	R382
HISTOGRAMS, QUALITY CONTROL SAMPLE STATISTICS	BKC	360	F4	RSBP	P	\$ 614
HISTORY	ANL	370	F4	RS PL C G	SCURIE, FISSION PRODUCT INVENTORY DECAY	196
HISTORY	LASL	6600	F4	RS P T D	SPHENIX, 2-D DIFFUSION BURNUP REFUELING	454
HOH, STEAM TABLES 14.5-2538 PSIA	BAPL	6600	F4	RS P	H SM0899,	R294
HOME HEATING & COOLING ENERGY USE	ORNL	360	F4	RS P X	R \$MOBY, MOBILE	724
HONDO, A DYNAMIC RESPONSE FINITE-ELEMENT CODE	SLA	6600B	F4	RS P T I	\$	672
HOT2, 2-D TRANSIENT HEAT CONDUCTION PROGRAM	BAPL	6600	F4	RS P T H	\$	R286
HRG3, SLOWING-DOWN SPECTRUM, MULTIGP CONSTANTS	BNW	1108	F4	RS PLX T B	\$	467
HRG3, SLOWING-DOWN SPECTRUM, MULTIGP CONSTANTS	TVA	360	F4	RS PLX T B	\$	467
HTGR ACCIDENT ANALYSIS DOSE CALC	GGA	1108	F4	RS T G	SGADOSE, DOSET,	261
HTGR METALLIC FISSION PRODUCT RELEASE	GGA	1108	F4	RS P	D \$FREVAPE,	301
HWOCR-SAFE, 2-D MONTE CARLO CELL CALCULATION	AI	360	F+BAL	RS P X T B	\$	307
HYDRODYNAM RESPONSE TO EXCURSION	ANL	360	F4	RS P CT F	SREXCO-H, 2-D	550
HYDRODYNAM RESPONSE TO EXCURSION	ANL	360	F4	RS P CT F	SREXCO-H2, 2-D	R615
HYDRODYNAMIC ANALYSIS DURING BLOWDOWN	PPCO	360	F4	RS P X	G \$BURST1,	435
HYDRODYNAMIC ELASTICMAGNETO PLASTIC	LLL	7600	F4	RS P T F	\$HEMP,	775
HYDRODYNAMIC MASS MATRIX GENERATION	BAPL	6600	F+COM	RS P H	\$HYMAS,	R560
HYDROGEN PERMEATION WITH TRAPPING	DP	360	F4	RSBP	Q \$XDTRAP,	655
HYDROLOGIC TRANSPORT MODEL	ORNL	360	F+BAL	RS P CT R	\$WHTM, WISCONSIN	808
HYDROLOGIC TRANSPORT WITH OPTIMIZATION	ORNL	360	F+BAL	RS P CT R	\$OPTRM,	794
HYMAS, HYDRODYNAMIC MASS MATRIX GENERATION	BAPL	6600	F+COM	RS P H	\$	R560
IBM OS SYSTEM CATALOG UTILITY ROUTINE	ANL	360D	BAL	RS X T P	\$COPYCAT,	646
IBM2280 OR CALCOMP780	ANL	360	F4	RS P T N	\$PLOT-3D, 3-D PLOTS ON	544
IBM360 FORTRAN H PROGRAM CHECKER	ANL	360B	PL1	S P CT P	\$SLOP,CROSS,	647
IBM360&2250 FORTRAN GRAPHICS SUBROUTINES	AI	360	F+BAL	RS T P	\$FIGS,	484
IBM370 MACROS	ANL	370	BAL	RSBP CT P	\$FORTIO, FORTRAN INTERFACE TO	772
IMPACT ANALYSIS	LASL	7600	F4	RS P I	\$IMPAC2, B SHIPPING CONTAINER	715
IMPAC2, B SHIPPING CONTAINER IMPACT ANALYSIS	LASL	7600	F4	RS P I	\$	715
IMPLANTATION DEPOSITION	SLA	6600	F4	RS P T Q	\$SCOREL, RASE4, DAMG2, ION	758
IMPORTANCE, FTA BASIC EVENT & CUT SET RANKING	ANL	370	F4	RS P T G	\$	779
INCEXE, 1-GP 3-D XYZ XENON OSCILLATION	CEND	360	F4	RS P X T F	\$CEXE,	415
INCITE, THERMAL SPECTRA & MULTI-GP CONSTANTS	EG&G	360	F4	RS PL CT B	\$	565
INDEXING	LASL	6600	F+COM	RS P Q	\$INDX, XRAY DIFFRACTION POWDER PATTERN	609
INDUCED X-SECTIONS & SPECTRA	LASL	7600B	F+COM	RS PL T A	\$GNASH, PARTICLE	757
INDX, XRAY DIFFRACTION POWDER PATTERN INDEXING	LASL	6600	F+COM	RS P Q	\$	609
INELASTIC LARGE DEFLECTION STRESS STUDY	BAPL	6600	F+COM	RS P T I	\$GAPL3,	R397
INELASTIC PIPING ANALYSIS	BCL	6400	F4	RS P T I	\$PIRAX2, SIMPLIFIED	R735
INELASTIC SCAT X-SECTION CALC MODERATOR	GGA	1108	F4	RS P A	\$GAKER,	289
INELASTIC SCATTERING FORM FACTORS	ORNL	360	F4	RS P T A	\$ATHENA4,	417
INELASTIC SCATTERING LAW CALC	GGA	1108	F4	RS P X A	\$CORBE, COHERENT	385
INELASTIC STRUCTURAL ANALYSIS	ORNL	360	F4	RS P CT I	\$PLACRE, FEM	R740
INELASTIC STRUCTURAL ANALYSIS	ORNL	360	F+BAL	RS P XCT I	\$CREEP-PLAST2, 2D	R810
INELASTIC STRUCTURAL ANALYSIS	ORNL	360B	F+BAL	RS P X T I	\$CREEP-PLAST, 2-D	R707
INFORMATION SYSTEM	KAPL	6600B	F+ASC	RSB X T M	\$TIGIR2, MODULAR DOCUMENT	R403
INFORMATION SYSTEM	H&N	6400	F4	RS P CT M	\$SKILLS INVENTORY, PERSONNEL	801
INITIALLY OVAL TUBE	BNW	6600C	F4	RS P I	\$BUCKLE, CREEP BUCKLING OF	667
INLET PLENUM	DP	360	F4	RS P H	\$PLENUM, FLOW DIST. IN CYL COOLANT	586
INPUT DATA PROCESSING MODULE	ANL	360	F4	RSBP CT L	\$ARC-NUI002, BCD	533
INPUT GEN	KAPL	6600B	F+C	RS P T L	\$DATATRAN2, RAD1 GEOMETRY MODULES 2-D	406
INPUT PROCESSOR	LASL	360	F4	RS P L	\$GENRD, FREE-FORMAT CARD	530
INPUT PROCESSOR	LASL	6600	F4	RS P L	\$GENRD, FREE-FORMAT CARD	530
INSPEC, MARKOV SIMULATION OF REACTOR OPN	DP	360	F4	RS P G	\$INTEG,	590
INTG, INSPEC, MARKOV SIMULATION OF REACTOR OPN	DP	360	F4	RS P G	\$	590
INTEGER OPTIMIZATION	EG&G	360	F4	RS P P	\$ARSTEC, NONLINEAR MIXED	738
INTERACTION ANALYSIS	ANL	360	F4	RS P G	\$SOCOOL2, SODIUM-FUEL	521
INTERACTION ANALYSIS	HEDL	110"	F4	RS P G	\$SOCOOL2, SODIUM-FUEL	521
INTERFACE FILE PROCESSOR	LASL	360	F4	RS P CT M	\$LASIP3, CCCC STANDARD	691
INTERFACE TO IBM370 MACROS	ANL	370	BAL	RSBP CT P	\$FORTIO, FORTRAN	772
INTERMEDIATE POWER TRANSIENTS	BAPL	6600	F4	RS P T H	\$CHIC-KIN, FAST +	R473
INTERPRETER, MINIMAL BASIC LANGUAGE	LLL	8080	ASM	RS P T P	\$SBASIC2	803
INTERSECTION MESH GENERATOR	WARD	7600	F4	RS P T L	\$SEURCYL1, CYL-CYL	R746
INTRP, SOLN OF ORDINARY DIFF EQUATIONS	SLA	360D	F4	RS P X T P	\$DE/STEP,	640
INTRP, SOLN OF ORDINARY DIFF EQUATIONS	SLA	6600D	F4	RS P X T P	\$DE/STEP,	640
INVENTORY	ANL	360	F4	RSBP CT C	\$ARC-DIF1D, 1-D MULTI-GP DIFFUSION &	626

INVENTORY

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INVENTORY DECAY HISTORY	ANL	370	F4	RS PL C	G	SCURIE, FISSION PRODUCT	196
INVENTORY, PERSONNEL INFORMATION SYSTEM	H&N	6400	F4	RS P	CT M	SKILLS	801
INVERSE KINETICS CALC	ANL	360	F4	RS P	E	SR102, SPACE-INDEPENDENT	168
IODINE DECAY HEAT ON CHARCOAL ADSORBERS	ORNL	360	F4	RS P	T G	CHART,	804
IODINE REMOVAL	BCL	6400B	F4	RS P	X T G	SMIRAB, MIRAP, CONTAINMENT SYSTEM	499
ION IMPLANTATION DEPOSITION	SLA	6600	F4	RS P	T Q	SCOREL, RASE4, DAMG2,	758
ISOGEN, RADIONUCLIDE GENERATION AND DECAY	BNW	1108	F5	RSBPL	T D	\$	367
ISOPLETH-AREA CALC FROM SINGLE SOURCE	ANL	GETS	F	R	R	SPLETHS,	591
ISOSEARCH, ISOTOPE PRODUCTION FLUX, X-SEC CALC	ORNL	360	F+BAL	RS P	D	\$	322
ISOTAB, PU POWER OUTPUT FROM MIXED ISOTOPES	MLMO	360B	F4	RS P	C Q	\$	R619
ISOTOPE PRODUCTION FLUX, X-SEC CALC	ORNL	360	F+BAL	RS P	D	ISOSEARCH,	322
ISOTOPES	MLMO	360B	F4	RS P	C Q	ISOTAB, PU POWER OUTPUT FROM MIXED	R619
ISOTOPES, MAXIMUM YIELD FROM REACTION OR DECAY	LMSC	1109	F5	RS P	D	\$	179
ISOTOPIC BURNUP ANALYSIS	NED	635	F4	RS P	T O	SBURNUP, HEAVY ELEMENT	311
ISOTROPIC DIELECTRICS	ANL	360	F4	RS P	CT T	SFFEARS, LAPLACE EQUATION	577
ISOTROPIC DIELECTRICS	SLA	6600B	F4	RS P	T T	SFFEARS, LAPLACE EQUATION	577
JACOBIAN	LLL	360C	F4	RS P	X T P	SGEARB, SOLVE ODE SYSTEM WITH BANDED	661
JACOBIAN	LLL	6600C	F4	RS P	X T P	SGEARB, SOLVE ODE SYSTEM WITH BANDED	661
JACOBIAN	LLL	360	F4	RS P	X T P	SEPIISODEB, SOLVE ODE SYST WITH BANDED	705
JAER	230	F4	RS P	T B	SCLUP77, SQUARE CELL COLLISION PROBABILITY CALC		526
JCL PROCLIBS	HCI	370	F+C+A	RS	XC P	SJCLCROSS, DSN CROSS-REF LIST FROM	725
JCLCROSS, DSN CROSS-REF LIST FROM JCL PROCLIBS	HCI	370	F+C+A	RS	XC P	\$	725
JITER, FLUCTUATION EXPERIMENT ANALYSIS	BAPL	6600	F4	RS P	O	\$	R394
JNC	1108B	F5	RS PLX	T B	SLEOPARD, SPOTS, SPECTRUM CALC WITH DEPLETION		279
JOB ENTRY SYSTEM	EG&G	360	BAL	RSB	T P	SNRTS-RJE, OS/360 MVT REMOTE	519
JOINTS	ORNL	360B	F4	RS P	T I	SFLANGE-ORNL, ANALYSIS OF FLANGED	689
JOSHUA SYSTEM LATTICE PHYSICS MODULES	DP	360	F+BAL	S	X T B	SFAHAB,	536
JOURNAL CONTROL, LIBRARY JOURNAL MANAGEMENT	ORNL	360	C+BAL	RS PL	CT M	\$	660
JOURNAL MANAGEMENT	ORNL	360	C+BAL	RS PL	CT M	SJOURNAL CONTROL, LIBRARY	660
JP1XR, COUPLED-CHANNEL SCATTERING X-SEC CALC	KAPL	6600	F4	RS P	T A	\$	R506
JUPITOR1, COUPLED CHANNEL X-SEC EVALUATION	ENEA	360	F4	RS P	CT A	\$	308
K-FIX, TRANSIENT 2-DIMENSIONAL 2-FLUID FLOW	LASL	7600	F4	RS P	X T H	\$	727
KAPL 6600	F+ASC	RS	P	SSIMPLE1, TIME-SHARING PROGRAMMING LANGUAGE			R442
KAPL 6600	F+ASC	RS P	T I	SGEM, EIGENVALUE PROBLEM FOR VIBRATING SYSTEMS			R344
KAPL 6600	F+ASC	RS P	T P	SCURFIT, CURVE FITTING EXPERIMENTAL DATA POINTS			R 43
KAPL 6600	F+ASC	RS P	T P	SDOGGY, DESK CALCULATOR FORM SHEET DP PACKAGE			R428
KAPL 6600	F+ASC	RS P	T P	SLIZARD, NONLINEAR DIFFERENTIAL EQNS. SOLUTION			R445
KAPL 6600	F+ASC	RS P	T P	SSNEQ, NONLINEAR ALGEBRAIC EQN SOLN CURVE PLOT			R364
KAPL 6600	F+COM	RS	T P	SKAPLPLOT, KAPL CALCOMP PLOTTING ROUTINES			R496
KAPL 6600	F4	RS	I	SSORSDB, PRESSURE VESSEL STRESS AND FATIGUE			R391
KAPL 6600	F4	RS	T O	SGASPAN, COMPLEX GAMMA-RAY SPECTRA ANALYSIS			R485
KAPL 6600	F4	RS P	A	SCLEM, ANGULAR DISTRIBUTION LEGENDRE FITTING			R531
KAPL 6600	F4	RS P	A	SMULTI, MULTI-LEVEL RESONANCE THEORY XSEC CALC			R535
KAPL 6600	F4	RS P	A	SPHASER, PHASE SHIFT X-SEC & POLARIZATION CALC			R507
KAPL 6600	F4	RS P	F	SRAUMZEIT, 1-D TIME-DEPENDENT DIFFUSION CALC			R352
KAPL 6600	F4	RS P	F	SSTINT3, SINGLE-CHANNEL SPACE-TIME SYNTHESIS			R389
KAPL 6600	F4	RS P	H	SRAPP, HIGH-VELOCITY FLOW STUDY STEAM-WATER MIX			R382
KAPL 6600	F4	RS P	I	SSTEM, MATRIX GENERATION FOR A SYSTEM OF BEAMS			R337
KAPL 6600	F4	RS P	I	STUBE, U-TUBE HEAT EXCHANGER STRESS ANALYSIS			R378
KAPL 6600	F4	RS P	O	SDYNO1, PHOTOMULTIPLIER ELECTRON DISTRIBUTION			R464
KAPL 6600	F4	RS P	P	SMOST, A MULTIDIMENSIONAL OPTIMIZATION SCHEME			R446
KAPL 6600	F4	RS P	P	SROPE, FINDING ROOTS OF A POLYNOMIAL			R444
KAPL 6600	F4	RS P	W	SCONDYN, POLYA MODEL SECONDARY ELECTRON SPECTRA			786
KAPL 6600	F4	RS P	T A	SJP1XR, COUPLED-CHANNEL SCATTERING X-SEC CALC			R506
KAPL 6600	F4	RS P	T D	S3DXT, DEP3, 3-D XENON TRANSIENT & DEPLETION			R477
KAPL 6600	F4	RS P	T H	SHAFMAT, SYSTEM STEADY-STATE FLOW DISTRIBUTION			R616
KAPL 6600	F4	RS P	X I	SFINEL, FINITE-ELEMENT STUDY 2,3-D STRUCTURES			R404
KAPL 6600B	F+ASC	RS P	T H	SLION4, 3-D TEMPERATURE DISTRIBUTION PROGRAM			R299
KAPL 6600B	F+ASC	RSB	X T M	STIGIR2, MODULAR DOCUMENT INFORMATION SYSTEM			R403
KAPL 6600B	F+C	RS P	T L	SDATATRAN2, RAD1 GEOMETRY MODULES 2-D INPUT GEN			406
KAPL 6600B	F+COM	RS P	T P	SDATATRAN2, UTILITY PLOT MODULES F(X) & F(X,Y)			407
KAPL 6600B	F+COM	RS P	X T M	SDATATRAN2, MODULAR PROGRAMMING AND DATA SYSTEM			386
KAPL 6600C	F4	RS P	T I	SSOR3, STRESS ANALYSIS SHELLS OF REVOLUTION			R 80
KAPL 7600C	F+COM	RS P	T M	SDATATRAN2, MODULAR PROGRAMMING AND DATA SYSTEM			386
KAPL CALCOMP PLOTTING ROUTINES	KAPL	6600	F+COM	RS	T P	SKAPLPLOT,	R496
KAPLPLOT, KAPL CALCOMP PLOTTING ROUTINES	KAPL	6600	F+COM	RS	T P	\$	R496
KEELE, LINEARLY-CONSTRAINED OPTIMIZATION	ORNL	360	F4	RS P	P	\$	556
KEFF, MGBS, TGAN, NUCLEAR CRITICALITY SAFETY	DP	360	F4	RS P	T C	\$	617
KENDALL CORRELATION	ORNL	360	F4	RS P	T P	SSPEKEN, PEARSON SPEARMAN &	781
KENO2, MONTE CARLO MULTIGROUP CRITICALITY CODE	DP	360B	F+BAL	RSBP	CT C	\$	450
KENO2, MONTE CARLO MULTIGROUP CRITICALITY CODE	RFD	6600B	F+COM	RS PLX	T C	\$	450
KENO4, MONTE CARLO MULTIGROUP CRITICALITY CODE	ORNL	360C	F+BAL	RSBPLXCT	C	\$	450

KERNELS

LASL

KERNELS	DP	360	BCD	R	LX	T	Z	STHERMOS LIBRARY, 30-GP ENDF/B SCAT	543
KEX OPTIONS	ANL	360	F4	RS	P		E	SR101, SPACE-INDEPENDENT KINETICS	255
KINETIC SIMULATION SYSTEM	CUP1	370	F+BAL	RS	P	CT	U	SBIOSIM, BIOCHEMICAL	736
KINETICS	AI	360	F4	RS	P	T	F	STSN, SPATIALLY-DEPENDENT REACTOR	309
KINETICS	GGA	1108	F4	RS	P		E	SGAPOTKIN, SPACE-INDEPENDENT REACTOR	317
KINETICS	BCL	6400	F4	RS	P	T	F	SADEP, 1-D & 2-D FEW-GROUP SPACE-TIME	494
KINETICS CALC	ANL	360	F4	RS	P		E	SR102, SPACE-INDEPENDENT INVERSE	168
KINETICS CODE	ANL	360	F4	RS	P	T	E	SANCON, SPACE-INDEPENDENT REACTOR	486
KINETICS CODE	ANL	360	F4	RS	P	CT	F	SQX1, QUASISTATIC SPATIAL REACTOR	474
KINETICS CODE	LASL	6600	F4	RS	P	T	E	SANCON, SPACE-INDEPENDENT REACTOR	486
KINETICS EQNS	GGA	1108	F4	RS	P		E	SGASA, STABILITY ANALYSIS REACTOR	290
KINETICS KEX OPTIONS	ANL	360	F4	RS	P		E	SR101, SPACE-INDEPENDENT	255
KINETICS PROGRAM	ORNL	360	F4	RS	P	XCT	E	STASK, 1-D MULTIGROUP REACTOR	558
KINETICS TEMPERATURE DIST STUDY	AEB	360	F4	RS	P		E	SBLAST, REACTOR	363
KINETICS TEMPERATURE FEEDBACK	BAPL	6600	F4	RS	P		F	SNOWIG, 1-D 2-GP	R371
KINETICS W/FEEDBACK	AEB	360	F4	RS	P		E	SAIREK3, SPACE-INDEPENDENT	121
KINETICS WITH TEMP FEEDBACK	GGA	1108	F4	RS	P	T	F	SGAKIT, 1-D MULTIGP	370
KINETICS 2-D HEAT TRANSFER	GGA	1108	F+BAL	RS	P	T	E	SBLOOST6, COMBINED	303
KITT, SYSTEM FAULT TREE EVALUATION CODES	EG&G	360	F4	RSBP	CT	G		\$PREP,	528
KITT, SYSTEM FAULT TREE EVALUATION CODES	EG&G	1108	F4	RS	P	T	G	\$PREP,	528
KLYSTRON TUBE ANALYSIS	SLAC	360	F4	RS	P	T	V	\$SLACKLY, 1D MULTICAVITY	807
KSUN	360	F4	RS	P		O		SCORGAM, UNFOLDING OF COMPLEX GAMMA-RAY SPECTRA	390
LAGRANGIAN EQNS OF MOTION SOLUTION	SLA	3600	F36	RS	P	T	I	STOODY2, 2-D	627
LANGUAGE	KAPL	6600	F+ASC	RS	P			\$SIMPLE1, TIME-SHARING PROGRAMMING	R442
LANGUAGE	LLL	8080	ASM	RS	P	T	P	\$BASIC2 INTERPRETER, MINIMAL BASIC	803
LANGUAGE PROCESSOR TSO OR BATCH	ANL	360	F+BAL	RSBP	X	T	P	\$SPEAKEASY MU+,	593
LAPLACE EQUATION ISOTROPIC DIELECTRICS	ANL	360	F4	RS	P	CT	T	\$FFEARS,	577
LAPLACE EQUATION ISOTROPIC DIELECTRICS	SLA	6600B	F4	RS	P	T	T	\$FFEARS,	577
LARCA, FLUX-WEIGHTING OF DTF4 CROSS SECTIONS	LASL	6600	F4	RS	P		N	\$	409
LARGE DEFLECTION STRESS STUDY	BAPL	6600	F+COM	RS	P	T	I	SGAPL3, INELASTIC	R397
LASER, SPECTRUM CALC WITH BURNUP CYL LATTICE	TVA	360B	F4	RSBP	XCT	B		\$	249
LASIP3, CCCC STANDARD INTERFACE FILE PROCESSOR	LASL	360	F4	RS	P	CT	M	\$	691
LASL	360	F+BAL	RS	P	CT	C		\$TRIDENT, 2D MULTIGP TRANSPORT TRIANGULAR MESH	741
LASL	360	F4	RS	P	L			\$GENRD, FREE-FORMAT CARD INPUT PROCESSOR	530
LASL	360	F4	RS	P	T	F		\$TIMEX, 1-D TIME-DEP MULTIGP DISCRETE ORDINATES	756
LASL	360	F4	RS	P	CT	M		\$LASIP3, CCCC STANDARD INTERFACE FILE PROCESSOR	691
LASL	360	F4	RSBP	CT	C			\$TRIPILET, 2-D TRIANGULAR MESH TRANSPORT PROGRAM	608
LASL	360D	F4	RSBP	CT	C			\$TWOTRAN2, 2-D MULTI-GP TRANSPORT XY RZ RTHETA	358
LASL	6600	BCD	R	LX	T	Z		\$LASL XSEC SETS, SN 18- 24- AND 25-GROUP SETS	532
LASL	6600	F+COM	RS	P		Q		\$INDEX, XRAY DIFFRACTION POWDER PATTERN INDEXING	609
LASL	6600	F+COM	RS	P	T	P		\$LENSES, NONLINEAR LEAST SQ LENS DESIGN SYSTEM	602
LASL	6600	F4	RS	P		L		\$GENRD, FREE-FORMAT CARD INPUT PROCESSOR	530
LASL	6600	F4	RS	P		N		\$DAC1, SN PERTURBATION CODE USING DTF4 FLUXES	455
LASL	6600	F4	RS	P		N		\$LARCA, FLUX-WEIGHTING OF DTF4 CROSS SECTIONS	409
LASL	6600	F4	RS	P	T	A		\$TOR, THERMAL SCATTERING CRYSTALLINE MATERIALS	360
LASL	6600	F4	RS	P	T	B		\$GLEN, GROUP CONSTANT CALC FROM TOR OUTPUT DATA	361
LASL	6600	F4	RS	P	T	C		\$DTF4, 1-D MULTI-GP DISCRETE ORDINATE PROGRAM	209
LASL	6600	F4	RS	P	T	C		\$TRIPILET, 2-D TRIANGULAR MESH TRANSPORT PROGRAM	608
LASL	6600	F4	RS	P	T	D		\$PHENIX, 2-D DIFFUSION BURNUP REFUELING HISTORY	454
LASL	6600	F4	RS	P	T	D		\$2DB, 2-D MULTIGROUP DIFFUSION AND DEPLETION	325
LASL	6600	F4	RS	P	T	D		\$3DDT, 3-D MULTIGROUP DIFFUSION XYZ R-THETA-Z	463
LASL	6600	F4	RS	P	T	E		\$ANCON, SPACE-INDEPENDENT REACTOR KINETICS CODE	486
LASL	6600	F4	RS	P	T	Q		\$GROUP2, GROUP THEORY OF LATTICE DYNAMICS	620
LASL	6600	F4	RS	P	X	T	U	\$PRICE-LASL, CHEMICALLY REACTIVE MIXTURE FLOW	720
LASL	6600C	F+COM	RS	P	T	P		\$LASLIB, LOS ALAMOS SUBROUTINE LIBRARY ROUTINES	633
LASL	6600D	F4	RS	P	T	C		\$TWOTRAN2, 2-D MULTI-GP TRANSPORT XY RZ RTHETA	358
LASL	7600	F4	RS	P		H		\$SOLA-ICE, TRANSIENT COMPRESSIBLE FLUID FLOW	723
LASL	7600	F4	RS	P		I		\$SIMPAC2, B SHIPPING CONTAINER IMPACT ANALYSIS	715
LASL	7600	F4	RS	P	T	C		\$TRIDENT, 2D MULTIGP TRANSPORT TRIANGULAR MESH	741
LASL	7600	F4	RS	P	T	C		\$TRIPILET, 2-D TRIANGULAR MESH TRANSPORT PROGRAM	608
LASL	7600	F4	RS	P	T	C		\$TWOTRAN-PNVW, 2-D PARTICLE TRANSPORT XY RZ RTH	573
LASL	7600	F4	RS	P	T	F		\$TIMEX, 1-D TIME-DEP MULTIGP DISCRETE ORDINATES	756
LASL	7600	F4	RS	P	T	H		\$COMPARE-MOD1, TRANSIENT FLOW W/SINKS & DOORS	776
LASL	7600	F4	RS	P	T	H		\$COMPARE, TRANSIENT FLOW IN VENTED FLUID SYSTEM	702
LASL	7600	F4	RS	P	T	H		\$STVENT, VENTILATION SYSTEM TRANSIENT ANALYSIS	809
LASL	7600	F4	RS	P	T	X		\$STEEL4, THERMONUCLEAR REACTION RATES	749
LASL	7600	F4	RS	P	CT	A		\$SALVIN, DIFFERENTIAL-INTEGRAL DATA CONSISTENCY	815
LASL	7600	F4	RS	P	X	T	H	\$K-FIX, TRANSIENT 2-DIMENSIONAL 2-FLUID FLOW	727
LASL	7600B	F	RS	P		H		\$SOLA,SOLA-SURF, TRANSIENT FLUID FLOW ALGORITHM	651
LASL	7600B	F+COM	RS	P	L	T	A	\$GNASH, PARTICLE INDUCED X-SECTIONS & SPECTRA	757
LASL	7600D	F4	RS	P	T	C		\$TWOTRAN2, 2-D MULTI-GP TRANSPORT XY RZ RTHETA	358
LASL XSEC SETS, SN 18- 24- AND 25-GROUP SETS	LASL	6600	BCD	R	LX	T	Z	\$	532

LASLIB

LIZARD

LASLIB, LOS ALAMOS SUBROUTINE LIBRARY ROUTINES	LASL	6600C	F+COM	RS	T	P	S	633
LATIN SQ, NXN LATIN SQUARE EXPERIMENTAL DESIGN	MLMO	360	F4	RSBP	C	P	S	630
LATIN SQUARE EXPERIMENTAL DESIGN	MLMO	360	F4	RSBP	C	P	SLATIN SQ, NXN	630
LATTICE	GGA	1108	F4	RS	B	SHEXSCAT,	ELASTIC SCAT X-SECTIONS	291
LATTICE	TVA	360B	F4	RSBPLXCT	B	SLASER,	SPECTRUM CALC WITH BURNUP CYL	249
LATTICE DYNAMICS	ANL	360	F4	RS	P	T	Q	SGROUP2, GROUP THEORY OF
LATTICE DYNAMICS	LASL	6600	F4	RS	P	T	Q	SGROUP2, GROUP THEORY OF
LATTICE PHYSICS MODULES	DP	360	F+BAL	S	X	T	B	SRAHAB, JOSHUA SYSTEM
LATTICE VIBRATION NEUTRON SCATTERING CODES	EG&G	360	F4	RS	P	CT	W	SMACS
LEASE ANALYSIS	SLA	360	COBOL	RSBP	CT	M	SBECOM,	AEC DP PURCHASE VERSUS
LEASE ANALYSIS	SLA	1108	COBOL	RS	P	M	SBECOM,	AEC DP PURCHASE VERSUS
LEAST SQ LENS DESIGN SYSTEM	LASL	6600	F+COM	RS	P	T	P	SLENDES, NONLINEAR
LEAST SQUARES ANALYSIS RESONANCE DATA	UICS	360	F4	RS	P	A	SCODILLI,	
LEAST SQUARES EXPONENTIAL DECAY CURVES	LLL	7600	F4	RS	P	P	SEXPALS,	
LEAST SQUARES FIT FISSION NUCLIDE DATA	BAPL	6600	F4	RS	P	P	SDAFT1,	R327
LEAST SQUARES FIT SUM OF EXPONENTIALS	ANL	370	F4	RS	P	P	SFRANTIC,	
LEAST SQUARES FIT TO NONLINEAR FORMS	DP	360	F4	RS	P	P	SNIXLIN,	
LEAST SQUARES PHOTOPEAK SPECTRA CODE	BNW	1108	F+BAL	RS	P	T	O	SGSSLRN1B,
LEAST SQUARES TRANSMUTATION ANALYSIS	BNW	1108	F5	RS	P	T	D	SDBUFIT1,
LEGENDRE FITTING	KAPL	6600	F4	RS	P	A	SCLEAM,	ANGULAR DISTRIBUTION
LENS DESIGN SYSTEM	LASL	6600	F+COM	RS	P	T	P	SLENDES, NONLINEAR LEAST SQ
SLENDES, NONLINEAR LEAST SQ LENS DESIGN SYSTEM	LASL	6600	F+COM	RS	P	T	P	S
LEOPARD.SPOTS, SPECTRUM CALC WITH DEPLETION	JNC	1108B	F5	RS	PLX	T	B	S
LEOPARD.SPOTS, SPECTRUM CALC WITH DEPLETION	WAPD	360C	F4	RS	PLXCT	B	S	
LETO, 1-D SLAB GAMMA-RAY TRANSPORT	BAPL	6600	F4	RS	P	T	J	SM0756,
LIB SCOPE2.0 CEND	7600B	F4	RS	T	P	SMODEL,	MODIFIED BETTIS ENVIRNMNTL	478
LIB SCOPE3.3 CDC	6600D	F+COM	RS	T	P	SMODEL,	MODIFIED BETTIS ENVIRNMNTL	478
LIB. AI	360	F4	RSBPLX	T	C	SCAESAR4,LIBLST,	1-D MULTI-GP DIFFUSION &	270
LIB. NED	635	F+GMP	RS	T	P	SGENED	ENVIRONMENTAL ROUTINES, SUBROUTINE	515
LIB. BAPL	6600A	F+ASC	RS	T	P	SBETTIS	ENVIRONMENTAL ROUTINES, SUBROUTINE	478
LIBLST, 1-D MULTI-GP DIFFUSION & LIB.	AI	360	F4	RSBPLX	T	C	SCAESAR4,	270
LIBRARIES FROM ENDF/B DATA	WAPD	7600	F4	RS	P	T	B	SETOT2, THERMAL
LIBRARIES, MUFT4 OR 5, GAM1 OR 2	WAPD	6600	BCD	R	L	T	Z	SETOG1 DATA
LIBRARY	BAPL	6600	F+COM	RS	T	P	SBETTIS	PROGRAMMING ENVIRONMENT
LIBRARY	BAPL	7600	F+COM	RS	T	P	SBETTIS	PROGRAMMING ENVIRONMENT
LIBRARY CAT. A-E	ANL	360B	F+P+A	RS	T	P	SAMDLIBAE,	ARGONNE SUBROUTINE
LIBRARY CAT. F	ANL	360B	F+BAL	RS	T	P	SAMDLIBF,	ARGONNE SUBROUTINE
LIBRARY CAT. G-Z	ANL	360B	F+P+A	RS	T	P	SAMDLIBGZ,	ARGONNE SUBROUTINE
LIBRARY FORM	WAPD	7600	F4	RS	P	T	B	SETOT3, ENDF/B V3 DATA TO THERMAL
LIBRARY GENERATION	BAPL	6600	F+COM	RS	P	T	B	SRECAP-0, RECAP-12 X-SECTION
LIBRARY GROUP-COLLAPSING	APG	6600	F4	RS	B	SAPRFX1,	99-GP DLC-2B	466
LIBRARY JOURNAL MANAGEMENT	ORNL	360	C+BAL	RS	PL	CT	M	SJOURNAL CONTROL,
LIBRARY MAINTENANCE	NED	635	F4	RS	P	T	M	STROUT, MUG MULTIGROUP XSEC
LIBRARY MAINTENANCE	NED	1108	F5	RS	P	T	M	STROUT, MUG MULTIGROUP XSEC
LIBRARY PREPARATION	GGA	1108	F4	RS	P	X	T	L
LIBRARY ROUTINES	LASL	6600C	F+COM	RS	T	P	S'ASLIB,	LOS ALAMOS SUBROUTINE
LIBRARY UTILITY ROUTINE	AI	360	F4	RSB	L	T	M	SCCLIP, FORM OR THREDES
LIBRARY, 30-GP ENDF/B SCAT KERNELS	DP	360	BCD	R	LX	T	Z	STHERMOS
LIFE3, MIXED-OXIDE FUEL ELEMENT PERFORMANCE	ANL	370	F4	RS	P	CT	I	S
LIFE3, MIXED-OXIDE FUEL ELEMENT PERFORMANCE	ANL	7600	F4	RS	P	T	I	S
LIMITS	BKC	360	F4	RSBP	P	SGRAPH,	LINEAR REGRESSION W/CONFIDENCE	624
LINDA, EVALUATION OF STRAIN-GAGE DATA	ORNL	360	F+BAL	RS	P	T	I	S
LINE PRINTER PLOT SUBROUTINE PACKAGE	ACRC	370	F4	RS	P	CT	N	SPRPLT,
LINEAR ALGEBRAIC EQUATNS	ANL	370	F4	RS	P	X	T	P
LINEAR ELASTIC SINGULARITY MODELING	SLA	6600	FTN	RS	P	T	I	SCHILES,
LINEAR ELASTIC STRUCTURAL DYNAMICS	BAPL	6600	F4	RS	P	I	SM0266,	R383
LINEAR ELASTIC SYSTEMS	BAPL	6600	F4	RS	P	I	SM0552,	DYNAMIC ANALYSIS
LINEAR REGRESSION W/CONFIDENCE LIMITS	BKC	360	F4	RSBP	P	SGRAPH,		624
LINEAR SYSTEMS	ANL	370D	F4	RS	P	CT	I	SSAP4,
LINEAR, SIGMA1, LINEARIZE & BROADEN ENDF/B DATA	LLL	7600	F4	RS	P	T	B	S
LINEARIZE & BROADEN ENDF/B DATA	LLL	7600	F4	RS	P	T	B	SLINEAR, SIGMA1,
LINEARLY-CONSTRAINED OPTIMIZATION	ORNL	360	F4	RS	P	P	SKEELE,	556
LINPACK, SIMULTANEOUS LINEAR ALGEBRAIC EQUATNS	ANL	370	F4	RS	P	X	T	P
LION4, 3-D TEMPERATURE DISTRIBUTION PROGRAM	CHI	1108A	F4	RS	P	T	H	S
LION4, 3-D TEMPERATURE DISTRIBUTION PROGRAM	FW	360	F4	RS	P	CT	H	S
LION4, 3-D TEMPERATURE DISTRIBUTION PROGRAM	FW	1108B	F4	RS	P	T	H	S
LION4, 3-D TEMPERATURE DISTRIBUTION PROGRAM	KAPL	6600B	F+ASC	RS	P	T	H	S
LIQUID-FILLED PIPING SYSTEM ANALYSIS	ANL	7600B	F4	RS	P	T	G	SWHAM6,
LIQUID-FILLED PIPING SYSTEM ANALYSIS	EG&G	360B	F+BAL	RS	P	T	G	SWHAM6,
LIST FROM JCL PROCLIBS	HCI	370	F+C+A	RS	XC	P	SJCLCROSS,	DSN CROSS-REF
LITHE.HELP, CRITICAL ANALYSIS SYSTEM	DP	360	F+BAL	RS	P	XCT	B	SHAMMER,
LIZARD, NONLINEAR DIFFERENTIAL EQNS. SOLUTION	KAPL	6600	F+ASC	RS	P	T	P	S

LLL

MATERIALS

LLL	360	F4	RS	P	X	T	P	SEPISODE, ORDINARY DIFF EQUATION SYSTEM SOLVER	675	
LLL	360	F4	RS	P	X	T	P	SEPISODEB, SOLVE ODE SYST WITH BANDED JACOBIAN	705	
LLL	360C	F4	RS	P	X	T	P	SGEARB, SOLVE ODE SYSTEM WITH BANDED JACOBIAN	661	
LLL	6600C	F4	RS	P	X	T	P	SGEAR, ORDINARY DIFFERENTIAL EQN SYSTEM SOLVER	592	
LLL	6600C	F4	RS	P	X	T	P	SGEARB, SOLVE ODE SYSTEM WITH BANDED JACOBIAN	661	
LLL	7600	F	RS	P	T	N		SZONE, 2-D FINITE ELEMENT MESH GENERATOR	765	
LLL	7600	F4	RS	P			P	SEXPALS, LEAST SQUARES EXPONENTIAL DECAY CURVES	321	
LLL	7600	F4	RS	P			P	SPDEONE, SOLUTIONS OF PARTIAL DIFFERENTIAL EQNS	777	
LLL	7600	F4	RS	P	T	B		SLINEAR, SIGMA1, LINEARIZE & BROADEN ENDF/B DATA	747	
LLL	7600	F4	RS	P	T	F		SHEMP, HYDRODYNAMIC ELASTICMAGNETO PLASTIC	775	
LLL	7600	F4	RS	P	T	T		SWFLL2B, WIRE CONFIGURATION FREQUENCY DOMAIN	721	
LLL	8080	ASM	RS	P	T	P		SBASIC2 INTERPRETER, MINIMAL BASIC LANGUAGE	803	
LMFBR	CONTAINMENT ACCIDENT ANALYSIS							HEDL 6600 F4 RS P T G	SCACECO,	R762
LMFBR	COOLANT TEMPERATURE PREDICTION							MIT 370 F4 RS P T H	SENERGY,	696
LMFBR	FUEL PIN THERMAL PERFORMANCE MODEL							HEDL 6600 F RS P T H	\$SIEX,	673
LMFBR	FUELPIN	ANL	360	F4	RS	P	H	SMARGE/SLUMP, MAXIMUM TEMPERATURE	677	
LMFBR	MIXED-OXIDE CORES							FBRD 6000 F4 RS P T D	SCOROPT, OPTIMIZING	S752
LMFBR	POWER EXCURSION DISASSEMBLY							ANL 360 F4 RS P XCT F	SVENUS, 2-D	511
LMFBR	ROD BUNDLE							NED 635 F4 RS P T H	\$VELVET2, TURBULENT FLOW IN	458
LMFBR	TRANSIENT RESPONSE TO ACCIDENT							BNL 7600 F+COM RS P T G	SNALAP,	780
LMSC	1100	F5	RS	P		D		\$ISOTOPES, MAXIMUM YIELD FROM REACTION OR DECAY	179	
LOAD	BAPL	6600	F4	RS	P	T	I	\$SEALSHL2, SHELL STRESS ANALYSIS AXISYM	R282	
LOAD	SR	360	F4	RS	P	T	I	\$SEALSHL2, SHELL STRESS ANALYSIS AXISYM	R282	
LOAD	WTSC	7600	F4	RS	P	T	I	\$SEALSHL2, SHELL STRESS ANALYSIS AXISYM	R282	
LOCA	EG&G	360	F4	RSBP	X	T	G	\$THETA1-B, FUEL ROD THERMAL RESPONSE	512	
LOCA	BCL	6400	F4	RS	P	T	G	\$CORRAL2, RADIONUCLIDE CONTAINMENT AFTER	745	
LOCA	ANALYSIS DUKE POWER MCGUIRE UNITS							DUCO 635 F4 RS	G \$ANVENT,	529
LOCA	EXPERIMENTS							ORNL 360 F4 RS P T H	\$HETRAP, FUEL ROD RESPONSE	730
LOCA	FISSION PRODUCT RELEASE ANALYSIS							BCL 6400 F4 RS P G	\$FRCL2,	500
LOCA	ROD BUNDLE CHF DATA ANALYSIS							EG&G 360 F4 RS PL CT P	\$SERREST,	518
LOCK	FEW-CHANNEL COOLANT-FLOW BLOCKAGE							STUDY PNC 360 F4 RS P T H	\$	732
LOG	GAMMA SUBROUTINES							SLA 6600 F4 RS P T P	\$BESSEL FUNCTIONS, AIRY &	656
LOG-NORMAL	DIST MODEL							BCL 6400 F4 RS P T G	\$SHAARM3, AEROSOL BEHAVIOR	797
LOGNORMAL	MODEL							AI 370 F RS P T G	\$SHAA3B, AEROSOL BEHAVIOR	443
LOS	ALAMOS SUBROUTINE LIBRARY ROUTINES							LASL 6600C F+COM RS T P	\$LASLIB,	633
LOSS-OF-COOLANT	& EMERGENCY COOLING							BCL 6400 F4 RS P T G	\$ECCSA4,	330
LOSS-OF-COOLANT	ACCIDENT ANALYSIS							BAPL 6600 F4 RS P T G	\$FLASH3,	R295
LOSS-OF-COOLANT	ACCIDENT ANALYSIS							BAPL 6600 F4 RS P T G	\$M0555,ACT1,	R284
LOSS-OF-COOLANT	THERMAL ANALYSIS							BCL 6400 F4 RS P T G	\$NURLOC-1.0,	328
LSU	360	F4	RS	P	J			\$DEMONR, UNBIASED MONTECARLO SLAB SHIELD CODE	754	
LUGS	STRESS FOR INTEGRAL ATTACHMENTS TO PIPE							ORNL 360 F4 RS P I	\$	648
LUMPED-MASS	SYSTEMS							SLL 6600 F4 RS P T I	\$SHOCK, DYNAMIC RESPONSE OF	795
LWRB	FUEL SWELLING TEMPERATURE STUDY							BAPL 6600 F4 RS P T H	\$FIGRO,	R272
LWR	REFLOOD HEAT TRANSFER PREDICTION							MIT 360 F4 RS P T H	\$REFLUX,	763
MA-G	360	F4	RSBP	CT	G			\$FLASH4, FULLY-IMPLICIT TRANSIENT SIMULATION	R448	
MACH1	1-D MULTI-GP DIFFUSION SLAB CYL SPHERE							MTS 360 F4 RSBPXCT C	\$	262
MACH1	1-D MULTI-GP DIFFUSION SLAB CYL SPHERE							PURD 6500 F4 RSPLXTC	\$	262
MACRO-BASED	STRUCTURED FORTRAN							SLAC 360 F4 RSBPXCT P	\$MORTAN2,	678
MACROS	ANL	370	BAL	RSBP	CT	P		\$FORTIO, FORTRAN INTERFACE TO IBM370	772	
MACS	LATTICE VIBRATION NEUTRON SCATTERING CODES							EG&G 360 F4 RS P CT W	\$	574
MAGNETIC	NETWORK SOLUTION							BAPL 6600B F4 RS P I	\$MANE1, RECTANGULAR	R412
MAINTENANCE	NED	635	F4	RS	P	T	M	\$TROUT, MUG MULTIGROUP XSEC LIBRARY	493	
MAINTENANCE	NED	1108	F5	RS	P	T	M	\$TROUT, MUG MULTIGROUP XSEC LIBRARY	493	
MANAGEMENT	ORNL	360	C+BAL	RS	PL	CT	M	\$JOURNAL CONTROL, LIBRARY JOURNAL	660	
MANAGEMENT	NED	635	F4	RS	P	T	D	\$FUMBLE, FAST REACTOR FUEL BURNUP &	480	
MANAGEMENT	SYSTEM	UCND	370	COBOL	RS			\$NMSS, NUCLEAR MATERIALS	695	
MANAGEMENT	SYSTEM	ALOO	360	COBOL	RS	P		\$SAEC-ALO FAU, RADIO FREQUENCY	587	
MANAGEMENT	EDITING, & ANALYSIS							BAPL 6600 F4 RS P T M	\$SHLOG, DATA	R557
MANE1	RECTANGULAR MAGNETIC NETWORK SOLUTION							BAPL 6600B F4 RS P I	\$	R412
MANIPULATION	ANL	360	F4	RSBP	CT	L		\$ARC-XSEC1, MICROSCOPIC X-SECTION	594	
MANTA	STEADY-STATE THERMAL-HYDRAULIC ANALYSIS							NED 635 F4 RS P T H	\$	256
MANTA	STEADY-STATE THERMAL-HYDRAULIC ANALYSIS							WARD 6600 F4 RS P T H	\$	256
MANUFACTURING	REQUIREMENTS							GEPI GETS BASIC R	\$MAPPER, PREDICTING	595
MAPPER	PREDICTING MANUFACTURING REQUIREMENTS							GEPI GETS BASIC R	\$	595
MARGE/SLUMP	MAXIMUM TEMPERATURE							LMFBR FUELPIN ANL 360 F4 RS P H	\$	677
MARKOV	SIMULATION OF REACTOR OPN							DP 360 F4 RS P G	\$INTEG, INSPEC,	590
MARLOWE	BINARY COLLISION CASCADE SIMULATION							ORNL 360C F+BAL RS P X T Q	\$	680
MARLOWE	BINARY COLLISION CASCADE SIMULATION							ORNL 7600 F+BAL RS P X T Q	\$	680
MASS	MATRIX GENERATION							BAPL 6600 F+COM RS P H	\$HYMAS, HYDRODYNAMIC	R560
MASS	SPECTROMETRY							RFD 360 F4 RS P U	\$DYNAMIC ANALYSIS OF GASES BY	645
MATERIAL	BUCKLING CYL FUEL ELEMENTS							AEB 360 F4 RS P B	\$WELWING,	362
MATERIALS	LASL	6600	F4	RS	P	T	A	\$TOR, THERMAL SCATTERING CRYSTALLINE	360	

MATERIALS

MOCUS

MATERIALS MANAGEMENT SYSTEM	UCND	370	COBOL	RS	CT	M	SMSS, NUCLEAR	695
MATHEMATICAL SUBROUTINES	SLA	6600C	F+COM	RS	P	X	T	654
MATHLIB, SANDIA MATHEMATICAL SUBROUTINES	SLA	6600C	F+COM	RS	P	X	T	654
MATRIX EIGENVALUE/VECTOR PACKAGE	ANL	360B	F4	RSBP	XCT	P	SEISPACK2,	534
MATRIX EIGENVALUE/VECTOR PACKAGE	ANL	PD10B	F4	RS	P	X	T	534
MATRIX EIGENVALUE/VECTOR PACKAGE	ANL	1110B	F4	RS	P	X	T	534
MATRIX EIGENVALUE/VECTOR PACKAGE	ANL	6600B	F4	RS	P	X	T	534
MATRIX EIGENVALUE/VECTOR PACKAGE	ANL	6700B	F4	RS	P	X	T	534
MATRIX GENERATION	BAPL	6600	F+COM	RS	P	H	SHYMAS, HYDRODYNAMIC MASS	R560
MATRIX GENERATION FOR A SYSTEM OF BEAMS	KAPL	6600	F4	RS	P	I	SSTEM,	R337
MATUS, 3-D FINITE-ELEMENT ELASTIC ANALYSIS	BAPL	6600	F+COM	RS	P	X	T	R597
MAXIMUM TEMPERATURE LMFBR FUELPIN	ANL	360	F4	RS	P	H	SMARGE/SLUMP,	677
MAXIMUM YIELD FROM REACTION OR DECAY	LMSC	1100	F5	RS	P	D	SISOTOPES,	179
MC ORNL 360B F+BAL RS P T B SRAFFLE, 1ST FLIGHT COLLISION PROBABILITIES								392
MC-2-2, FAST NEUTRON SPECTRA & MULTIGP X-SECS	ANL	370	F+BAL	RSBP	CT	B	S	355
MC-2-2, FAST NEUTRON SPECTRA & MULTIGP X-SECS	ANL	7600	F+COM	RS	PLXCT	B	S	355
MCGUIRE UNITS DUCO 635 F4 RS G SANVENT, LOCA ANALYSIS DUKE POWER								529
MEASUREMENT ANALYSIS	GEC	635	F4	RSBP	O	SMICHRD, MICROHARDNESS		421
MEASUREMENTS	GGA	1108	F4	RS	P	T	A	410
MECHANICAL ANALYSIS OF TEES	ORNL	360B	F4	RS	P	CT	I	759
MECHANICS FBPD 7600 F4 RS P T H SBHAVE-SST, OVERPOWER TRANSIENT FUEL								768
MEDIA BKY 7600 F4 RS P T H SSCHAFF, HEAT & WATER TRANSFER IN POROUS								802
MEDIA TLD CORRECTION CALC	AI	360	F4	RS	P	Q	SRESPOND, DISSIMILAR	566
MELTDOWN BCL 6400 F4 RS P G SBOILL, BOILOFF ACCIDENT CORE HEATUP &								734
MELT3, FAST REACTOR TRANSIENT OVERPOWER STUDY	HEDL	6600	F4	RS	P	CT	F	700
MEMORY DUMP UTILITY	BKY	7600	F+COM	RS	P	T	P	698
MESH	GGA	1108	F4	RS	P	T	C	360
MESH LASL 360 F+BAL RS P CT C STRIDEIT, 2D MULTIGP TRANSPORT TRIANGULAR								741
MESH LASL 7300 F4 RS P T C STRIDENT, 2D MULTIGP TRANSPORT TRIANGULAR								741
MESH GGA 1108 F+BAL RS P T C SGAMTRI, 2-D MULTI-GP DIFFUSION TRIANGULAR								401
MESH COLLAPSING	RW	6500	F4	RS	P	B	SPARTI, OPTIMAL GROUP OR	416
MESH GENERATION	ANL	360	F4	RS	P	CT	L	612
MESH GENERATION	SLA	6600	F4	RS	P	T	L	612
MESH GENERATOR	LLL	7600	F	RS	P	T	N	765
MESH GENERATOR	WARD	7600	F4	RS	P	T	L	R746
MESH TRANSPORT PROGRAM	LASL	360	F4	RSBP	CT	C	STRIPLET, 2-D TRIANGULAR	608
MESH TRANSPORT PROGRAM	LASL	6600	F4	RS	P	T	C	608
MESH TRANSPORT PROGRAM	LASL	7600	F4	RS	P	T	C	608
MESH2.GPRINT, 2-D NONLINEAR ANALYSIS	SLL	6600	F+COM	RS	P	T	I	682
METALLIC FISSION PRODUCT RELEASE	GGA	1108	F4	RS	P	D	SFREVAP6, HTGR	301
METHOD ORNL 360 F4 RS P D SPRP, PRODUCT PRICE CALCULATED BY DCF								739
METRIC TO U.S. CUSTOMARY UNITS	MLMO	360	F4	RS	P	XC	P	812
METRICATION, CONVERSION TO OR FROM SI UNITS	RDYN	370B	F4	RS	P	T	P	G668
MGBS.TGAN, NUCLEAR CRITICALITY SAFETY	DP	360	F4	RS	P	T	C	617
MHD DIFFUSER PERFORMANCE	ANL	370	F4	RS	P	H	SDIFFUSER, 2D SUBSONIC	737
MICHRD, MICROHARDNESS MEASUREMENT ANALYSIS	GEC	635	F4	RSBP	O	S		421
MICROHARDNESS MEASUREMENT ANALYSIS	GEC	635	F4	RSBP	O	SMICHRD,		421
MICROSCOPIC X-SECTION MANIPULATION	ANL	360	F4	RSBP	CT	L	SARC-XSEC1,	594
MINIMAL BASIC LANGUAGE	LLL	8080	ASM	RS	P	T	P	803
MINIMAL SETS FROM FAULT TREES	EG&G	360	F4	RSBP	CT	G	SMOCUS,	653
MIRAB.MIRAP, CONTAINMENT SYSTEM IODINE REMOVAL	BCL	6400B	F4	RS	P	X	T	499
MIRAP, CONTAINMENT SYSTEM IODINE REMOVAL	BCL	6400B	F4	RS	P	X	T	499
MIT 360 F4 RS P T H SREFLUX, LWR REFLOOD HEAT TRANSFER PREDICTION								763
MIT 360 F4 RS P T I SSABOR4, DISCRETE-ELEMENT ANALYSIS THIN SHELLS								R402
MIT 370 F4 RS P T H SENERGY, LMFBR COOLANT TEMPERATURE PREDICTION								696
MIT 370 F4 RS P T T STDIST2, COMMUNITY ENERGY CONSUMPTION ANALYSIS								799
MIX KAPL 6600 F4 RS P H SRAPP, HIGH-VELOCITY FLOW STUDY STEAM-WATER								R382
MIXED INTEGER OPTIMIZATION	EG&G	360	F4	RS	P	P	SARSTEC, NONLINEAR	738
MIXED ISOTOPES	MLMO	360B	F4	RS	P	C	Q	R619
MIXED-OXIDE CORES	FBPD	6000	F4	RS	P	T	D	S752
MIXED-OXIDE FUEL ELEMENT PERFORMANCE	ANL	370	F4	RS	P	CT	I	R460
MIXED-OXIDE FUEL ELEMENT PERFORMANCE	ANL	7600	F4	RS	P	T	I	R460
MIXTURE FLOW	LASL	6600	F4	RS	P	X	T	720
MLMO 360 F+C+R RSBP T M SRALCRTPH, RESOURCE ALLOCATION PROJECT PLANNING								G603
MLMO 360 F+COB RSBP XC M SRANDOM SAMPLING TABLE, FOR NON-BIAS ORDERING								679
MLMO 360 F4 RS P XC P SMTRC0001, SI METRIC TO U.S. CUSTOMARY UNITS								812
MLMO 360 F4 RSBP C P \$LATIN SQ, NXN LATIN SQUARE EXPERIMENTAL DESIGN								630
MLMO 360B F4 RS P C Q \$ISOTAB, PU POWER OUTPUT FROM MIXED ISOTOPES								R619
MM3, COORDINATE ANALYSES SEMI-RIGID MOLECULES	EG&G	360	F4	RS	P	W	S	632
MOBILE HOME HEATING & COOLING ENERGY USE	ORNL	360	F4	RS	P	X	R	724
MOBY, MOBILE HOME HEATING & COOLING ENERGY USE	ORNL	360	F4	RS	P	X	R	724
MOCUS, MINIMAL SETS FROM FAULT TREES	EG&G	360	F4	RSBP	CT	G	S	653

MODE

MULTI-GP

MODE	BAPL	6600	F4	RS P	P	SREL01, RELIABILITY FOR A SINGLE FAILURE	R497
MODE	FAST REACTOR X-SEC CALC	BNW	1108	F4	RS P T B	SFCC4, FUNDAMENTAL	306
MODELING	SLA	6600	FTN	RS P T I	SCHILES, LINEAR ELASTIC SINGULARITY		611
MODELS FOR DUCT SURFACES	ANL	370	F4	RS P	H	SSLGTR, SLAG TRANSPORT	783
MODERATOR	GGA	1108	F4	RS P	A	SGAKER, INELASTIC SCAT X-SECTION CALC	289
MODIFIED BETTIS ENVIRNMNTL LIB SCOPE2.0	CEND	7600B	F4	RS	T P	SMODEL,	478
MODIFIED BETTIS ENVIRNMNTL LIB SCOPE3.3	CDC	6600D	F+COM	RS	T P	SMODEL,	478
MODULAR DOCUMENT INFORMATION SYSTEM	KAPL	6600B	F+ASC	RSB	X T M	\$TIGIR2,	R403
MODULAR PROGRAMMING AND DATA SYSTEM	KAPL	6600B	F+COM	RS P X T M		\$DATATRAN2,	386
MODULAR PROGRAMMING AND DATA SYSTEM	KAPL	7600C	F+COM	RS P T M		\$DATATRAN2,	386
MODULE	ANL	360	F4	RSBP CT L	SARC-NU1002, BCD INPUT DATA PROCESSING		533
MODULES	ANL	360	F+BAL	RSBP CT M	SARC-SYSTEM, SYSTEM SUBPROGRAMS AND		522
MODULES	DP	360	F+BAL	S X T B	SRAHAB, JOSHUA SYSTEM LATTICE PHYSICS		536
MODULES F(X) & F(X,Y)	KAPL	6600B	F+COM	RS P T P	\$DATATRAN2, UTILITY PLOT		407
MODULES 2-D INPUT GEN	KAPL	6600B	F+C	RS P T L	\$DATATRAN2, RAD1 GEOMETRY		406
MOD5, STOCHASTIC MODEL OF NEUTRON SLOWING-DOWN	NPGS	360	F4	RS P X T E S			491
MOLECULES	EG&G	360	F4	RS P W	SMM3, COORDINATE ANALYSES SEMI-RIGID		632
MONA, 1-D MULTIGROUP DIFFUSION SLAB, CYL, SPH	EG&G	360	F4	RSBP CT C S			582
MONITOR	SLAC	360B	F+BAL	RSB CT P	SROGLOOK, USER PROGRAM PERFORMANCE		642
MONITOR	SLAC	370	BAL	RSB CT P	SSLACMON/370, VERSION 4.0 VS SOFTWARE		635
MONITOR	SLAC	360	BAL	RS CT P	SSLACMON 2.2, OS360 MVT/MFT PERFORMANCE		635
MONTE CARLO CELL CALCULATION	AI	360	F+BAL	RS P X T B	SHWOCR-SAFE, 2-D		307
MONTE CARLO CRITICAL ASSEMBLY ANALYSIS	AI	7600	F4	RS PLX T C	SVIM1,		510
MONTE CARLO CRITICAL ASSEMBLY ANALYSIS	AI-A	360	F4	RSBPLXCT C	SVIM1X,		510
MONTE CARLO CRITICALITY CALCULATIONS	BAPL	7600	F+COM	RS P T C	SRECAP-12,		R670
MONTE CARLO FAULT TREE SIMULATION CODE	NEA	360	F4	RS P	G	SSAFTAC,	674
MONTE CARLO FAULT TREE SIMULATION CODE	UNI	1108	F+SLE	RS P	G	SSAFTAC,	674
MONTE CARLO MULTIGROUP CRITICALITY CODE	DP	360B	F+BAL	RSBP CT C	\$KENO2,		450
MONTE CARLO MULTIGROUP CRITICALITY CODE	ORNL	360C	F+BAL	RSBPLXCT C	\$KENO4,		450
MONTE CARLO MULTIGROUP CRITICALITY CODE	RFD	6600B	F+COM	RS PLX T C	\$KENO2,		450
MONTE CARLO NEUTRON TRANSPORT	EG&G	360	F+BAL	RSBPL CT B	SRAFFLE2/MOD2,		631
MONTE CARLO REACTOR ANALYSIS CALCULATION	ORNL	360	F+BAL	RSBPL CT C	SESP,		523
MONTECARLO SLAB SHIELD CODE	LSU	360	F4	RS P J	\$DEMONR, UNBIASED		754
MORTRAN2, MACRO-BASED STRUCTURED FORTRAN	SLAC	360	F4	RSBP XCT P S			678
MOST, A MULTIDIMENSIONAL OPTIMIZATION SCHEME	KAPL	6600	F4	RS P	P S		R446
MOTION SOLUTION	SLA	3600	F36	RS P T I	STOODY2, 2-D LAGRANGIAN EQNS OF		627
MOXY/MOD032, BWR CORE HEAT TRANSFER CODE	EG&G	360B	F4	RSBP XCT H S			551
MSCAT, SLOW NEUTRON MULTIPLE SCATTERING CALC	ANL	360	F4	RS P CT W S			575
MSF21,VTE21, DESALINATION PLANT OPTIMIZATION	ORNL	360	F+BAL	RS P T D S			798
MSS	360	F4	RS P	H	SFLOW-MODEL, MULTI-CHANNEL 2-D 2-PHASE FLOW		246
MSS	360	F4	RS P CT C	SFLARE, 3-D REACTIVITY AND POWER DISTRIBUTION			167
MTRC0001, SI METRIC TO U.S. CUSTOMARY UNITS	MLMO	360	F4	RS P XC P S			812
MTS	360	F4	RSBPLXCT C	SMACH1, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE			262
MU+, LANGUAGE PROCESSOR TSO OR BATCH	ANL	360	F+BAL	RSBP X T P	\$SPEAKEASY		593
MUCHA1,MUCHA2, MULTIPLE CHANNEL ANALYSIS	ECC	BCL	6400	F4	RS P X T G S		508
MUCHA2, MULTIPLE CHANNEL ANALYSIS	ECC	BCL	6400	F4	RS P X T G	\$MUCHA1,	508
MUFT FORMAT X-SECTIONS	WAPD	6600	F4	RS P T B	SETOM1, ENDF/B FORMAT TO		436
MUFT, GAM, ANISN X-SEC FORMAT	WAPD	6600	F4	RS PL T B	SETOG1, ENDF/B TO		437
MUFT, GAM, ANISN X-SEC FORMAT	WAPD	7600	F4	RS P T B	SETOG3, ENDF/B TO		538
MUFT4 OR 5, GAM1 OR 2	WAPD	6600	BCD	R L T Z	SETOG1 DATA LIBRARIES,		447
MUG MULTIGROUP XSEC LIBRARY MAINTENANCE	NED	635	F4	RS P T M	STROUT,		493
MUG MULTIGROUP XSEC LIBRARY MAINTENANCE	NED	1108	F5	RS P T M	STROUT,		493
MULTI-CHANNEL 2-D 2-PHASE FLOW	MSS	360	F4	RS P H	SFLOW-MODEL,		246
MULTI-GP	ORNL	360I	F4	RS P T K	\$CITATION, 1,2,3-D DIFFUSION DEPLETION		387
MULTI-GP CONSTANT & FAST SPECTRA CALC	EG&G	360	F4	RS PLXCT B	\$PHROG,		520
MULTI-GP CONSTANT CALC 0 TO 10 MEV	BC	625	F4	RS PLX T B	\$GAMTEC2,		185
MULTI-GP CONSTANT CALC 0 TO 10 MEV	BNW	1107	F4	RS PL T B	\$GAMTEC2,		185
MULTI-GP CONSTANT CALC 0 TO 10 MEV	UVAC	6400	F4	RS PLX T B	\$GAMTEC2,		185
MULTI-GP CONSTANTS	EG&G	360	F4	RS PL CT B	\$INCITE, THERMAL SPECTRA &		565
MULTI-GP CONSTANTS FROM ENDF/B FOR 1DX	HEDL	360	F4	RSBP XCT B	SETOX3,		388
MULTI-GP CONSTANTS FROM ENDF/B FOR 1DX	HEDL	1108B	F4	RS P X T B	SETOX3,		388
MULTI-GP DIFFUSION	UMCC	360	F4	RS P T C	SVARI-QUIR, TIME-DEP 2-D		212
MULTI-GP DIFFUSION	WANL	6600	F4	RS P T C	SVARI-QUIR, TIME-DEP 2-D		212
MULTI-GP DIFFUSION & INVENTORY	ANL	360	F4	RSBP CT C	SARC-DIF1D, 1-D		626
MULTI-GP DIFFUSION & LIB	AI	360	F4	RSBPLX T C	SCAESAR4, LIBLST, 1-D		270
MULTI-GP DIFFUSION PROGRAM	BC	625	F4	RS	T C	SEXTERMINATOR2, 2-D	156
MULTI-GP DIFFUSION PROGRAM	CEND	6600	F4	RS P T C	SEXTERMINATOR2, 2-D		156
MULTI-GP DIFFUSION PROGRAM	ORNL	360	F4	RS P T C	SEXTERMINATOR2, 2-D		156
MULTI-GP DIFFUSION SLAB CYL SPHERE	BNW	1107	F4	RS P T C	SHFN, 1-D		241
MULTI-GP DIFFUSION SLAB CYL SPHERE	BNW	6600	F4	RS P X T C	SHFN, 1-D		241
MULTI-GP DIFFUSION SLAB CYL SPHERE	OSUC	370	F4	RS PL CT C	SAIM6, 1-D		29
MULTI-GP DIFFUSION SLAB CYL SPHERE	MTS	360	F4	RSBPLXCT C	SMACH1, 1-D		262

MULTI-GP

M0756

MULTI-GP DIFFUSION SLAB CYL SPHERE	PURD	6500	F4	RS PLX T C	SMACH1, 1-D	262
MULTI-GP DIFFUSION SLAB CYL SPHERE	BHSC	360	F4	RS P T C	SFAIMOS, 1-D	120
MULTI-GP DIFFUSION SYNTHESIS CALC	NED	635	F4	RS PL T C	SBISYN, 2-D	287
MULTI-GP DIFFUSION SYNTHESIS CALC	NED	1108	F4	RS P T C	SBISYN, 2-D	287
MULTI-GP DIFFUSION TRIANGULAR MESH	GGA	1108	F+BAL	RS P T C	SGAMTRI, 2-D	401
MULTI-GP DIFFUSION XY RZ GEOMETRY	GGA	1108	F+BAL	RS P T C	SGAMBLE5, 2-D	222
MULTI-GP DISCRETE ORDINATE CODE	GGA	1108	F5	RS P T C	\$2DF, 2-D	173
MULTI-GP DISCRETE ORDINATE PROGRAM	ANL	360	F+BAL	RS P T C	\$DTF4, 1-D	209
MULTI-GP DISCRETE ORDINATE PROGRAM	BC	625	F+MAP	RS P T C	\$DTF4, 1-D	209
MULTI-GP DISCRETE ORDINATE PROGRAM	LASL	6600	F4	RS P T C	\$DTF4, 1-D	209
MULTI-GP TRANSPORT XY RZ RTHETA	LASL	360D	F4	RSBP CT C	STWOTRAN2, 2-D	358
MULTI-GP TRANSPORT XY RZ RTHETA	LASL	6600D	F4	RS P T C	STWOTRAN2, 2-D	358
MULTI-GP TRANSPORT XY RZ RTHETA	LASL	7600D	F4	RS P T C	STWOTRAN2, 2-D	358
MULTI-GP X-SECTIONS FAST THERMAL SPECTRA	GGA	1108B	F4	RS PLXCT B	\$GGC4, 298	
MULTI-GP X-SECTIONS FAST THERMAL SPECTRA	WANL	6600	F4	RS L T B	\$GGC4, 298	
MULTI-LEVEL RESONANCE THEORY XSEC CALC	KAPL	6600	F4	RS P A	\$MULTI, R535	
MULTI, MULTI-LEVEL RESONANCE THEORY XSEC CALC	KAPL	6600	F4	RS P A	\$MULTI, R535	
MULTIANCHOR PIPE SYSTEM	AI	360	F4	RS P C I	\$PSA2, STRESS ANALYSIS	542
MULTICAVITY KLYSTRON TUBE ANALYSIS	SLAC	360	F4	RS P T V	\$SLACKLY, 1D	807
MULTICHANNEL ANALYSIS	ANL	370	F4	RS P CT H	\$TH13D, THERMAL-HYDRAULIC	706
MULTICOMPARTMENT CONTAINMENT	EG&G	7600	F+COM	RSBP LXCT G	\$CONTEMPT4/MOD2, 818	
MULTICOMPARTMENT CONTAINMENT	EG&G	7600B	F+COM	RS PLXCT G	\$CONTEMPT4/MOD2, 818	
MULTIDIMENSIONAL OPTIMIZATION SCHEME	KAPL	6600	F4	RS P P	\$MOST, A R446	
MULTIGP CONSTANTS	BNW	1108	F4	RS PLX T B	\$HRG3, SLOWING-DOWN SPECTRUM, 467	
MULTIGP CONSTANTS	TVA	360	F4	RS PLX T B	\$HRG3, SLOWING-DOWN SPECTRUM, 467	
MULTIGP DIFF & IGP DEPLETION	NED	635	F+GMP	RS P T D	\$SYN, 2D SYNTHESIS	495
MULTIGP DIFFUSION & BURNUP TRI-MESH	GGA	1108	F+BAL	RS P T D	\$BUGTRI, 2D	439
MULTIGP DISCRETE ORDINATES	LASL	360	F4	RS P T F	\$TIMEX, 1-D TIME-DEP	756
MULTIGP DISCRETE ORDINATES	LASL	7600	F4	RS P T F	\$TIMEX, 1-D TIME-DEP	756
MULTIGP KINETICS WITH TEMP FEEDBACK	GGA	1108	F4	RS P T F	\$GAKIT, 1-D	370
MULTIGP TRANSPORT TRIANGULAR MESH	LASL	360	F+BAL	RS P CT C	\$STRIDENT, 2D	741
MULTIGP TRANSPORT TRIANGULAR MESH	LASL	7600	F4	RS P T C	\$STRIDENT, 2D	741
MULTIGP X-SECS	ANL	370	F+BAL	RSBP CT B	\$MC+2-2, FAST NEUTRON SPECTRA & 355	
MULTIGP X-SECS	ANL	7600	F+COM	RS PLXCT B	\$MC+2-2, FAST NEUTRON SPECTRA & 355	
MULTIGROUP CONSTANTS FROM ENDF/B DATA	FBRD	635	F+GMP	RS P XCT B	\$ENDRUN2, 501	
MULTIGROUP CRITICALITY CODE	DP	360B	F+BAL	RSBP CT C	\$KENO2, MONTE CARLO	450
MULTIGROUP CRITICALITY CODE	ORNL	360C	F+BAL	RSBP LXCT C	\$KENO4, MONTE CARLO	450
MULTIGROUP CRITICALITY CODE	RFD	6600B	F+COM	RS PLX T C	\$KENO2, MONTE CARLO	450
MULTIGROUP DIFFUSION	ORNL	360	F+BAL	RSBP CT C	\$VENTURE, 1, 2, OR 3-D	686
MULTIGROUP DIFFUSION & BURNUP XY, RZ	GGA	1108	F+BAL	RS P T D	\$BUG2, 2-D	438
MULTIGROUP DIFFUSION & SN THEORY	NED	635	F4	RS P T C	\$DOT2DB, 2-D	459
MULTIGROUP DIFFUSION AND DEPLETION	BNW	1108	F4	RS P T D	\$2DB, 2-D	325
MULTIGROUP DIFFUSION AND DEPLETION	LASL	6600	F4	RS P T D	\$2DB, 2-D	325
MULTIGROUP DIFFUSION AND DEPLETION	GGA	1108	F4	RS P T D	\$FEVER7, 1-D	318
MULTIGROUP DIFFUSION BURNUP ANALYSIS	ANL	360	F4	RS P CT D	\$3DB, 3-D	567
MULTIGROUP DIFFUSION BURNUP ANALYSIS	HEDL	1108	F4	RS P T D	\$3DB, 3-D	567
MULTIGROUP DIFFUSION DEPLETION	AI	360	F4	RSBP X T D	\$SIZZLE, 1-D	58
MULTIGROUP DIFFUSION SLAB, CYL, SPH	EG&G	360	F4	RSBP CT C	\$MONA, 1-D	582
MULTIGROUP DIFFUSION SLAB, SPH, CYL	GGA	1108	F+BAL	RS P T C	\$GAZE2, 1-D	430
MULTIGROUP DIFFUSION XYZ R-THETA-Z	LASL	6600	F4	RS P T D	\$3DDT, 3-D	463
MULTIGROUP REACTOR KINETICS PROGRAM	ORNL	360	F4	RS P XCT E	\$TASK, 1-D	558
MULTIGROUP TIME-DEPENDENT DIFFUSION	UFCC	370B	F4	RS P T F	\$GAKIN2, 10	310
MULTIGROUP XSEC LIBRARY MAINTENANCE	NED	635	F4	RS P T M	\$TROUT, MUG	493
MULTIGROUP XSEC LIBRARY MAINTENANCE	NED	1108	F5	RS P T M	\$TROUT, MUG	493
MULTILEVEL B-W X-SEC CALC	BNL	6600	F4	RS P A	\$SIGPLOT, RESOLVED	377
MULTIPLE CHANNEL ANALYSIS ECC	BCL	6400	F4	RS P X T G	\$MUCHA1, MUCHA2, 508	
MULTIPLE SCATTERING CALC	ANL	360	F4	RS P CT W	\$MSCAT, SLOW NEUTRON	575
MUSCAT, VIEW FACTOR SHIELDING CODE CAVITY GEOM	GGA	1108	F4	RS P T J	\$	259
MVT REMOTE JOB ENTRY SYSTEM	EG&G	360	BAL	RSB T P	\$NRTS-RJE, OS/360	519
MVT/MFT PERFORMANCE MONITOR	SLAC	360	BAL	RS CT P	\$SLACMON 2.2, OS/360	635
M0102, POINT DEPLETION FISSION PRODUCT	BAPL	6600	F4	RS P D	\$CINDER, 313	
M0102, POINT DEPLETION FISSION PRODUCT	DP	360	F+BAL	RS P T D	\$CINDER, 313	
M0219, PWR FLOW TRANSIENT ANALYSIS	BAPL	6600	F4	RS P T H	\$FLOT1, R331	
M0266, LINEAR ELASTIC STRUCTURAL DYNAMICS	BAPL	6600	F4	RS P I	\$	R383
M0457, PIPE, ELASTIC STRESS OF PIPING SYSTEM	BAPL	6600	F4	RS P T I	\$	R329
M0552, DYNAMIC ANALYSIS LINEAR ELASTIC SYSTEMS	BAPL	6600	F4	RS P I	\$	R283
M0555, ACT1, LOSS-OF-COOLANT ACCIDENT ANALYSIS	BAPL	6600	F4	RS P T G	\$	R284
M0626, POLYNOMIAL CURVE FITTING	BAPL	6600	F4	RS P T P	\$M0661, M0657, R411	
M0648, 1-D SLAB TRANSPORT WITH SLOWING DOWN	BAPL	6600	F4	RS C	\$	R342
M0657, M0626, POLYNOMIAL CURVE FITTING	BAPL	6600	F4	RS P T P	\$M0661, R411	
M0661, M0657, M0626, POLYNOMIAL CURVE FITTING	BAPL	6600	F4	RS P T P	\$	R411
M0756, LETO 1-D SLAB GAMMA-RAY TRANSPORT	BAPL	6600	F4	RS P T J	\$	R343

MO807

NUCLEAR

MO807, 2-D DIFFUSION ABSORPTION REMOVAL X-SECS	BAPL	6600	F4	RS	B	S	R280
MO899, HOH, STEAM TABLES 14.5-2538 PSIA	BAPL	6600	F4	RS P	H	S	R294
NAHAMMER, FLUID HAMMER ANALYSIS PIPING SYSTEM	ANL	360	F4	RS P	G	S	717
NAHAMMER, FLUID HAMMER ANALYSIS PIPING SYSTEM	ANL	7600	F4	RS P	G	S	717
NAIAD, COMPRESSIBLE 2-PHASE COOLANT BEHAVIOR	AAEC	360	F+BAL	RSBPLXCT	G	S	726
NALAP, LMFBR TRANSIENT RESPONSE TO ACCIDENT	BNL	7600	F+COM	RS P T	G	S	780
NATTRANSIENT, FLUID HAMMER ANALYSIS 1-D PIPING	ANL	360	F4	RS P	G	S	718
NATRAN2, FLUID HAMMER ANALYSIS 1D & 2D SYSTEMS	ANL	360	F4	RS P T	G	S	719
NEA 360 F4 RS P G	SSAFTAC, MONTE CARLO FAULT TREE SIMULATION CODE						674
NED 635 F+GMP RS T P	SGENED ENVIRONMENTAL ROUTINES, SUBROUTINE LIB.						515
NED 635 F+GMP RS P T D	SSYN, 2D SYNTHESIS MULTIGP DIFF & 1GP DEPLETION						495
NED 635 F4 RS P D	SRAPFU, FUEL CYCLE PARAMETERS FAST BREEDERS						372
NED 635 F4 RS P T B	SREAX, RESOLVED RESONANCE EPITHERMAL X-SECTIONS						257
NED 635 F4 RS P T C	SDOT2DB, 2-D MULTIGROUP DIFFUSION & SN THEORY						459
NED 635 F4 RS P T C	SFLARE, 3-D REACTIVITY AND POWER DISTRIBUTION						167
NED 635 F4 RS P T D	SFUMBLE, FAST REACTOR FUEL BURNUP & MANAGEMENT						480
NED 635 F4 RS P T G	SFREADM1, FAST REACTOR CORE ACCIDENT ANALYSIS						479
NED 635 F4 RS P T H	SMANTA, STEADY-STATE THERMAL-HYDRAULIC ANALYSIS						256
NED 635 F4 RS P T H	SVELVET2, TURBULENT FLOW IN LMFBR ROD BUNDLE						458
NED 635 F4 RS P T M	STROUT, MUG MULTIGROUP XSEC LIBRARY MAINTENANCE						493
NED 635 F4 RS P T O	SBURNUP, HEAVY ELEMENT ISOTOPIC BURNUP ANALYSIS						311
NED 635 F4 RS P T O	SEXPN, ANALYSIS OF PULSED NEUTRON SOURCE DATA						258
NED 635 F4 RS P X T F	SFORE2, FAST REACTOR EXCURSION CALCULATIONS						174
NED 635 F4 RS PL T C	SBISYN, 2-D MULTI-GP DIFFUSION SYNTHESIS CALC						287
NED 1108 F4 RS P T C	SBISYN, 2-D MULTI-GP DIFFUSION SYNTHESIS CALC						287
NED 1108 F5 RS P T M	STROUT, MUG MULTIGROUP XSEC LIBRARY MAINTENANCE						493
NETWORK ANALYSIS OF 3-D TWO-PHASE FLOW	BAPL	7600B	F4	RS P T H	\$FLOW3,		R664
NETWORK SOLUTION	BAPL	6600B	F4	RS P I	SMANE1, RECTANGULAR MAGNETIC		R412
NEUTRON AGE CALCULATION OF ENDF/B DATA	BAPL	6600	F4	RS P T B	SEPOCH,		R461
NEUTRON FLUX-DOSIMETER ACTIVITY RELATION	GEC	635	F4	RSBP	D	SDOS,	423
NEUTRON MULTIPLE SCATTERING CALC	ANL	360	F4	RS P CT W	SMSCAT, SLOW		575
NEUTRON POLARIZATION EXPERIMENT	UCND	360B	F+BAL	RS P O	SPMS1, FAST		469
NEUTRON SCATTERING CODES EG&G	360	F4	RS P CT W	SMACS	LATTICE VIBRATION		574
NEUTRON SLOWING-DOWN NPGS	360	F4	RS P X T E	\$MOD5,	STOCHASTIC MODEL OF		491
NEUTRON SOURCE DATA	NED	635	F4	RS P T O	SEXPN, ANALYSIS OF PULSED		258
NEUTRON SOURCE DATA ANALYSIS	CNEA	360	F4	RS P E	STRIFIDO, PULSED		489
NEUTRON SPECTRA & MULTIGP X-SECS	ANL	370	F+BAL	RSBPL CT B	SMC**2-2, FAST		355
NEUTRON SPECTRA & MULTIGP X-SECS	ANL	7600	F+COM	RS PLXCT B	SMC**2-2, FAST		355
NEUTRON SPECTRUM X-SECTION CALC	OSUC	370	F4	RS PLXCT B	SFORM, FAST		51
NEUTRON SPECTRUM X-SECTIONS	BHSC	360	F4	RS PL T B	STEMPEST2, THERMAL		50
NEUTRON TRANSPORT	EG&G	360	F+BAL	RSBPL CT B	SRAFFLE2/MOD2, MONTE CARLO		631
NEUTRON X-SECTION CALCULATION	BAPL	6600	F4	RS P T A	SSUMOR, S-WAVE		R399
NIXLIN, LEAST SQUARES FIT TO NONLINEAR FORMS	DP	360	F4	RS P P			709
NMMSS, NUCLEAR MATERIALS MANAGEMENT SYSTEM	UCND	370	COBOL	RS CT M			695
NOAH, 1-D ONE-GP SPACE-TIME DIFFUSION FEEDBACK	BNL	6600	F4	RS P T F			405
NOISY1, AUTO- AND CROSS-SPECTRAL DENSITIES	BNW	1108	F5	RS P X T F			488
NON-BIAS ORDERING	MLMO	360	F+COB	RSBP XC M	\$RANDOM SAMPLING TABLE, FOR		679
NON-FUEL O & M COST STUDY	ORNL	360	F+BAL	RS P D	SOMCST, POWER PLANT		688
NONLINEAR ALGEBRAIC EQN SOLN CURVE PLOT	KAPL	6600	F+ASC	RS P T P	SSNEQ,		R364
NONLINEAR ANALYSIS	SLL	6600	F+COM	RS P T I	SGNATS, MESH2, GPRINT, 2-D		682
NONLINEAR DIFFERENTIAL EQNS. SOLUTION	KAPL	6600	F+ASC	RS P T P	SLIZARD,		R445
NONLINEAR FORMS	DP	360	F4	RS P P	\$NIXLIN, LEAST SQUARES FIT TO		709
NONLINEAR LEAST SQ LENS DESIGN SYSTEM	LASL	6600	F+COM	RS P T P	SLENSDES,		602
NONLINEAR MIXED INTEGER OPTIMIZATION	EG&G	360	F4	RS P P	\$ARSTEC,		738
NOWIG, 1-D 2-GP KINETICS TEMPERATURE FEEDBACK	BAPL	6600	F4	RS P F			R371
NPGS 360 F4 RS P X T E	\$MOD5, STOCHASTIC MODEL OF NEUTRON SLOWING-DOWN						491
NPRFCCP, FUEL CYCLE COSTS PERFORMANCE DATA	ANL	360	F4	RS P D			146
NPRFCCP, FUEL CYCLE COSTS PERFORMANCE DATA	UEC	6600	F4	RS P D			146
NRC 370 F4 RS P T H	\$COMPARE, TRANSIENT FLOW IN VENTED FLUID SYSTEM						702
NRC 370 F4 RS P XCT G	\$FRANTIC-NRC, TIME SYSTEM UNAVAILABILITY						766
NRC 370 F4 RS PLX T G	\$CRAC, CALC OF REACTOR ACCIDENT CONSEQUENCES						722
NRC 370 F4 RSBP CT G	\$WREM-TOODEE2/MOD3, 2D TIME-DEP FUEL ELEM STUDY						712
NRTS ENVIRONMENTAL ROUTINES, FORTRAN UTILITIES	EG&G	360B	F+BAL	RSB T P			613
NRTS-RJE, OS/360 MVT REMOTE JOB ENTRY SYSTEM	EG&G	360	BAL	RSB T P			519
NUBOW, STRUCTURAL ANALYSIS BOWED REACTOR CORES	ANL	360B	F4	RS P I			643
NUBOW2D-INELASTIC, BOWED REACTOR CORE ANALYSIS	ANL	370	F4	RS P I			790
NUCLEAR CRITICALITY SAFETY	DP	360	F4	RS P T C	\$KEFF, MGBS, TGAN,		617
NUCLEAR FUEL CYCLE COST AND ECONOMICS	CWE	360	F4	RS P T D	\$CINCAS,		354
NUCLEAR FUEL CYCLE COST AND ECONOMICS	WAPD	6600	F4	RS P T D	\$CINCAS,		354
NUCLEAR FUEL CYCLE ECONOMICS	UICS	360	F4	RS P CT D	\$GEM, ANALYSIS OF		576
NUCLEAR FUEL CYCLE REQUIREMENTS	ERDA	370C	F4	RS P CT D	\$NUFUEL,		683
NUCLEAR MATERIALS MANAGEMENT SYSTEM	UCND	370	COBOL	RS CT M	\$NMMSS,		695

NUCLEAR

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NUCLEAR POWER PLANT COST CODE	HEDL	1108	F5	RS P X T D	SPACTOLUS,CLOTHO,	540
NUCLEAR POWER PLANTS	ANL	370	F4	RS P X T K	SDSNP, DYNAMIC SIMULATION	784
NUCLEAR REACTOR POWER PLANT ANALYSIS	BAPL	6600	F4	RS P T K	SPARK1,	R743
NUCLEAR REACTOR POWER PLANT ANALYSIS	BAPL	7600	F4	RS P T K	SPARK1,	R743
NUCLEAR STATION.ELECTRICITY COSTS	UEC	6600	F4	RS P D	SPOWERCO,	340
NUCLEAR STEAM TURBINE CYCLE ANALYSIS	ORNL	360B	F4	RS P T H	SORCENT,	703
NUCLEUS REACTION	AI	360	F+BAL	RS P T A	\$COMNUC,CASCADE, COMPOUND	482
NUCLIDE DATA	BAPL	6600	F4	RS P P	\$DAFT1, LEAST SQUARES FIT FISSILE	R327
NUFUEL, NUCLEAR FUEL CYCLE REQUIREMENTS	ERDA	370C	F4	RS P CT D	\$	683
NURLOC-1.0, LOSS-OF-COOLANT THERMAL ANALYSIS	BCL	6400	F4	RS P T G	\$	328
NXN LATIN SQUARE EXPERIMENTAL DESIGN	MLMO	360	F4	RSBP C P	\$LATIN SQ,	630
NYU	6600	F4	RS P T P	\$DPOLE, HELMHOLTZ EQUATION ON GENERAL 3D REGION		816
OCOPTR, DRVOCR, UNCONSTRAINED OPTIMIZATION	ANL	360	F4	RS P T P	\$	753
ODE SYST WITH BANDED JACOBIAN	LLL	360	F4	RS P X T P	\$EPISODEB, SOLVE	705
ODE SYSTEM WITH BANDED JACOBIAN	LLL	360C	F4	RS P X T P	\$GEARB, SOLVE	661
ODE SYSTEM WITH BANDED JACOBIAN	LLL	6600C	F4	RS P X T P	\$GEARB, SOLVE	661
ODE'S	ANL	360	F	RSBP T P	\$STFODE,COLODE, COLLOCATION SOLN OF STIFF	652
ODE'S	SLA	6600	F	RS P T P	\$STFODE,COLODE, COLLOCATION SOLN OF STIFF	652
ODMOD, SOIL-WATER TRACE-CONTAINMENT TRANSPORT	ORNL	360	F+BAL	RS P CT R	\$	789
OMCST, POWER PLANT NON-FUEL O & M COST STUDY	ORNL	360	F+BAL	RS P D	\$	688
ONE-GP SPACE-TIME DIFFUSION FEEDBACK	BNL	6600	F4	RS P T F	\$NOAH, 1-D	405
OPN	OPPD	6400	F4	S P H	\$PWR-PPM, BORATION-DILUTION TABLES FOR PWR	552
OPN	DP	360	F4	RS P G	\$INTEG,INSPEC, MARKOV SIMULATION OF REACTOR	590
OPPD	6400	F4	S P H	\$PWR-PPM, BORATION-DILUTION TABLES FOR PWR OPN		552
OPTIMAL DISK DATA SET REORDERING	DP	370	F+BAL	RS P XCT P	\$DYNDISK,	729
OPTIMAL ELECTRIC UTILITY EXPANSION	TVA	370	F4	RS P CT D	\$SAGE-WASP,	S744
OPTIMAL GROUP OR MESH COLLAPSING	RW	6500	F4	RS P B	\$PARTI,	416
OPTIMIZATION	ORNL	360	F4	RS P P	\$KEELE, LINEARLY-CONSTRAINED	556
OPTIMIZATION	ANL	360	F4	RS P T P	\$OCOPTR, DRVOCR, UNCONSTRAINED	753
OPTIMIZATION	EG&G	360	F4	RS P P	\$ARSTEC, NONLINEAR MIXED INTEGER	738
OPTIMIZATION	ORNL	360	F+BAL	RS P T D	\$MSF21,VTE21, DESALINATION PLANT	798
OPTIMIZATION	ORNL	360	F+BAL	RS P CT R	\$OPTRM, HYDROLOGIC TRANSPORT WITH	794
OPTIMIZATION SCHEME	KAPL	6600	F4	RS P P	\$MOST, A MULTIDIMENSIONAL	R446
OPTIMIZING LMFBR MIXED-OXIDE CORES	FBRD	6000	F4	RS P T D	\$COROPT,	S752
OPTIMIZING UTILITY GENERATION PLANNING	ORNL	360	F+BAL	RS P X T D	\$ORSIM,	699
OPTRM, HYDROLOGIC TRANSPORT WITH OPTIMIZATION	ORNL	360	F+BAL	RS P CT R	\$	794
OPUS, POWER PLANT PERFORMANCE AND PRICE STUDY	GGA	1108	F4	RS P CT D	\$	226
ORCENT, NUCLEAR STEAM TURBINE CYCLE ANALYSIS	ORNL	360B	F4	RS P T H	\$	703
ORCOST2, POWER PLANT CAPITAL COST ESTIMATING	ORNL	360	F+BAL	RS P T D	\$	588
ORDERING	MLMO	360	F+COB	RSBP XC M	\$RANDOM SAMPLING TABLE, FOR NON-BIAS	679
ORDINARY DIFF EQNS	CRNL	6600B	F4	RS P CT P	\$FORSIM, SOLN OF PARTIAL OR	514
ORDINARY DIFF EQUATION SYSTEM SOLVER	LLL	360	F4	RS P X T P	\$EPISODE,	675
ORDINARY DIFF EQUATIONS	SLA	360D	F4	RS P X T P	\$DE/STEP,INTRP, SOLN OF	640
ORDINARY DIFF EQUATIONS	SLA	6600D	F4	RS P X T P	\$DE/STEP,INTRP, SOLN OF	640
ORDINARY DIFFERENTIAL EQN SYSTEM SOLVER	ANL	360C	F4	RS P X P	\$GEAR,	592
ORDINARY DIFFERENTIAL EQN SYSTEM SOLVER	LLL	6600C	F4	RS P X P	\$GEAR,	592
ORDINATE CODE	GGA	1108	F5	RS P T C	\$2DF, 2-D MULTI-GP DISCRETE	173
ORDINATE PROGRAM	ANL	360	F+BAL	RS P T C	\$DTF4, 1-D MULTI-GP DISCRETE	209
ORDINATE PROGRAM	BC	625	F+MAP	RS P T C	\$DTF4, 1-D MULTI-GP DISCRETE	209
ORDINATE PROGRAM	LASL	6600	F4	RS P T C	\$DTF4, 1-D MULTI-GP DISCRETE	209
ORDINATES	LASL	360	F4	RS P T F	\$TIMEX, 1-D TIME-DEP MULTIGP DISCRETE	756
ORDINATES	LASL	7600	F4	RS P T F	\$TIMEX, 1-D TIME-DEP MULTIGP DISCRETE	756
ORDINATES SLAB GEOMETRY	BAPL	6600	F4	RS P T C	\$BE21, FEW-GP DISCRETE	R398
ORNL	360	BAL+F	RS P C P	\$GETCOR,FRECOR, FORTRAN DYNAMIC STORAGE ALLOC		644
ORNL	360	C+BAL	RS PL CT M	\$JOURNAL CONTROL, LIBRARY JOURNAL MANAGEMENT		660
ORNL	360	F+BAL	RS P D	\$ISOSEARCH, ISOTOPE PRODUCTION FLUX, X-SEC CALC		322
ORNL	360	F+BAL	RS P D	\$OMCST, POWER PLANT NON-FUEL O & M COST STUDY		688
ORNL	360	F+BAL	RS P I	\$ELBOW-ORNL, PIPE STRESS & FLEXIBILITY CALC		650
ORNL	360	F+BAL	RS P T D	\$MSF21,VTE21, DESALINATION PLANT OPTIMIZATION		798
ORNL	360	F+BAL	RS P T D	\$ORCOST2, POWER PLANT CAPITAL COST ESTIMATING		588
ORNL	360	F+BAL	RS P T I	\$LINDA, EVALUATION OF STRAIN-GAGE DATA		657
ORNL	360	F+BAL	RS P T I	\$SAFE-3D, 3-D COMPOSITE STRUCTURE STRESS STUDY		332
ORNL	360	F+BAL	RS P T R	\$ATM, ATMOSPHERIC TRANSPORT & DIFFUSION MODEL		787
ORNL	360	F+BAL	RS P CT R	\$SCHNSED, SEDIMENT & CONTAINMENT TRANSPORT MODEL		793
ORNL	360	F+BAL	RS P CT R	\$SODMOD, SOIL-WATER TRACE-CONTAINMENT TRANSPORT		789
ORNL	360	F+BAL	RS P CT R	\$OPTRM, HYDROLOGIC TRANSPORT WITH OPTIMIZATION		794
ORNL	360	F+BAL	RS P CT R	\$SWHTM, WISCONSIN HYDROLOGIC TRANSPORT MODEL		808
ORNL	360	F+BAL	RS P X T D	\$CONCEPT5, POWER PLANT CONCEPTUAL COST ESTIMATE		498
ORNL	360	F+BAL	RS P X T D	\$ORSIM, OPTIMIZING UTILITY GENERATION PLANNING		699
ORNL	360	F+BAL	RS P XCT I	\$SCREEP-PLAST2, 2D INELASTIC STRUCTURAL ANALYSIS		R810
ORNL	360	F+BAL	RS P XCT I	\$CURT2, CURVED TUBES OR ELBOWS & ATTACHED PIPES		R750
ORNL	360	F+BAL	RS PLXCT H	\$STRUMP, TRANSIENT & S-STATE TEMPERATURE DIST		771

ORNL

PARTICLE

ORNL	360	F+BAL	RSBP	CT	C	SVENTURE, 1, 2, OR 3-D MULTIGROUP DIFFUSION	686	
ORNL	360	F+BAL	RSBPL	CT	C	SESP, MONTE CARLO REACTOR ANALYSIS CALCULATION	523	
ORNL	360	F4	RS	P	A	SPOLLA, CONVERTS R-MATRIX RESONANCE PARAMETERS	639	
ORNL	360	F4	RS	P	D	SPRP, PRODUCT PRICE CALCULATED BY DCF METHOD	739	
ORNL	360	F4	RS	P	I	SLUGS, STRESS FOR INTEGRAL ATTACHMENTS TO PIPE	648	
ORNL	360	F4	RS	P	O	SALPHA-M, RESOLUTION OF GAMMA-RAY SPECTRA	413	
ORNL	360	F4	RS	P	P	SKEELE, LINEARLY-CONSTRAINED OPTIMIZATION	556	
ORNL	360	F4	RS	P	R	SSULCAL, MODEL OF SULFUR CHEMISTRY IN A PLUME	788	
ORNL	360	F4	RS	P	T A	SATHENA4, INELASTIC SCATTERING FORM FACTORS	417	
ORNL	360	F4	RS	P	T B	SRICE, PRIMARY RECOIL ATOM SPECTRA ENDF/B DATA	453	
ORNL	360	F4	RS	P	T B	SSUPERTOG, ENDF/B FINE-GP CONSTANTS GENERATION	431	
ORNL	360	F4	RS	P	T C	SEXTERMINATOR2, 2-D MULTI-GP DIFFUSION PROGRAM	156	
ORNL	360	F4	RS	P	T G	SCHART, IODINE DECAY HEAT ON CHARCOAL ADSORBERS	804	
ORNL	360	F4	RS	P	T H	SHEATING5, 1,2, OR 3-D HEAT CONDUCTION PROGRAM	517	
ORNL	360	F4	RS	P	T H	SHETRAP, FUEL ROD RESPONSE LOCA EXPERIMENTS	730	
ORNL	360	F4	RS	P	T H	SORRIBLE, ROD BUNDLE FLOW & TEMPERATURE DIST.	629	
ORNL	360	F4	RS	P	T P	SSPEKEN, PEARSON SPEARMAN & KENDALL CORRELATION	781	
ORNL	360	F4	RS	P	T U	SSEPHIS/MOD4, SOLVENT EXTRACTION SIMULATION	R690	
ORNL	360	F4	RS	P	C G	SSTEFEG, ANALYSIS OF PWR & BWR GASEOUS RELEASE	583	
ORNL	360	F4	RS	P	CT I	SPLACRE, FEM INELASTIC STRUCTURAL ANALYSIS	R740	
ORNL	360	F4	RS	P	CT N	SGRFPK, PLOT PACKAGE FOR CORTES FEM PROGRAMS	760	
ORNL	360	F4	RS	P	X R	SMOBY, MOBILE HOME HEATING & COOLING ENERGY USE	724	
ORNL	360	F4	RS	P	X T H	SORTHIS, ORTHAT, 2-DIMENSIONAL HEAT CONDUCTION	525	
ORNL	360	F4	RS	P	XCT E	STASK, 1-D MULTIGROUP REACTOR KINETICS PROGRAM	558	
ORNL	360B	F+BAL	RS	P	T B	SRAFFLE, 1ST FLIGHT COLLISION PROBABILITIES MC	392	
ORNL	360B	F+BAL	RS	P	X T I	SCREEP-PLAST, 2-D INELASTIC STRUCTURAL ANALYSIS	R707	
ORNL	360B	F4	RS	P	T H	SORCENT, NUCLEAR STEAM TURBINE CYCLE ANALYSIS	703	
ORNL	360B	F4	RS	P	T I	SFLANGE-ORNL, ANALYSIS OF FLANGED JOINTS	689	
ORNL	360B	F4	RS	P	CT I	SCORTES, THERMAL & MECHANICAL ANALYSIS OF TEES	759	
ORNL	360B	F4	RS	PL	CT M	SEDTOR, ENDF/B TAPE PROCESSING AND EDITING	502	
ORNL	360C	F+BAL	RS	P	X T Q	SMARLOWE, BINARY COLLISION CASCADE SIMULATION	680	
ORNL	360C	F+BAL	RSBPLXCT	C		SKENO4, MONTE CARLO MULTIGROUP CRITICALITY CODE	450	
ORNL	360I	F4	RS	P	T K	SCITATION, 1,2,3-D DIFFUSION DEPLETION MULTI-GP	387	
ORNL	6600	F4	RS	PL	T M	SEDTOR, ENDF/B TAPE PROCESSING AND EDITING	502	
ORNL	7600	F+BAL	RS	P	X T Q	SMARLOWE, BINARY COLLISION CASCADE SIMULATION	680	
ORRIBLE, ROD BUNDLE FLOW & TEMPERATURE DIST.	ORNL	360	F4	RS	P T H S		629	
ORSIM, OPTIMIZING UTILITY GENERATION PLANNING	ORNL	360	F+BAL	RS	P X T D S		699	
ORTHAT, 2-DIMENSIONAL HEAT CONDUCTION	ORNL	360	F4	RS	P X T H S		525	
ORTHIS, ORTHAT, 2-DIMENSIONAL HEAT CONDUCTION	ORNL	360	F4	RS	P X T H S		525	
OS SYSTEM CATALOG UTILITY ROUTINE	ANL	360D	BAL	RS	X T P	SCOPYCAT, IBM	646	
OS/360 MVT REMOTE JOB ENTRY SYSTEM	EG&G	360	BAL	RSB	T P	SNRTS-RJE,	519	
OSCILLATION	CEND	360	F4	RS	P X T F	SCEXE, INCXE, 1-GP 3-D XYZ XENON	415	
OSUC	370	F4	RS	PL	CT C	SAIM6, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	29	
OSUC	370	F4	RS	PLXCT	B	SFORM, FAST NEUTRON SPECTRUM X-SECTION CALC	51	
OS360 MVT/MFT PERFORMANCE MONITOR	SLAC	360	BAL	RS	CT P	SSLACMON 2.2,	635	
OUTLIERS	UCND	360	F4	RS	P	P	SPCTEST, PRINCIPAL COMPONENT TEST FOR	769
OUTPUT	GGA	1108	F5	RS	P T N	SGAPER2D, 2-D PERTURBATION CALC FROM 2DF	471	
OUTPUT DATA	LASL	6600	F4	RS	P T B	SGLEN, GROUP CONSTANT CALC FROM TOR	361	
OUTPUT FROM MIXED ISOTOPES	MLMO	360B	F4	RS	P C Q	SISOTAB, PU POWER	R619	
OVAL FUEL PIN TUBE	BNW	6600	F4	RS	P T I	SCOVE1, CREEP COLLAPSE FOR	817	
OVAL TUBE	BNW	6600C	F4	RS	P	I	SBUCKLE, CREEP BUCKLING OF INITIALLY	667
OVERPOWER STUDY	HEDL	6600	F4	RS	P CT F	SMELT3, FAST REACTOR TRANSIENT	700	
OVERPOWER TRANSIENT FUEL MECHANICS	FBRD	7600	F4	RS	P T H	SBEHAVE-SST,	768	
OXIDE FUEL PERFORMANCE FINITE-ELEMENT	FBRD	635	F4	RS	P CT I	SBEHAVE2,	R568	
OXIDE FUEL ROD STRESS & DEFORMATION	AN-T	360B	F4	RSBP	CT I	SCYGR03,	R449	
OXIDE FUEL ROD STRESS & DEFORMATION	BAPL	6600	F4	RS	P T I	SCYGR03,	R449	
OXIDE FUEL RODS	EG&G	360	F+BAL	RSBP	XCT G	SFRAP-T, TRANSIENT ANALYSIS OF	658	
OXIDE FUEL RODS	EG&G	360	F+BAL	RS	P X T H	SFRAP-S1, STEADY STATE ANALYSIS	694	
OXIDE FUEL RODS	EG&G	7600	F4	RS	P T H	SFRAP-S3, STEADY STATE ANALYSIS	694	
OXIDE FUEL RODS	EG&G	7600	F4	RSBP	XCT G	SFRAP-T3, TRANSIENT ANALYSIS OF	658	
PACTOLUS, CLOTHO, NUCLEAR POWER PLANT COST CODE	HEDL	1108	F5	RS	P X T D S		540	
PACT2, COOLANT & CLADDING TEMPERATURE ANALYSIS	FBRD	7600	F4	RS	P T H S		S796	
PARABOLIC & EIGENVALUE SOLNS.	PURD	8500	F4	RS	P CT P	S2DEPEP, ELLIPTIC	806	
PARET, WATER-COOLED CORE TRANSIENT ANALYSIS	EG&G	360	F+BAL	RSBPL	CT G		555	
PARK1, NUCLEAR REACTOR POWER PLANT ANALYSIS	BAPL	6600	F4	RS	P T K S		R743	
PARK1, NUCLEAR REACTOR POWER PLANT ANALYSIS	BAPL	7600	F4	RS	P T K S		R743	
PART1, OPTIMAL GROUP OR MESH COLLAPSING	RW	6500	F4	RS	P B S		416	
PARTIAL DIFFERENTIAL EQNS	LLL	7600	F4	RS	P	P	SPDEONE, SOLUTIONS OF	777
PARTIAL OR ORDINARY DIFF EQNS	CRNL	6600B	F4	RS	P CT P	SFORSIM, SOLN OF	514	
PARTICLE BEAMS	SLAC	370	F4	RS	P T V	STRANSPO, DESIGN OF CHARGED	791	
PARTICLE INDUCED X-SECTIONS & SPECTRA	LASL	7600B	F+COM	RS	PL T A	SGNASH,	757	
PARTICLE TRANSPORT STUDY	ANL	370	F4	RS	P	G	SDISPER1, AEROSOL	554

PARTICLE

PLANE

PARTICLE TRANSPORT XY RZ RTH	LASL	7600	F4	RS P	T C	\$TWOTRAN-PNVW, 2-D	573
PARTICLES SAMPLING STUDY	BAPL	6600	F4	RS P	H	\$BETTY, ENTRAINED	R545
PATTERN INDEXING	LASL	6600	F+COM	RS P	Q	\$INDEX, XRAY DIFFRACTION POWDER	609
PAX03, HARMONY-PDQ X-SECTION GENERATION CODE	BAPL	6600	F+COM	RS P	X T B	\$	R426
PCTEST, PRINCIPAL COMPONENT TEST FOR OUTLIERS	UCND	360	F4	RS P	P	\$	769
PDEONE, SOLUTIONS OF PARTIAL DIFFERENTIAL EQNS	LLL	7600	F4	RS P	P	\$	777
PDP-11 ON 360 EG&G 360 PL1	RS P	T P					
PDQ7, 1,2 OR 3-D FEW-GP DIFFUSION DEPLETION	SPTAC11,	2-PASS ASSEMBLER FOR THE					516
PDQ7, 1,2 OR 3-D FEW-GP DIFFUSION DEPLETION	BCSS	6600D	F+ASC	R B	T D	\$	R275
PDQ7, 1,2 OR 3-D FEW-GP DIFFUSION DEPLETION	EG&G	360G	F+BAL	RSBP	XCT D	\$	R275
PDQ7, 1,2 OR 3-D FEW-GP DIFFUSION DEPLETION	EG&G	7600	FTN	RS	LXCT D	\$	R275
PDQ8, 1,2 OR 3-D FEW-GP DIFFUSION DEPLETION	BAPL	7600B	F+COM	RS P	T D	\$	R275
PD10B F4 RS P X T P	SEISPACK2, MATRIX	EIGENVALUE/VECTOR PACKAGE					534
PEARSON SPEARMAN & KENDALL CORRELATION ORNL	360	F4	RS P	T P	\$SPEKEN,		781
PELEN, FUEL PELLET TEMPERATURE & DEFORMATION	BAPL	6600	F4	RS P	T I	\$	R598
PELLET CRACKING	BAPL	6600	F4	RS P	I	\$STRIPE, FUEL ROD CLAD STRAIN &	R570
PELLET TEMPERATURE & DEFORMATION	BAPL	6600	F4	RS P	T I	\$PELEN, FUEL	R598
PERFORMANCE	ANL	370	F4	RS P	CT I	\$LIFE3, MIXED-OXIDE FUEL ELEMENT	R460
PERFORMANCE	ANL	7600	F4	RS P	T I	\$LIFE3, MIXED-OXIDE FUEL ELEMENT	R460
PERFORMANCE	ANL	370	F4	RS P	H	\$DIFFUSER, 2D SUBSONIC MHD DIFFUSER	737
PERFORMANCE AND PRICE STUDY	GGA	1108	F4	RS P	CT D	\$OPUS, POWER PLANT	226
PERFORMANCE DATA	ANL	360	F4	RS P	D	\$NPRFCOP, FUEL CYCLE COSTS	146
PERFORMANCE DATA	UEC	6600	F4	RS P	D	\$NPRFCOP, FUEL CYCLE COSTS	146
PERFORMANCE FINITE-ELEMENT	FBRD	535	F4	RS P	CT I	\$BEHAVE2, OXIDE FUEL	R568
PERFORMANCE MODEL	HEDL	6600	F	RS P	T H	\$SIEX, LMFBR FUEL PIN THERMAL	673
PERFORMANCE MONITOR	SLAC	360B	F+BAL	RSB	CT P	\$PROGLOOK, USER PROGRAM	642
PERFORMANCE MONITOR	SLAC	360	BAL	RS	CT P	\$SLACMON 2.2, OS360 MVT/MFT	635
PERFORMANCE STUDY	UEC	6600	F4	RS P	D	\$WAMPUM, FUEL CYCLE COSTS	224
PERMEATION WITH TRAPPING	DP	360	F4	RSBP	Q	\$XOTRAP, HYDROGEN	655
PERSONNEL INFORMATION SYSTEM	H&N	6400	F4	RS P	CT M	\$SKILLS INVENTORY,	801
PERT, 1-D PERTURBATION FOR AIM AND FOG CODES	BHSC	360	F4	RS P	C	\$	30
PERTURBATION CALC FROM 2DF OUTPUT	GGA	1108	F5	RS P	T N	\$GAPER2D, 2-D	471
PERTURBATION CODE USING DTF4 FLUXES	LASL	6600	F4	RS P	N	\$DAC1, SN	455
PERTURBATION FOR AIM AND FOG CODES	BHSC	360	F4	RS P	C	\$PERT, 1-D	30
PERTURBATION THEORY	GGA	1108	F4	RS P	XCT C	\$GAPER1D, 1-D TRANSPORT	606
PERTURBATION XY RZ RTHETA GEOMETRY	BNW	1108	F4	RS P	C	\$PERT4, 2-D	304
PERT4, 2-D PERTURBATION XY RZ RTHETA GEOMETRY	BNW	1108	F4	RS P	C	\$	304
PGE	360	F4	RS P	T G	SEMERALD REV. 1, PWR ACCIDENT ACTIVITY RELEASE		546
PGE	360	F4	RS P	T G	SEMERALD-NORMAL, PWR ACTIVITY RELEASE AND DOSE		685
PHASE SHIFT X-SEC & POLARIZATION CALC	KAPL	6600	F4	RS P	A	\$PHASER,	R507
PHASER, PHASE SHIFT X-SEC & POLARIZATION CALC	KAPL	6600	F4	RS P	A	\$	R507
PHENIX, 2-D DIFFUSION BURNUP REFUELING HISTORY	LASL	6600	F4	RS P	T D	\$	454
PHOTOMULTIPLIER ELECTRON DISTRIBUTION	ANL	360	F4	RS P	O	\$DYNO1,	R464
PHOTOMULTIPLIER ELECTRON DISTRIBUTION	KAPL	6600	F4	RS P	O	\$DYNO1,	R464
PHOTOPEAK SPECTRA CODE	BNW	1108	F+BAL	RS P	T O	\$GSSLRN1B, LEAST SQUARES	457
PHROG, MULTI-GP CONSTANT & FAST SPECTRA CALC	EG&G	360	F4	RS	PLXCT B	\$	520
PHYSICS MODULES	DP	360	F+BAL	S X T B	\$RAHAB, JOSHUA SYSTEM LATTICE		536
PIN THERMAL PERFORMANCE MODEL	HEDL	6600	F	RS P	T H	\$SIEX, LMFBR FUEL	673
PIN THERMAL-HYDRAULIC ANALYSIS	ANL	360B	F4	RSBP	CT H	\$COBRA3M, FUEL	659
PIN TUBE	BNW	6600	F4	RS P	T I	\$SCOVE1, CREEP COLLAPSE FOR OVAL FUEL	817
PINS	EG&G	360	F4	RSBP	CT J	\$VIEWPIN, VIEW FACTOR CALC FOR CYLINDRICAL	569
PIPE	ORNL	360	F4	RS P	I	\$LUGS, STRESS FOR INTEGRAL ATTACHMENTS TO	648
PIPE STRESS & FLEXIBILITY CALC	ORNL	360	F+BAL	RS P	I	\$ELBOW-ORNL,	650
PIPE SYSTEM	AI	360	F4	RS P	C I	\$PSA2, STRESS ANALYSIS MULTIANCHOR	542
PIPE SYSTEM PRESSURE ANALYSIS	ANL	370	F4	RS P	T G	\$PTA1,	R761
PIPE, ELASTIC STRESS OF PIPING SYSTEM	BAPL	6600	F4	RS P	T I	\$M0457,	R329
PIPES	ORNL	360	F+BAL	RS P	XCT I	\$CURT2, CURVED TUBES OR ELBOWS & ATTACHED	R750
PIPING	ANL	360	F4	RS P	G	\$NATRANSIENT, FLUID HAMMER ANALYSIS 1-D	718
PIPING ANALYSIS	BCL	6400	F4	RS P	T I	\$PIRAX2, SIMPLIFIED INELASTIC	R735
PIPING SYSTEM	BAPL	6600	F4	RS P	T I	\$M0457, PIPE, ELASTIC STRESS OF	R329
PIPING SYSTEM	ANL	360	F4	RS P	G	\$NAHAMMER, FLUID HAMMER ANALYSIS	717
PIPING SYSTEM	ANL	7600	F4	RS P	G	\$NAHAMMER, FLUID HAMMER ANALYSIS	717
PIPING SYSTEM	HEDL	6600	F4	RS P	T G	\$HAMOC, FLUID HAMMER ANALYSIS OF	710
PIPING SYSTEM ANALYSIS	ANL	7600B	F4	RS P	T G	\$WHAM6, LIQUID-FILLED	278
PIPING SYSTEM ANALYSIS	EG&G	360B	F+BAL	RS P	T G	\$W-AM6, LIQUID-FILLED	278
PIRAX2, SIMPLIFIED INELASTIC PIPING ANALYSIS	BCL	6400	F4	RS P	T I	\$	R735
PKG	ANL	360B	F+ASM	RSB	CT P	\$WSP-HASP/DOS, DOS-MFT REMOTE WORKSTATION	541
PLACRE, FEM INELASTIC STRUCTURAL ANALYSIS	ORNL	360	F4	RS P	CT I	\$	R740
PLANE & AXISYMMETRIC STRESS ANALYSIS	GGA	1108	F4	RS P	T I	\$SAFE-2D,	379
PLANE ELASTIC-PLASTIC	BAPL	6600	F+COM	RS P	T I	\$DUZ2, 2-D AXISYMMETRIC &	R503
PLANE STRESS ANALYSIS, 2-D BODIES	BNL	6600	F4	RS P	T I	\$SAFE-PLANE,	252
PLANE STRESS ANALYSIS, 2-D BODIES	GGA	1108	F4	RS P	I	\$SAFE-PLANE,	252
PLANE STRUCTURES	BAPL	6600	F4	RS P	L	\$BL47, DRAFTING TOOL TO PLOT	R373

PLANNING

POWER

PLANNING	ORNL	360	F+BAL	RS P X T D	SORSIM, OPTIMIZING UTILITY GENERATION	699
PLANNING	MLMO	360	F+C+R	RSBP T M	SRALCRTPH, RESOURCE ALLOCATION PROJECT	G603
PLANT ANALYSIS	BAPL	6600	F4	RS P T K	\$PARK1, NUCLEAR REACTOR POWER	R743
PLANT ANALYSIS	BAPL	7600	F4	RS P T K	\$PARK1, NUCLEAR REACTOR POWER	R743
PLANT CAPITAL COST ESTIMATING	ORNL	360	F+BAL	RS P T D	\$ORCOST2, POWER	588
PLANT CONCEPTUAL COST ESTIMATE	GGA	1108	F4	RS P XCT D	\$CONCEPT3, POWER	498
PLANT CONCEPTUAL COST ESTIMATE	ORNL	360	F+BAL	RS P X T D	\$CONCEPT5, POWER	498
PLANT COST CODE	HEDL	1108	F5	RS P X T D	\$PACTOLUS,CLOTHO, NUCLEAR POWER	540
PLANT NON-FUEL O & M COST STUDY	ORNL	360	F+BAL	RS P D	\$OMCST, POWER	688
PLANT OPTIMIZATION	ORNL	360	F+BAL	RS P T D	\$MSF21,VTE21, DESALINATION	798
PLANT PERFORMANCE AND PRICE STUDY	GGA	1108	F4	RS P CT D	\$OPUS, POWER	226
PLANT THERMAL DISCHARGE STUDY	HEDL	1108	F5	RS P T R	\$TOPLYR2, POWER	599
PLANT TRANSIENT ANALYSIS	WARD	7600	F4	RS P T K	\$DEMO4, CRBR REACTOR &	R676
PLANTS	ANL	370	F4	RS P X T K	\$DSNP, DYNAMIC SIMULATION NUCLEAR POWER	784
PLASTIC	LLL	7600	F4	RS P T F	\$HEMP, HYDRODYNAMIC ELASTICMAGNETO	775
PLENUM	DP	360	F4	RS P H	\$PLENUM, FLOW DIST. IN CYL COOLANT INLET	586
PLENUM, FLOW DIST. IN CYL COOLANT INLET	PLENUM	DP	360	F4	RS P H	\$
PLETHS, ISOPLETH-AREA CALC FROM SINGLE SOURCE	ANL	GETS	F	R	R	\$
PLOT	KAPL	6600	F+ASC	RS P T P	\$SNEQ, NONLINEAR ALGEBRAIC EQN SOLN CURVE	R364
PLOT MODULES F(X) & F(X,Y)	KAPL	6600B	F+COM	RS P T P	\$DATATNAN2, UTILITY	407
PLOT PACKAGE FOR CORTES FEM PROGRAMS	ORNL	360	F4	RS P CT N	\$GRFPAK,	760
PLOT PLANE STRUCTURES	BAPL	6600	F4	RS P L	\$BL47, DRAFTING TOOL TO	R373
PLOT SUBROUTINE PACKAGE	ACRC	370	F4	RS P CT N	\$SPRLOT, LINE PRINTER	773
PLOT-3D, 3-D PLOTS ON IBM2280 OR CALCOMP780	ANL	360	F4	RS P T N	\$	544
PLOTFB,... ENDF/B V1 PROC	BNL	6600B	F4	RS T M	\$CHECKER,CRECT,DAMMET,	384
PLOTFB,... ENDF/B V2 PROC	BNL	6600B	F4	RS T M	\$CRECT,CHECKER,RIGEL,	475
PLOTR, 2-D CONTOUR PLOTS & AREA CALCULATION	SLA	6600	F4	RS P	\$	R578
PLOTS & AREA CALCULATION	SLA	6600	F4	RS P	\$PLOTR, 2-D CONTOUR	R578
PLOTS ON IBM2280 OR CALCOMP780	ANL	360	F4	RS P T N	\$PLOT-3D, 3-D	544
PLOTTING ROUTINES	KAPL	6600	F+COM	RS T P	\$KAPLPLOT, KAPL CALCOMP	R496
PLUME	ORNL	360	F4	RS P R	\$SULCAL, MODEL OF SULFUR CHEMISTRY IN A	788
PL1	S P CT P	\$SLOP,CROSS, IBM260 FORTRAN H PROGRAM CHECKER	ANL	360B		647
PL1	RS P T P	\$PTAC11, 2-PASS ASSEMBLER FOR THE PDP-11 ON 360	EG&G	360		516
PL1	RS P T R	\$COMB, 1D HIGH-TEMPERATURE COAL COMBUSTOR MODEL	ANL	370		811
PMS1, FAST NEUTRON POLARIZATION EXPERIMENT	UCND	360B	F+BAL	RS P O	\$	469
PNC	360	F4	RS P T H	\$LOCK, FEW-CHANNEL COOLANT-FLOW BLOCKAGE STUDY		732
POINT DEPLETION FISSION PRODUCT	BAPL	6600	F4	RS P D	\$CINDER,M0102,	313
POINT DEPLETION FISSION PRODUCT	DP	360	F+BAL	RS P T D	\$CINDER,M0102,	313
POINT-KERNEL SHIELD EVALUATION CODE	BAPL	6600B	F+ASC	RS P T J	\$SPAN4, A	R462
POINTS	KAPL	6600	F+ASC	RS P T P	\$CURFIT, CURVE FITTING EXPERIMENTAL DATA	R 43
POINTWISE XSECS. FROM B-W PARAMETERS	GGA	1108	F5	RS P CT A	\$FSDP3,	216
POLARIZATION CALC	KAPL	6600	F4	RS P A	\$PHASER, PHASE SHIFT X-SEC &	R507
POLARIZATION EXPERIMENT	UCND	360B	F+BAL	RS P O	\$PMS1, FAST NEUTRON	469
POLLA, CONVERTS R-MATRIX RESONANCE PARAMETERS	ORNL	360	F4	RS P A	\$	639
POLLUTANT UPTAKE MODEL	DP	360	CSMP	RS R	\$POLUTE, FOREST AIR	774
POLUTE, FOREST AIR POLLUTANT UPTAKE MODEL	DP	360	CSMP	RS R	\$	774
POLYA MODEL SECONDARY ELECTRON SPECTRA	KAPL	6600	F4	RS P W	\$CONDYN,	786
POLYNOMIAL	KAPL	6600	F4	RS P P	\$ROPE, FINDING ROOTS OF A	R444
POLYNOMIAL CURVE FITTING	BAPL	6600	F4	RS P T P	\$M0661,M0657,M0626,	R411
POOL FIRE 1- & 2-CELL ANALYSIS	AI	360	F4	RS P G	\$SOFIRE2, SODIUM	559
POROUS MEDIA	BKY	7600	F4	RS P T H	\$SCHAFF, HEAT & WATER TRANSFER IN	802
POSTERS	ANL	370	F4	RS P C P	\$SLIDES, FOR DISSPLA-LETTERED SLIDES &	728
POWDER PATTERN INDEXING	LASL	6600	F+COM	RS P Q	\$INDX, XRAY DIFFRACTION	609
POWER AND FLOW TRANSIENTS	ANL	360	F4	RS P T F	\$SAS1A, FAST REACTOR	400
POWER AND FLOW TRANSIENTS	ANL	6600	F4	RS P T F	\$SAS1A, FAST REACTOR	400
POWER DISTRIBUTION	AINS	7600	F4	RS P T C	\$FLARE, 3-D REACTIVITY AND	167
POWER DISTRIBUTION	MSS	360	F4	RS P CT C	\$FLARE, 3-D REACTIVITY AND	167
POWER DISTRIBUTION	NED	635	F4	RS P T C	\$FLARE, 3-D REACTIVITY AND	167
POWER DISTRIBUTION SEARCH	GGA	1108	F4	RS P T C	\$GASP7, 1-D BURNUP	319
POWER EXCURSION DISASSEMBLY	ANL	360	F4	RS P XCT F	\$VENUS, 2-D LMFBR	511
POWER MCGUIRE UNITS	DUCC	635	F4	RS G	\$ANVENT, LOCA ANALYSIS DUKE	529
POWER OUTPUT FROM MIXED ISOTOPES	MLMO	360B	F4	RS P C Q	\$ISOTAB, PU	R619
POWER PLANT ANALYSIS	BAPL	6600	F4	RS P T K	\$PARK1, NUCLEAR REACTOR	R743
POWER PLANT ANALYSIS	BAPL	7600	F4	RS P T K	\$PARK1, NUCLEAR REACTOR	R743
POWER PLANT CAPITAL COST ESTIMATING	ORNL	360	F+BAL	RS P T D	\$ORCOST2,	588
POWER PLANT CONCEPTUAL COST ESTIMATE	GGA	1108	F4	RS P XCT D	\$CONCEPT3,	498
POWER PLANT CONCEPTUAL COST ESTIMATE	ORNL	360	F+BAL	RS P X T D	\$CONCEPT5,	498
POWER PLANT COST CODE	HEDL	1108	F5	RS P X T D	\$PACTOLUS,CLOTHO, NUCLEAR	540
POWER PLANT NON-FUEL O & M COST STUDY	ORNL	360	F+BAL	RS P D	\$OMCST,	688
POWER PLANT PERFORMANCE AND PRICE STUDY	GGA	1108	F4	RS P CT D	\$OPUS,	226
POWER PLANT THERMAL DISCHARGE STUDY	HEDL	1108	F5	RS P T R	\$TOPLYR2,	599
POWER PLANTS	ANL	370	F4	RS P X T K	\$DSNP, DYNAMIC SIMULATION NUCLEAR	784

POWER

PURCHASE

POWER TRANSIENTS	BAPL 6600 F4	RS P T H	SCHIC-KIN, FAST + INTERMEDIATE	R473
POWERCO, NUCLEAR STATION ELECTRICITY COSTS	UEC 6600 F4	RS P D S		340
PPCO 360 F4	RS P X G	\$BURST1, HYDRODYNAMIC ANALYSIS DURING BLOWDOWN		435
PREDICTING MANUFACTURING REQUIREMENTS	GEPI	GETS BASIC R	M \$MAPPER,	595
PREDICTION MIT 360 F4	RS P T H	\$REFLUX, LWR REFLOOD HEAT TRANSFER		763
PREDICTION MIT 370 F4	RS P T H	\$ENERGY, LMFBR COOLANT TEMPERATURE		696
PREP,KITT, SYSTEM FAULT TREE EVALUATION CODES	EG&G 360 F4	RSBP CT G S		528
PREP,KITT, SYSTEM FAULT TREE EVALUATION CODES	EG&G 1108 F4	RS P T G S		528
PREPARATION GGA 1108 F4	RS P X T L	\$GAND, GAFGAR X-SECTION LIBRARY		345
PRESSURE BAPL 6600 F4	RS P I	STCB01, CREEP-BUCKLING OF TUBES UNDER		R604
PRESSURE ANALYSIS	ANL 370 F4	RS P T G	\$PTA1, PIPE SYSTEM	R761
PRESSURE DISTRIBUTION A&TS 370 F4	RS P C H	\$FLAC, STEADY-STATE FLOW,		395
PRESSURE DISTRIBUTION GGA 1108 F5	RS P H	\$FLAC, STEADY-STATE FLOW,		395
PRESSURE VESSEL STRESS AND FATIGUE	KAPL 6600 F4	RS I	\$SORSDB,	R391
PRESSURE-TEMPERATURE RESPONSE	EG&G 360B F+BAL	RSBPLXCT G	\$CONTEMPT-LT/026,	433
PRESSURIZERS BAPL 6600 F4	RS P T H	\$TOPS, TRANSIENT THERMODYNAMICS OF		R348
PRICE CALCULATED BY DCF METHOD	ORNL 360 F4	RS P D	\$PRP, PRODUCT	739
PRICE STUDY GGA 1108 F4	RS P CT D	\$OPUS, POWER PLANT PERFORMANCE AND		226
PRIMARY RECOIL ATOM SPECTRA ENDF/B DATA	ORNL 360 F4	RS P T B	\$PRICE,	453
PRINCIPAL COMPONENT TEST FOR OUTLIERS	UCND 360 F4	RS P P	\$PCTEST,	769
PRINTED-CIRCUIT BOARDS SLA 1108 F+BAL	RSBP T T	\$ACCEL(MOD2), DESIGN OF		681
PRINTED-CIRCUIT BOARDS SLA 6600 F+COM	RS P T T	\$ACCEL(MOD2), DESIGN OF		681
PRINTER PLOT SUBROUTINE PACKAGE	ACRC 370 F4	RS P CT N	\$PRPLOT, LINE	773
PROBABILITIES MC ORNL 360B F+BAL	RS P T B	\$RAFFLE, 1ST FLIGHT COLLISION		392
PROBABILITY CALC ANL 360 F4	RS P T B	\$CLUP77, SQUARE CELL COLLISION		526
PROBABILITY CALC JAER 230 F4	RS P T B	\$CLUP77, SQUARE CELL COLLISION		526
PROBABILITY TABLES AI 360 F+BAL	RS P CT A	\$U3R, UNRESOL RESONANCE XSEC		553
PROBABLISTIC RESPONSE SURFACE CODE	ANL 370 F+BAL	RS P T G	\$PROSA1,	R778
PROBLEMS ANL 370B F4	RS P T P	\$SUPPORT, SOLUTION OF BOUNDARY-VALUE		731
PROBLEMS SLA 6600 F4	RS P T P	\$SUPPORT, SOLUTION OF BOUNDARY-VALUE		731
PROC BNL 6600B F4	RS T M	\$CRECT,CHECKER,RIGEL,PLOTFB,... ENDF/B V2		475
PROC BNL 6600B F4	RS T M	\$CHECKER,CRECT,DAMMET,PLOTFB,... ENDF/B V1		384
PROCESS SIMULATION DP 360 F4	RS P U	\$SOLVEX, SOLVENT EXTRACTION		662
PROCESSING AND EDITING ORNL 360B F4	RS PL CT M	\$EDITOR, ENDF/B TAPE		502
PROCESSING AND EDITING ORNL 6600 F4	RS PL T M	\$EDITOR, ENDF/B TAPE		502
PROCESSING CODE ANL 360 F4	RS T M	\$RIGEL, ENDF/B V3 DATA		571
PROCESSING CODES ANL 360 F4	RS P T M	\$CRECT,CHECKER, ENDF/B V2		475
PROCESSING CODES BNL 6600 F4	RS T M	\$CHECK3,RIGEL3, ENDF/B V3		571
PROCESSING CODES BNL 6600B F4	RS T M	\$RIGEL4,CHECK4,... ENDF/B V4		638
PROCESSING MODULE ANL 360 F4	RSBP CT L	\$ARC-NU1002, BCD INPUT DATA		533
PROCESSING OF ANALYZER GAMMA-RAY SPECTRA	GGA 1108 F+BAL	RS P T O	\$STOAD,	333
PROCESSOR LASL 360 F4	RS P L	\$GENRD, FREE-FORMAT CARD INPUT		530
PROCESSOR LASL 6600 F4	RS P L	\$GENRD, FREE-FORMAT CARD INPUT		530
PROCESSOR LASL 360 F4	RS P CT M	\$LASIP3, CCCC STANDARD INTERFACE FILE		691
PROCESSOR TSO OR BATCH ANL 360 F+BAL	RSBP X T P	\$SPEAKEASY MU+, LANGUAGE		593
PROCLIBS HCI 370 F+C+A	RS XC P	\$JCLCROSS, DSN CROSS-REF LIST FROM JCL		725
PROGLOOK, USER PROGRAM PERFORMANCE MONITOR	SLAC 360B F+BAL	RSB CT P S		642
PROGRAMMING AND DATA SYSTEM KAPL 6600B F+COM	RS P X T M	\$DATATRAN2, MODULAR		386
PROGRAMMING AND DATA SYSTEM KAPL 7600C F+COM	RS P T M	\$DATATRAN2, MODULAR		386
PROGRAMMING ENVIRONMENT LIBRARY	BAPL 6600 F+COM	RS T P	\$BETTIS	R665
PROGRAMMING ENVIRONMENT LIBRARY	BAPL 7600 F+COM	RS T P	\$BETTIS	R665
PROGRAMMING LANGUAGE KAPL 6600 F+ASC	RS P	\$SIMPLE1, TIME-SHARING		R442
PROJECT PLANNING MLMO 360 F+C+R	RSBP T M	\$RACRTPH, RESOURCE ALLOCATION		G603
PROPAGATION CODE EG&G 360 F4	RS P P	\$SOERP, SECOND-ORDER ERROR		764
PROPAGATION CODE EG&G 7600 F4	RS P P	\$SOERP, SECOND-ORDER ERROR		764
PROPERTIES BG&E 360C F4	RS T H	\$STEAM-67, 1967 ASME STEAM AND WATER		487
PROPERTIES FOR SAFETY ANALYSIS	BAPL 7600 F4	RS P T H	\$WASP2, WATER	R396
PROPERTIES WATER & STEAM BCAC 6600 F4	RS P T H	\$ASTEM, THERMODYNAMIC		580
PROPERTIES WATER & STEAM EG-D 360B F4	RS P X T H	\$ASTEM, THERMODYNAMIC		580
PROSA1, PROBABLISTIC RESPONSE SURFACE CODE	ANL 370 F+BAL	RS P T G S		R778
PRP, PRODUCT PRICE CALCULATED BY DCF METHOD	ORNL 360 F4	RS P D		739
PRPLOT, LINE PRINTER PLOT SUBROUTINE PACKAGE	ACRC 370 F4	RS P CT N S		773
PSA2, STRESS ANALYSIS MULTIANCHOR PIPE SYSTEM	AI 360 F4	RS P C I S		542
PSEUDO, STATISTICAL RESONANCE PARAMETER CALC	ENEA 360 F4	RS P A S		292
PSEUDO, STATISTICAL RESONANCE PARAMETER CALC	GGA 1108 F4	RS P A S		292
PTAC11, 2-PASS ASSEMBLER FOR THE PDP-11 ON 360	EG&G 360 PL1	RS P T P S		516
PTA1, PIPE SYSTEM PRESSURE ANALYSIS	ANL 370 F4	RS P T G S		R761
PU POWER OUTPUT FROM MIXED ISOTOPES	MLMO 360B F4	RS P C Q	\$ISOTAB,	R619
PULSED NEUTRON SOURCE DATA NED 635 F4	RS P T O	\$EXPN, ANALYSIS OF		258
PULSED NEUTRON SOURCE DATA ANALYSIS	CNEA 360 F4	RS P E	\$TRIFIDO,	489
PUN1, UNRESOLVED RESONANCE INTEGRALS X-SECS	BAPL 6600 F4	RS P T A S		R359
PURCHASE VERSUS LEASE ANALYSIS SLA 360	COBOL RSBP CT M	\$BECOM, AEC DP		R589

PURCHASE

RELAP4/MOD6

PURCHASE VERSUS LEASE ANALYSIS	SLA	1108	COBOL	RS P	M	\$BECOM, AFC DP	R589	
PURD 6500 F4 RS P CT P	\$2DEPEP, ELLIPTIC PARABOLIC & EIGENVALUE SOLNS.						806	
PURD 6500 F4 RS PLX T C	\$MACH1, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE						262	
PWCOST, REACTOR FUEL CYCLE COST CALCULATION	GGA	1108	F4	RS P	T D	\$	441	
PWR & BWR GASEOUS RELEASE	ORNL	360	F4	RS P	C G	\$STEFEG, ANALYSIS OF	583	
PWR ACCIDENT ACTIVITY RELEASE	PGE	360	F4	RS P	T G	\$EMERALD REV. 1,	546	
PWR ACTIVITY RELEASE AND DOSE	PGE	360	F4	RS P	T G	\$EMERALD-NORMAL,	685	
PWR FLOW TRANSIENT ANALYSIS	BAPL	6600	F4	RS P	T H	\$FLOT1,M0219,	R331	
PWR OPN OPPD 6400 F4 S P H	SPWR-PPM, BORATION-DILUTION TABLES FOR						552	
PWR-PPM, BORATION-DILUTION TABLES FOR PWR OPN	OPPD	6400	F4	S P	H	\$	552	
QMESH,RENUM, SELF-ORGANIZING MESH GENERATION	ANL	360	F4	RS P	CT L	\$	612	
QMESH,RENUM, SELF-ORGANIZING MESH GENERATION	SLA	6600	F4	RS P	T L	\$	612	
QUALITY CONTROL DATA ANALYSIS ROUTINES	BKC	360	F4	RS P	P	\$COMQC,	649	
QUALITY CONTROL SAMPLE STATISTICS	BKC	360	F4	RSBP	P	\$HISTOGRAMS,	614	
QUASISTATIC SPATIAL REACTOR KINETICS CODE	ANL	360	F4	RS PL	CT F	\$QX1,	474	
QX1, QUASISTATIC SPATIAL REACTOR KINETICS CODE	ANL	360	F4	RS PL	CT F	\$	474	
R-M PARAMETERS OF UNRESOLVED RESONANCES	BAPL	6600	F4	RS P	A	\$GRAMP,	R470	
R-MATRIX RESONANCE PARAMETERS	ORNL	360	F4	RS P	A	\$POLLA, CONVERTS	639	
R-THETA-Z	LASL	6600	F4	RS P	T D	\$3DDT, 3-D MULTIGROUP DIFFUSION XYZ	463	
RADI GEOMETRY MODULES 2-D INPUT GEN	KAPL	6600B	F+C	RS P	T L	\$DATATRAN2,	406	
RADIO FREQUENCY MANAGEMENT SYSTEM	ALOO	360	COBOL	RS P	M	\$AEC-ALO FAU,	587	
RADIOACTIVE DECAY CHAINS	GEC	635	F4	RSBP	D	\$CHAINS, ANALYSIS OF	418	
RADIOACTIVE-DECAY GAMMA-RAY CATALOG	DP	360B	EBCDC	R	L T Z	\$GAMTAB,	637	
RADIOLOGICAL DOSE	AI	370	F4	RS P	T G	\$COMRADEX4, ACCIDENT RELEASED	663	
RADIOLOGICAL EFFECTS ANALYSIS	HEDL	1108	F+SLE	RS P	XCT R	\$HERMES, REGIONAL	527	
RADIOLOGICAL SAFETY ANALYSIS PROGRAM	EG&G	360B	F4	RSBP	CT G	\$RSAC,	265	
RADIONUCLIDE CONTAINMENT AFTER LOCA	BCL	6400	F4	RS P	T G	\$CORRAL2,	745	
RADIONUCLIDE GENERATION AND DECAY	BNW	1108	F5	RSBPL	T D	\$ISOGEN,	367	
RAFFLE, 1ST FLIGHT COLLISION PROBABILITIES MC	ORNL	360B	F+BAL	RS P	T B	\$	392	
RAFFLE2/MOD2, MONTE CARLO NEUTRON TRANSPORT	EG&G	360	F+BAL	RSBPL	CT B	\$	631	
RAHAB, JOSHUA SYSTEM LATTICE PHYSICS MODULES	DP	360	F+BAL	S	X T B	\$	536	
RALCRTPH, RESOURCE ALLOCATION PROJECT PLANNING	MLMO	360	F+C+R	RSBP	T M	\$	G603	
RAMP1, REICH-MOORE RESOLVED REGION X-SECTIONS	BNL	6600	F4	RS P	A	\$	492	
RANDOM SAMPLING TABLE, FOR NON-BIAS ORDERING	MLMO	360	F+COB	RSBP	XC	M	\$	679
RANKING	ANL	370	F4	RS P	T G	\$IMPORTANCE, FTA BASIC EVENT & CUT SET	779	
RAPFU, FUEL CYCLE PARAMETERS FAST BREEDERS	NED	635	F4	RS P	D	\$	372	
RAPP, HIGH-VELOCITY FLOW STUDY STEAM-WATER MIX	KAPL	6600	F4	RS P	H	\$	R382	
RASE4,DAMG2, ION IMPLANTATION DEPOSITION	SLA	6600	F4	RS P	T Q	\$COREL,	758	
RATES	LASL	7600	F4	RS P	T X	\$STEEP4, THERMONUCLEAR REACTION	749	
RATES FROM 2-D FLUX SETS	FBRD	6000	F4	RS P	C C	\$TRIAL, 3-D REACTION	585	
RAUMZEIT, 1-D TIME-DEPENDENT DIFFUSION CALC	KAPL	6600	F4	RS P	F	\$	R352	
RDYN 370B F4 RS P T P	SMETRICATION, CONVERSION TO OR FROM SI UNITS						G668	
REACTION	AI	360	F+BAL	RS P	T A	\$COMNUC,CASCADE, COMPOUND NUCLEUS	482	
REACTION	CEND	7600	F4	RS P	G	\$CEBUG, STEAM GENERATOR SODIUM-WATER	548	
REACTION OR DECAY	LMSC	1100	F5	RS P	D	\$ISOTOPE, MAXIMUM YIELD FROM	179	
REACTION RATES	LASL	7600	F4	RS P	T X	\$STEEP4, THERMONUCLEAR	749	
REACTION RATES FROM 2-D FLUX SETS	FBRD	6000	F4	RS P	C C	\$TRIAL, 3-D	585	
REACTION X-SECTION	ENEA	360	F4	RS P	A	\$THRES2, STATISTICAL MODEL	504	
REACTION X-SECTIONS	BNL	6600B	F4	RS P	A	\$THRES2, STATISTICAL MODEL	504	
REACTIVE MIXTURE FLOW	LASL	6600	F4	RS P	X T U	\$PRICE-LASL, CHEMICALLY	720	
REACTIVITY AND POWER DISTRIBUTION	AINS	7600	F4	RS P	T C	\$FLARE, 3-D	167	
REACTIVITY AND POWER DISTRIBUTION	MSS	360	F4	RS P	CT C	\$FLARE, 3-D	167	
REACTIVITY AND POWER DISTRIBUTION	NED	635	F4	RS P	T C	\$FLARE, 3-D	167	
REACTORS	ANL	360B	F+BAL	RSBPL	CT D	\$REBUS2, FUEL CYCLE ANALYSIS FOR FAST	634	
REAX, RESOLVED RESONANCE EPITHERMAL X-SECTIONS	NED	635	F4	RS P	T B	\$	257	
REBUS2, FUEL CYCLE ANALYSIS FOR FAST REACTORS	ANL	360B	F+BAL	RSBPL	CT D	\$	634	
RECAP-0, RECAP-12 X-SECTION LIBRARY GENERATION	BAPL	6600	F+COM	RS P	T B	\$	R671	
RECAP-12 X-SECTION LIBRARY GENERATION	BAPL	6600	F+COM	RS P	T B	\$RECAP-0,	R671	
RECAP-12, MONTE CARLO CRITICALITY CALCULATIONS	BAPL	7600	F+COM	RS P	T C	\$	R670	
RECOIL ATOM SPECTRA END/FB DATA	ORNL	360	F4	RS P	T B	\$PRICE, PRIMARY	453	
RECTANGULAR MAGNETIC NETWORK SOLUTION	BAPL	6600B	F4	RS P	I	\$MANE1,	R412	
REDUX, REACTOR FLUCTUATION EXPERIMENT ANALYSIS	BAPL	6600	F4	RS P	O	\$	R425	
REFLOOD HEAT TRANSFER PREDICTION	MIT	360	F4	RS P	T H	\$REFLUX, LWR	763	
REFLUX, LWR REFLOOD HEAT TRANSFER PREDICTION	MIT	360	F4	RS P	T H	\$	763	
REFUELING HISTORY	LASL	6600	F4	RS P	T D	\$PHENIX, 2-D DIFFUSION BURNUP	454	
REGIONAL RADIOLOGICAL EFFECTS ANALYSIS	HEDL	1108	F+SLE	RS P	XCT R	\$HERMES,	527	
REGRESSION W/CONFIDENCE LIMITS	BKC	360	F4	RSBP	P	\$GRAPH, LINEAR	624	
REICH-MOORE RESOLVED REGION X-SECTIONS	BNL	6600	F4	RS P	A	\$RAMP1,	492	
RELAP3B/MOD110, REACTOR SYSTEM TRANSIENT CODE	BNL	7600	F4	RS P	T G	\$	733	
RELAP4/MOD6, TRANSIENT THERMAL-HYDRAULIC STUDY	EG&G	360F	F+BAL	RSBPL	XCT	G	\$	369
RELAP4/MOD6, TRANSIENT THERMAL-HYDRAULIC STUDY	EG&G	7600D	F+COM	RS PLX	T	G	\$	369
RELAP4/MOD6, TRANSIENT THERMAL-HYDRAULIC STUDY	EG&G	7600E	F+COM	RS PLX	T	G	\$	369

RELATION

ROD

RELATION	GEC	635	F4	RSBP	D	SDOS, NEUTRON FLUX-DOSIMETER ACTIVITY	423	
RELEASE	ORNL	360	F4	RS P C	G	\$SSTFEGL, ANALYSIS OF PWR & BWR GASEOUS	583	
RELEASE	PGE	360	F4	RS P T	G	\$SEMERALD REV. 1, PWR ACCIDENT ACTIVITY	546	
RELEASE	GGA	1108	F4	RS P	D	\$SFREYAP6, HTGR METALLIC FISSION PRODUCT	301	
RELEASE ANALYSIS	BCL	6400	F4	RS P	G	\$SFRCL2, LOCA FISSION PRODUCT	500	
RELEASE AND DOSE	PGE	360	F4	RS P T	G	\$SEMERALD-NORMAL, PWR ACTIVITY	685	
RELEASE SAFETY ANALYSIS	HEDL	CY74	F4	RS P	G	\$SPRAY3, SODIUM SPRAY	716	
RELEASE SIMULATION	BAPL	6600	F4	RS P	I	\$SBUBL1, FUEL SWELLING & GAS	R468	
RELEASED RADIOLOGICAL DOSE	A1	370	F4	RS P T	G	\$SCOMRADEX4, ACCIDENT	663	
RELIABILITY FOR A SINGLE FAILURE MODE	BAPL	6600	F4	RS P	P	\$SREL01,	R497	
REL01, RELIABILITY FOR A SINGLE FAILURE MODE	BAPL	6600	F4	RS P	P	\$	R497	
REMOTE JOB ENTRY SYSTEM	EG&G	360	BAL	RSB	T P	\$NRTS-RJE, OS/360 MVT	519	
REMOTE WORKSTATION PKG	ANL	360B	F+ASM	RSB	CT P	\$WSP-HASP/DOS, DOS-MFT	541	
REMOVAL	BCL	6400B	F4	RS P X T	G	\$SMIRAB, MIRAP, CONTAINMENT SYSTEM IODINE	499	
REMOVAL X-SECS	BAPL	6600	F4	RS	B	\$SM0807, 2-D DIFFUSION ABSORPTION	R280	
RENUM, SELF-ORGANIZING MESH GENERATION	ANL	360	F4	RS P	CT L	\$QMESH,	612	
RENUM, SELF-ORGANIZING MESH GENERATION	SLA	6600	F4	RS P T	L	\$QMESH,	612	
REORDERING	DP	370	F+BAL	RS P XCT	P	\$SDYNSK, OPTIMAL DICK DATA SET	729	
REPP, THERMAL-HYDRAULIC WATER REACTOR DESIGN	BNW	1108	F5	RS P	CT H	\$	483	
RESEND,ADLER, ENDF/B RESONANCE XSECTION CODES	BNL	6600B	F4	RS P	T A	\$	465	
RESOLUTION OF GAMMA-RAY SPECTRA	ORNL	360	F4	RS P	O	\$ALPHA-M,	413	
RESOLVED MULTILEVEL B-W X-SEC CALC	BNL	6600	F4	RS P	A	\$SIGPLOT,	377	
RESOLVED REGION X-SECTIONS	BNL	6600	F4	RS P	A	\$SRAMP1, REICH-MOORE	492	
RESOLVED RESONANCE EPITHERMAL X-SECTIONS	NED	635	F4	RS P T	B	\$SREAX,	257	
RESONANCE DATA UICS	360	F4	RS P	A	\$CODILLI, LEAST SQUARES ANALYSIS	347		
RESONANCE EPITHERMAL X-SECTIONS	NED	635	F4	RS P T	B	\$SREAX, RESOLVED	257	
RESONANCE INTEGRAL HEX CELL	BAPL	6600	F+ASC	RS P X T	B	\$SRESQ2, RESQ0, DBF1,	R285	
RESONANCE INTEGRALS X-SECS	BAPL	6600	F4	RS P T	A	\$SPUN1, UNRESOLVED	R359	
RESONANCE MEASUREMENTS	GGA	1108	F4	RS P T	A	\$STACASI, ANALYSIS OF	410	
RESONANCE PARAMETER CALC	ENEA	360	F4	RS P	A	\$SPSEUDO, STATISTICAL	292	
RESONANCE PARAMETER CALC	GGA	1108	F4	RS P	A	\$SPSEUDO, STATISTICAL	292	
RESONANCE PARAMETERS	ORNL	360	F4	RS P	A	\$SPOLLA, CONVERTS R-MATRIX	639	
RESONANCE REGION	RRC	370	F4	RS P T	A	\$SDOPSEL, SELF-SHIELDING IN THE	805	
RESONANCE THEORY XSEC CALC	KAPL	6600	F4	RS P	A	\$MULTI, MULTI-LEVEL	R535	
RESONANCE X-SECTION CALC	GGA	1108B	F4	RS P	A	\$SGANDY3, UNRESOLVED	341	
RESONANCE XSEC PROBABILITY TABLES	AI	360	F+BAL	RS P CT	A	\$SU3R, UNRESOL	553	
RESONANCE XSECTION CODES	BNL	6600B	F4	RS P T	A	\$SRESEND,ADLER, ENDF/B	465	
RESONANCES	AI	360	F4	RS PLX T	B	\$SAILMOE, X-SECTION CALC ELASTIC SCAT	147	
RESONANCES	BAPL	6600	F4	RS P	A	\$SGRAMP, R-M PARAMETERS OF UNRESOLVED	R470	
RESOURCE ALLOCATION PROJECT PLANNING	MLMO	360	F+C+R	RSBP	T M	\$SRALCRTPH,	G603	
RESPOND, DISSIMILAR MEDIA TLD CORRECTION CALC	AI	360	F4	RS P	Q	\$	566	
RESPONSE	EG&G	360B	F+BAL	RSBPXCT	G	\$CONTEMPT-LT/026, PRESSURE-TEMPERATURE	433	
RESPONSE	FINITE-ELEMENT CODE	SLA	6600B	F4	RS P T	I	\$SHONDO, A DYNAMIC	672
RESPONSE	LOCA	EG&G	360	F4	RSBP X T	G	\$STHETA1-B, FUEL ROD THERMAL	512
RESPONSE	LOCA EXPERIMENTS	ORNL	360	F4	RS P T	H	\$SHETRAP, FUEL ROD	730
RESPONSE	OF ELASTIC STRUCTURES	BAPL	6600	F4	RS P	I	\$SFUGIT, DYNAMIC	R537
RESPONSE	OF LUMPED-MASS SYSTEMS	SLL	6600	F4	RS P T	I	\$SSHOCK, DYNAMIC	795
RESPONSE	SURFACE CODE	ANL	370	F+BAL	RS P T	G	\$PROSA1, PROBABLISTIC	R778
RESPONSE	TO ACCIDENT	BNL	7600	F+COM	RS P T	G	\$SNALAP, LMFBR TRANSIENT	780
RESPONSE	TO EXCURSION	ANL	360	F4	RS P CT	F	\$SREXCO-H, 2-D HYDRODYNAM	550
RESPONSE	TO EXCURSION	ANL	360	F4	RS P CT	F	\$SREXCO-H2, 2-D HYDRODYNAM	R615
RESQ0,DBF1, RESONANCE INTEGRAL HEX CELL	BAPL	6600	F+ASC	RS P X T	B	\$SRESQ2,	R285	
RESQ2,RESQ0,DBF1, RESONANCE INTEGRAL HEX CELL	BAPL	6600	F+ASC	RS P X T	B	\$	R285	
RETRIEVAL	SLA	1108	F+BAL	RSBP	T M	\$SPIRAL, FULL-TEXT STORAGE, SEARCH &	R607	
REV. 1, PWR ACCIDENT ACTIVITY RELEASE	PGE	360	F4	RS P T	G	\$SEMERALD	546	
REVOLUTION	KAPL	6600C	F4	RS P T	I	\$SOR3, STRESS ANALYSIS SHELLS OF	R 80	
REXCO-H, 2-D HYDRODYNAM RESPONSE TO EXCURSION	ANL	360	F4	RS P CT	F	\$	550	
REXCO-H2, 2-D HYDRODYNAM RESPONSE TO EXCURSION	ANL	360	F4	RS P CT	F	\$	R615	
RFD	360	COBOL	RS P T	U	\$GLOVE CHANGE ANALYSIS SYSTEM, GLOVE DATA BASE		813	
RFD	360	F4	RS P	U	\$DYNAMIC ANALYSIS OF GASES BY MASS SPECTROMETRY		645	
RFD	6600B	F+COM	RS PLX T	C	\$KENO2, MONTE CARLO MULTIGROUP CRITICALITY CODE		450	
RICE-LASL, CHEMICALLY REACTIVE MIXTURE FLOW	LASL	6600	F4	RS P X T	U	\$	720	
RICE, PRIMARY RECOIL ATOM SPECTRA ENDF/B DATA	ORNL	360	F4	RS P T	B	\$	453	
RIGEL, ENDF/B V3 DATA PROCESSING CODE	ANL	360	F4	RS	T M	\$	571	
RIGEL,PLOTFB,... ENDF/B V2 PROC	BNL	6600B	F4	RS	T M	\$SRECT,CHECKER,	475	
RIGEL3, ENDF/B V3 PROCESSING CODES	BNL	6600	F4	RS	T M	\$CHECK3,	571	
RIGEL4,CHECK4,... ENDF/B V4 PROCESSING CODES	BNL	6600B	F4	RS	T M	\$	530	
ROD BUNDLE	NED	635	F4	RS P T	H	\$SVELVET2, TURBULENT FLOW IN LMFBR	458	
ROD BUNDLE & CORE THERMAL-HYDRAULICS	BNW	7600D	F4	RS P XCT	H	\$COBRA41,	432	
ROD BUNDLE CHF DATA ANALYSIS	EG&G	360	F4	RS PL CT	P	\$SERREST, LOCA	518	
ROD BUNDLE FLOW & TEMPERATURE DIST.	ORNL	360	F4	RS P T	H	\$SORRIBLE,	629	
ROD CLAD STRAIN & PELLETT CRACKING	BAPL	6600	F4	RS P	I	\$SSTRIPE, FUEL	R570	

ROD

SCOPE2

ROD RESPONSE LOCA EXPERIMENTS	ORNL	360	F4	RS P T H	SHETRAP, FUEL	730	
ROD STRESS & DEFORMATION	AN-T	360B	F4	RSBP CT I	SCYGR03, OXIDE FUEL	R449	
ROD STRESS & DEFORMATION	BAPL	6600	F4	RS P T I	SCYGR03, OXIDE FUEL	R449	
ROD THERMAL RESPONSE LOCA	EG&G	360	F4	RSBP X T G	STHETA1-B, FUEL	512	
RODS EG&G	360	F+BAL	RSBP XCT G	SFRAP-T, TRANSIENT ANALYSIS OF OXIDE FUEL	658		
RODS EG&G	360	F+BAL	RS P X T H	SFRAP-S1, STEADY STATE ANALYSIS OXIDE FUEL	694		
RODS EG&G	7600	F4	RS P T H	SFRAP-S3, STEADY STATE ANALYSIS OXIDE FUEL	694		
RODS EG&G	7600	F4	RSBP XCT G	SFRAP-T3, TRANSIENT ANALYSIS OF OXIDE FUEL	658		
ROOTS OF A POLYNOMIAL	KAPL	6600	F4	RS P P	SROPE, FINDING	R444	
ROPE, FINDING ROOTS OF A POLYNOMIAL	KAPL	6600	F4	RS P P	\$	R444	
RRC	370	F4	RS P T A	SDOPEL, SELF-SHIELDING IN THE RESONANCE REGION	805		
RSAC, RADIOLOGICAL SAFETY ANALYSIS PROGRAM	EG&G	360B	F4	RSBP CT G	\$	265	
RTH LASL	7600	F4	RS P T C	STWOTRAN-PNVW, 2-D PARTICLE TRANSPORT XY RZ	573		
RTHETA LASL	360D	F4	RSBP CT C	STWOTRAN2, 2-D MULTI-GP TRANSPORT XY RZ	358		
RTHETA LASL	6600D	F4	RS P T C	STWOTRAN2, 2-D MULTI-GP TRANSPORT XY RZ	358		
RTHETA LASL	7600D	F4	RS P T C	STWOTRAN2, 2-D MULTI-GP TRANSPORT XY RZ	358		
RTHETA GEOMETRY	BNW	1108	F4	RS P C	SPERT4, 2-D PERTURBATION XY RZ	304	
RW	6500	F4	RS P B	SPART1, OPTIMAL GROUP OR MESH COLLAPSING	416		
RZ GGA	1108	F+BAL	RS P T D	\$BUG2, 2-D MULTIGROUP DIFFUSION & BURNUP XY,	438		
RZ GEOMETRY GGA	1108	F+BAL	RS P T C	\$GAMBLES, 2-D MULTI-GP DIFFUSION XY	222		
RZ RTH LASL	7600	F4	RS P T C	STWOTRAN-PNVW, 2-D PARTICLE TRANSPORT XY	573		
RZ RTHETA LASL	360D	F4	RSBP CT C	STWOTRAN2, 2-D MULTI-GP TRANSPORT XY	358		
RZ RTHETA LASL	6600D	F4	RS P T C	STWOTRAN2, 2-D MULTI-GP TRANSPORT XY	358		
RZ RTHETA LASL	7600D	F4	RS P T C	STWOTRAN2, 2-D MULTI-GP TRANSPORT XY	358		
RZ RTHETA GEOMETRY	BNW	1108	F4	RS P C	SPERT4, 2-D PERTURBATION XY	304	
R101, SPACE-INDEPENDENT KINETICS KEX OPTIONS	ANL	360	F4	RS P	\$	255	
R102, SPACE-INDEPENDENT INVERSE KINETICS CALC	ANL	360	F4	RS P	\$	168	
S-STATE TEMPERATURE DIST	ORNL	360	F+BAL	RS PLXCT H	STRUMP, TRANSIENT &	771	
S-WAVE NEUTRON X-SECTION CALCULATION	BAPL	6600	F4	RS P T A	\$SUMOR,	R399	
SABOR4, DISCRETE-ELEMENT ANALYSIS THIN SHELLS	MIT	360	F4	RS P T I	\$	R402	
SAFE PROGRAMS	GGA	1108	F4	RS P	L	SGRDWRK, GRID GENERATION FOR	296
SAFE-CRACK, VISCOELASTIC ANALYSIS OF CONCRETE	GGA	1108	F5	RS P T I	\$	451	
SAFE-CREEP, VISCOELASTIC ANALYSIS CONCRETE	GGA	1108	F4	RS P	I	\$	300
SAFE-PLANE, PLANE STRESS ANALYSIS, 2-D BODIES	BNL	6600	F4	RS P T I	\$	252	
SAFE-PLANE, PLANE STRESS ANALYSIS, 2-D BODIES	GGA	1108	F4	RS P	I	\$	252
SAFE-SHELL, STRESS ANALYSIS THIN SHELLS	GGA	1108	F4	RS P	I	\$	253
SAFE-2D, PLANE & AXISYMMETRIC STRESS ANALYSIS	GGA	1108	F4	RS P T I	\$	379	
SAFE-3D, 3-D COMPOSITE STRUCTURE STRESS STUDY	GGA	1108	F4	RS P T I	\$	332	
SAFE-3D, 3-D COMPOSITE STRUCTURE STRESS STUDY	ORNL	360	F+BAL	RS P T I	\$	332	
SAFETY	DP	360	F4	RS P T C	SKEFF, MGBS, TGAN, NUCLEAR CRITICALITY	617	
SAFETY ANALYSIS	BAPL	7600	F4	RS P T H	\$WASP2, WATER PROPERTIES FOR	R396	
SAFETY ANALYSIS	HEDL	CY74	F4	RS P G	\$SPRAY3, SODIUM SPRAY RELEASE	716	
SAFETY ANALYSIS PROGRAM	EG&G	360B	F4	RSBP CT G	\$RSAC, RADIOLOGICAL	265	
SAFETY COMMON CAUSE ANALYSIS	EG&G	360	F+BAL	RS P T G	\$COMCAN, SYSTEM	704	
SAFTAC, MONTE CARLO FAULT TREE SIMULATION CODE	NEA	360	F4	RS P	\$G-	674	
SAFTAC, MONTE CARLO FAULT TREE SIMULATION CODE	UNI	1108	F+SLE	RS P	\$G	674	
SAGE-WASP, OPTIMAL ELECTRIC UTILITY EXPANSION	TVA	370	F4	RS P CT D	\$	\$744	
SAMPLE STATISTICS	BKC	360	F4	RSBP	\$HISTOGRAMS, QUALITY CONTROL	614	
SAMPLING STUDY	BAPL	6600	F4	RS P H	\$BETTY, ENTRAINED PARTICLES	R545	
SAMPLING TABLE, FOR NON-BIAS ORDERING	MLMO	360	F+COB	RSBP XC M	\$RANDOM	679	
SANDIA MATHEMATICAL SUBROUTINES	SLA	6600C	F+COM	RS P X T P	\$MATHLIB,	654	
SAP4, STRUCTURAL ANALYSIS OF LINEAR SYSTEMS	ANL	370D	F4	RS P CT I	\$	641	
SAS1A, FAST REACTOR POWER AND FLOW TRANSIENTS	ANL	360	F4	RS P T F	\$	400	
SAS1A, FAST REACTOR POWER AND FLOW TRANSIENTS	ANL	6600	F4	RS P T F	\$	400	
SCAT KERNELS	DP	360	BCD	R LX T Z	\$THERMOS LIBRARY, 30-GP ENDF/B	543	
SCAT RESONANCES	AI	360	F4	RS PLX T B	\$SAILMOE, X-SECTION CALC ELASTIC	147	
SCAT X-SEC	BNL	6600	F4	RS P A	\$BESFIT, DIFFRACTION MODEL ELASTIC	524	
SCAT X-SECTION CALC MODERATOR	GGA	1108	F4	RS P A	\$GAKER, INELASTIC	289	
SCAT X-SECTIONS HEX LATTICE	GGA	1108	F4	RS B	\$HEXSCAT, ELASTIC	291	
SCATTERING CALC	ANL	360	F4	RS P CT W	\$MSCAT, SLOW NEUTRON MULTIPLE	575	
SCATTERING CRYSTALLINE MATERIALS	LASL	6600	F4	RS P T A	\$TOR, THERMAL	360	
SCATTERING DATA	DP	360B	F4	RS P XCT B	\$FLANGE2(71-1), ENDF/B THERMAL	368	
SCATTERING FORM FACTORS	ORNL	360	F4	RS P T A	\$ATHENA4, INELASTIC	417	
SCATTERING LAW CALC	GGA	1108	F4	RS P X A	\$SCOBE, COHERENT INELASTIC	385	
SCATTERING LAW CALCULATION	GGA	1108	F4	RS P A	\$GASKET, THERMAL	263	
SCATTERING LAW X-SECTION CALCULATION	GGA	1108	F5	RS P A	\$FLANGE1,	247	
SCATTERING X-SEC CALC	KAPL	6600	F4	RS P T A	\$JP1XR, COUPLED-CHANNEL	R506	
SCATTRING CODES	EG&G	360	F4	RS P CT W	\$MACS LATTICE VIBRATION NEUTRON	574	
SCHAFF, HEAT & WATER TRANSFER IN POROUS MEDIA	BKY	7600	F4	RS P T H	\$	802	
SCHEME	KAPL	6600	F4	RS P P	\$MOST, A MULTIDIMENSIONAL OPTIMIZATION	R446	
SCISRS ENDF/B GRAPHIC X-SEC EVALUATION	AI	360	F+BAL	RSB L CT M	\$SCORE3,	375	
SCOPE2.0 CEND	7600B	F4	RS T P	\$MODEL, MODIFIED BETTIS ENVIRNMNTL LIB	478		

SCOPE3

SINGULARITY

SCOPE3.3 CDC 6600D F+COM RS T P SMODEL, MODIFIED BETTIS ENVIRNMNTL :IB	478
SCORE3, SCISRS ENDF/B GRAPHIC X-SEC EVALUATION AI 360 F+BAL RSB L CT M S	375
SEALSHL2, SHELL STRESS ANALYSIS AXISYM LOAD BAPL 6600 F4 RS P T I S	R282
SEALSHL2, SHELL STRESS ANALYSIS AXISYM LOAD SR 360 F4 RS P T I S	R282
SEALSHL2, SHELL STRESS ANALYSIS AXISYM LOAD WTSC 7600 F4 RS P T I S	R282
SEARCH GGA 1108 F4 RS P T C SGASP7, 1-D BURNUP POWER DISTRIBUTION	319
SEARCH & RETRIEVAL SLA 1108 F+BAL RSBP T M \$SPIRAL, FULL-TEXT STORAGE,	R607
SECOND-ORDER ERROR PROPAGATION CODE EG&G 360 F4 RS P P \$SOERP,	764
SECOND-ORDER ERROR PROPAGATION CODE EG&G 7600 F4 RS P P \$SOERP,	764
SECONDARY ELECTRON SPECTRA KAPL 6600 F4 RS P W \$CONDYN, POLYA MODEL	786
SECTIONS LASL 6600 F4 RS P N SLARCA, FLUX-WEIGHTING OF DTF4 CROSS	409
SEDIMENT & CONTAINMENT TRANSPORT MODEL ORNL 360 F+BAL RS P CT R SCHNSED,	793
SELF-ORGANIZING MESH GENERATION ANL 360 F4 RS P CT L \$QMESH, RENUM,	612
SELF-ORGANIZING MESH GENERATION SLA 6600 F4 RS P T L \$QMESH, RENUM,	612
SELF-SHIELDING IN THE RESONANCE REGION RRC 370 F4 RS P T A \$DOPSEL,	805
SEMI-RIGID MOLECULES EG&G 360 F4 RS P W \$MMM3, COORDINATE ANALYSES	632
SENSITIVITY ANL 360 F4 RSBPL CT C \$VARI-1D, 1-D VARIATIONAL	625
SEPHIS/MOD4, SOLVENT EXTRACTION SIMULATION ORNL 360 F4 RS P T U S	R690
SETS FBRD 6000 F4 RS P C C STRIAL, 3-D REACTION RATES FROM 2-D FLUX	585
SETS LASL 6600 BCD R LX T Z \$LASL XSEC SETS, SN 18- 24- AND 25-GROUP	532
SETS FROM FAULT TREES EG&G 360 F4 RSBP CT G \$MOCUS, MINIMAL	653
SETS, SET EQUATION TRANSFORMATION SYSTEM SLA 6600B FTN RS P T P S	623
SETS, SN 18- 24- AND 25-GROUP SETS LASL 6600 BCD R LX T Z \$LASL XSEC	532
SHAPER CUTTER CONTOUR GENERATOR ANL 360 F4 RS P T \$F0355,	697
SHAPER CUTTER CONTOUR GENERATOR BKC 6600 F4 RS P T \$F0355,	697
SHEET DP PACKAGE KAPL 6600 F+ASC RS P T P \$DOGGY, DESK CALCULATOR FORM	R428
SHELL BUCKLING COLLAPSE ANALYSIS BAPL 6600 F4 RS P T I \$BUSHL, CYL	R481
SHELL STRESS ANALYSIS AXISYM LOAD BAPL 6600 F4 RS P T I \$SEALSHL2,	R282
SHELL STRESS ANALYSIS AXISYM LOAD SR 360 F4 RS P T I \$SEALSHL2,	R282
SHELL STRESS ANALYSIS AXISYM LOAD WTSC 7600 F4 RS P T I \$SEALSHL2,	R282
SHELL 3-D STRUCTURAL ANALYSIS GGA 1108 F5 RS P T I \$SHELL5, THIN	452
SHELLS GGA 1108 F4 RS P I \$SAFE-SHELL, STRESS ANALYSIS THIN	253
SHELLS SLA 6600 F4 RS P T I \$SLADE-D, DYNAMIC ANALYSIS OF THIN	581
SHELLS MIT 360 F4 RS P T I \$SABOR4, DISCRETE-ELEMENT ANALYSIS THIN	R402
SHELLS OF REVOLUTION KAPL 6600C F4 RS P T I \$SOR3, STRESS ANALYSIS	R 80
SHELL5, THIN SHELL 3-D STRUCTURAL ANALYSIS GGA 1108 F5 RS P T I S	452
SHIELD CODE LSU 360 F4 RS P J \$DEMONR, UNBIASED MONTECARLO SLAB	754
SHIELD EVALUATION CODE BAPL 6600B F+ASC RS P T J \$SPAN4, A POINT-KERNEL	R462
SHIELDING CODE CAVITY GEOM GGA 1108 F4 RS P T J \$MUSCAT, VIEW FACTOR	259
SHIFT X-SEC & POLARIZATION CALC KAPL 6600 F4 RS P A \$PHASER, PHASE	R507
SHIPPING CONTAINER IMPACT ANALYSIS LASL 7600 F4 RS P I \$IMPAC2, B	715
SHLOG, DATA MANAGEMENT, EDITING, & ANALYSIS BAPL 6600 F4 RS P T M S	R557
SHOCK, DYNAMIC RESPONSE OF LUMPED-MASS SYSTEMS SLL 6600 F4 RS P T I S	795
SI METRIC TO U.S. CUSTOMARY UNITS MLMO 360 F4 RS P XC P \$MTRC0001,	812
SI UNITS RDYN 370B F4 RS P T P \$METRICATION, CONVERSION TO OR FROM	G668
SIEX, LMFBR FUEL PIN THERMAL PERFORMANCE MODEL HEDL 6600 F RS P T H S	673
SIGMA1, LINEARIZE & BROADEN ENDF/B DATA LLL 7600 F4 RS P T B \$LINEAR,	747
SIGPLOT, RESOLVED MULTILEVEL B-W X-SEC CALC BNL 6600 F4 RS P A S	377
SIMPLE1, TIME-SHARING PROGRAMMING LANGUAGE KAPL 6600 F+ASC RS P S	R442
SIMPLIFIED INELASTIC PIPING ANALYSIS BCL 6400 F4 RS P T I \$PIRAX2,	R735
SIMULATES HADRONIC CASCADE TRANSPORT FNAL 370 F+BAL RS P T W \$CASIM,	742
SIMULATION ORNL 360 F4 RS P T U \$SEPHIS/MOD4, SOLVENT EXTRACTION	R690
SIMULATION BAPL 7600 F4 RS P T G \$FLASH6, FULLY-IMPLICIT TRANSIENT	R448
SIMULATION MA-G 360 F4 RSBP CT G \$FLASH4, FULLY-IMPLICIT TRANSIENT	R448
SIMULATION ORNL 360C F+BAL RS P X T Q \$MARLOWE, BINARY COLLISION CASCADE	680
SIMULATION ORNL 7600 F+BAL RS P X T Q \$MARLOWE, BINARY COLLISION CASCADE	680
SIMULATION BAPL 6600 F4 RS P I \$BUBL1, FUEL SWELLING & GAS RELEASE	R468
SIMULATION DP 360 F4 RS P U \$SOLVEX, SOLVENT EXTRACTION PROCESS	662
SIMULATION CODE NEA 360 F4 RS P G \$SAFTAC, MONTE CARLO FAULT TREE	674
SIMULATION CODE UNI 1108 F+SLE RS P G \$SAFTAC, MONTE CARLO FAULT TREE	674
SIMULATION NUCLEAR POWER PLANTS ANL 370 F4 RS P X T K \$DSNP, DYNAMIC	784
SIMULATION OF REACTOR DYNAMICS AI 360 F+BAL RS P T E \$AIROS2A,	326
SIMULATION OF REACTOR OPN DP 360 F4 RS P G \$INT'EG, INSPEC, MARKOV	590
SIMULATION PROGRAM SLA 6600B F4 RS PL T R \$SOLSYS, SOLAR ENERGY SYSTEM	692
SIMULATION SYSTEM CUP1 370 F+BAL RS P CT U \$BIOSSIM, BIOCHEMICAL KINETIC	736
SIMULTANEOUS LINEAR ALGEBRAIC EQUATNS ANL 370 F4 RS P X T P \$LINPACK,	800
SINGLE FAILURE MODE BAPL 6600 F4 RS P P \$RELOT, RELIABILITY FOR A	R487
SINGLE SOURCE ANL GETS F R \$PLETHS, ISOPLETH-AREA CALC FROM	591
SINGLE-CHANNEL FLUX SYNTHESIS DIFFUSION ANL 370B F+BAL RS P XCT C \$SYN3D,	713
SINGLE-CHANNEL FLUX SYNTHESIS DIFFUSION ANL 7600 F+COM RS P XCT C \$SYN3D,	713
SINGLE-CHANNEL SPACE-TIME SYNTHESIS KAPL 6600 F4 RS P F \$STINT3,	R389
SINGULARITY MODELING SLA 6600 FTN RS P T I \$CHILES, LINEAR ELASTIC	611

SITE

SOCOOL2

SITE REQUIREMENT STUDY	AI	360	F4	RS	P	T	G	SAISITE2, PARAMETRIC	172
SITE2, ENERGY FACILITY SITING ASSESSMENT	ANL	360	F4	RS	P	T	R	S	687
SITING ASSESSMENT	ANL	360	F4	RS	P	T	R	SSITE2, ENERGY FACILITY	687
SIZZLE, 1-D MULTIGROUP DIFFUSION DEPLETION	AI	360	F4	RSBP	X	T	D	\$	58
SKILLS INVENTORY, PERSONNEL INFORMATION SYSTEM	H&N	6400	F4	RS	P	CT	M	\$	801
SLA 360 COBOL RSBP CT M	SBECOM, AEC DP PURCHASE VERSUS LEASE ANALYSIS	R589							
SLA 360D F4 RS P X T P	\$DE/STEP, INTRP, SOLN OF ORDINARY DIFF EQUATIONS	640							
SLA 1108 COBOL RS P M	SBECOM, AEC DP PURCHASE VERSUS LEASE ANALYSIS	R589							
SLA 1108 F+BAL RSBP T M	\$SPIRAL, FULL-TEXT STORAGE, SEARCH & RETRIEVAL	R607							
SLA 1108 F+BAL RSBP T T	\$ACCEL(MOD2), DESIGN OF PRINTED-CIRCUIT BOARDS	681							
SLA 3600 F36 RS P T I	\$TOODY2, 2-D LAGRANGIAN EQNS OF MOTION SOLUTION	627							
SLA 6600 BCD R L T Z	\$SOLDBAQ62, ALBUQUERQUE 1962 SOLAR DATA	693							
SLA 6600 F RS P T P	\$STFODE, COLODE, COLLOCATION SOLN OF STIFF ODE'S	652							
SLA 6600 F+COM RS P T T	\$ACCEL(MOD2), DESIGN OF PRINTED-CIRCUIT BOARDS	681							
SLA 6600 FTN RS P T I	\$CHILES, LINEAR ELASTIC SINGULARITY MODELING	611							
SLA 6600 F4 RS P P	\$SERF, ERFC, ERROR & COMPLEMENTARY ERROR FUNCTION	601							
SLA 6600 F4 RS P P	\$PLOT, 2-D CONTOUR PLOTS & AREA CALCULATION	R578							
SLA 6600 F4 RS P T I	\$SLADE-D, DYNAMIC ANALYSIS OF THIN SHELLS	581							
SLA 6600 F4 RS P T L	\$QMESH, RENUM, SELF-ORGANIZING MESH GENERATION	612							
SLA 6600 F4 RS P T P	\$SBESSEL FUNCTIONS, AIRY & LOG GAMMA SUBROUTINES	656							
SLA 6600 F4 RS P T P	\$SUPPORT, SOLUTION OF BOUNDARY-VALUE PROBLEMS	731							
SLA 6600 F4 RS P T Q	\$SCOREL, RASE4, DAMG2, ION IMPLANTATION DEPOSITION	758							
SLA 6600B BIN R L T Z	\$SOLDBAQ62, ALBUQUERQUE 1962 SOLAR DATA	693							
SLA 6600B FTN RS P T P	\$SETS, SET EQUATION TRANSFORMATION SYSTEM	623							
SLA 6600B F4 RS P T I	\$SHONDO, A DYNAMIC RESPONSE FINITE-ELEMENT CODE	672							
SLA 6600B F4 RS P T T	\$FFEARS, LAPLACE EQUATION ISOTROPIC DIELECTRICS	577							
SLA 6600B F4 RS PL T R	\$SOLSYS, SOLAR ENERGY SYSTEM SIMULATION PROGRAM	692							
SLA 6600C F+COM RS P X T P	\$MATHLIB, SANDIA MATHEMATICAL SUBROUTINES	654							
SLA 6600D F4 RS P X T P	\$DE/STEP, INTRP, SOLN OF ORDINARY DIFF EQUATIONS	640							
SLAB CYL SPHERE BNW 1107 F4 RS P T C	\$SHFN, 1-D MULTI-GP DIFFUSION	241							
SLAB CYL SPHERE BNW 6600 F4 RS P X T C	\$SHFN, 1-D MULTI-GP DIFFUSION	241							
SLAB CYL SPHERE OSUC 370 F4 RS PL CT C	\$AIM6, 1-D MULTI-GP DIFFUSION	29							
SLAB CYL SPHERE MTS 360 F4 RSBPLXCT C	\$SMACH1, 1-D MULTI-GP DIFFUSION	262							
SLAB CYL SPHERE PURD 6500 F4 RS PLX T C	\$SMACH1, 1-D MULTI-GP DIFFUSION	262							
SLAB CYL SPHERE BHSC 360 F4 RS P T C	\$FAIMOS, 1-D MULTI-GP DIFFUSION	120							
SLAB CYLINDER SPHERE AEB 360 F4 RS L T C	\$FIRE5, 1-D AGE-DIFFUSION	9							
SLAB CYLINDER SPHERE BC 625 F4 RS T C	\$FOG, 1-D FEW-GP DIFFUSION	28							
SLAB GAMMA-RAY TRANSPORT BAPL 6600 F4 RS P T J	\$M0756, LETO, 1-D	R343							
SLAB GEOMETRY BAPL 6600 F4 RS P T C	\$SBE21, FEW-GP DISCRETE ORDINATES	R398							
SLAB SHIELD CODE LSU 360 F4 RS P J	\$SDEMNR, UNBIASED MONTECARLO	754							
SLAB TRANSPORT WITH SLOWING DOWN BAPL 6600 F4 RS C	\$M0648, 1-D	R342							
SLAB, CYL, SPH EG&G 360 F4 RSBP CT C	\$MONA, 1-D MULTIGROUP DIFFUSION	582							
SLAB, SPH, CYL GGA 1108 F+BAL RS P T C	\$GAZE2, 1-D MULTIGROUP DIFFUSION	430							
SLAC 360 BAL RS CT P	\$SLACMON 2.2, OS360 MVT/MFT PERFORMANCE MONITOR	635							
SLAC 360 F4 RS P T V	\$SLACKLY, 1D MULTICAVITY KLYSTRON TUBE ANALYSIS	807							
SLAC 360 F4 RSBP XCT P	\$MORTAN2, MACRO-BASED STRUCTURED FORTAN	678							
SLAC 360B F+BAL RSB CT P	\$PROGLOOK, USER PROGRAM PERFORMANCE MONITOR	642							
SLAC 370 BAL RSB CT P	\$SLACMON/370, VERSION 4.0 VS SOFTWARE MONITOR	635							
SLAC 370 F4 RS P T V	\$TRANSPORT, DESIGN OF CHARGED PARTICLE BEAMS	791							
SLACKLY, 1D MULTICAVITY KLYSTRON TUBE ANALYSIS	SLAC 360 F4 RS P T V \$	807							
SLACMON 2.2, OS360 MVT/MFT PERFORMANCE MONITOR	SLAC 360 BAL RS CT P \$	635							
SLACMON/370, VERSION 4.0 VS SOFTWARE MONITOR	SLAC 370 BAL RSB CT P \$	635							
SLADE-D, DYNAMIC ANALYSIS OF THIN SHELLS	SLA 6600 F4 RS P T I \$	581							
SLAG TRANSPORT MODELS FOR DUCT SURFACES	370 F4 RS P H \$SLGTR,	783							
SLGTR, SLAG TRANSPORT MODELS FOR DUCT SURFACES	ANL 370 F4 RS P H \$	783							
SLIDES & POSTERS	ANL 370 F4 RS P C P \$SLIDES, FOR DISSPLA-LETTERED	728							
SLIDES, FOR DISSPLA-LETTERED SLIDES & POSTERS	ANL 370 F4 RS P C P \$	728							
SLL 6600 F+COM RS P T I	\$GNATS, MESH2, GPRINT, 2-D NONLINEAR ANALYSIS	682							
SLL 6600 F4 RS P N	\$SHEATME5, GEOMETRICAL DATA HEAT TRANSFER STUDY	434							
SLL 6600 F4 RS P T I	\$SHOCK, DYNAMIC RESPONSE OF LUMPED-MASS SYSTEMS	795							
SLOP, CROSS, IBM360 FORTRAN H PROGRAM CHECKER	ANL 360B PL1 S P CT P \$	647							
SLOW NEUTRON MULTIPLE SCATTERING CALC	ANL 360 F4 RS P CT W \$MSCAT,	575							
SLOWING DOWN	BAPL 6600 F4 RS C \$M0648, 1-D SLAB TRANSPORT WITH	R342							
SLOWING-DOWN NPGS 360 F4 RS P X T E	\$MOD5, STOCHASTIC MODEL OF NEUTRON	491							
SLOWING-DOWN SPECTRUM, MULTIGP CONSTANTS	BNW 1108 F4 RS PLX T B \$HRG3,	467							
SLOWING-DOWN SPECTRUM, MULTIGP CONSTANTS	TVA 360 F4 RS PLX T B \$HRG3,	467							
SN PERTURBATION CODE USING DTF4 FLUXES	LASL 6600 F4 RS P N \$DAC1,	455							
SN THEORY NED 635 F4 RS P T C	\$DOT2DB, 2-D MULTIGROUP DIFFUSION &	459							
SN 18- 24- AND 25-GROUP SETS	LASL 6600 BCD R LX T Z \$LASL XSEC SETS,	532							
SNEQ, NONLINEAR ALGEBRAIC EQN SOLN CURVE PLOT	KAPL 6600 F+ASC RS P T P \$	R364							
SOCOOL2, SODIUM-FUEL INTERACTION ANALYSIS	ANL 360 F4 RS P G \$	521							
SOCOOL2, SODIUM-FUEL INTERACTION ANALYSIS	HEDL 1108 F4 RS P G \$	521							

SODIUM

SPECTRA

SODIUM	ANL	370	F+CSM	RS P	G	\$SPOOL-FIRE, SPRAY-POOL BURNING OF	R714
SODIUM POOL FIRE 1- & 2-CELL ANALYSIS	AI	360	F4	RS P	G	\$SOFIRE2,	559
SODIUM SPRAY FIRES IN CYLINDRICAL CELL	AI	370	F4	RS P	T G	\$SOMIX1,	R751
SODIUM SPRAY RELEASE SAFETY ANALYSIS	HEDL	CY74	F4	RS P	G	\$SPRAY3,	716
SODIUM-FUEL INTERACTION ANALYSIS	ANL	360	F4	RS P	G	\$SOCOOL2,	521
SODIUM-FUEL INTERACTION ANALYSIS	HEDL	1108	F4	RS P	G	\$SOCOOL2,	521
SODIUM-WATER REACTION	CEND	7600	F4	RS P	G	\$CEBUG, STEAM GENERATOR	548
SOERP, SECOND-ORDER ERROR PROPAGATION CODE	EG&G	360	F4	RS P	P	\$	764
SOERP, SECOND-ORDER ERROR PROPAGATION CODE	EG&G	7600	F4	RS P	P	\$	764
SOFIRE2, SODIUM POOL FIRE 1- & 2-CELL ANALYSIS	AI	360	F4	RS P	G	\$	559
SOFTWARE MONITOR	SLAC	370	BAL	RSB	CT P	\$SLACMON/370, VERSION 4.0 VS	635
SOIL-WATER TRACE-CONTAINMENT TRANSPORT	ORNL	360	F+BAL	RS P	CT R	\$ODMOD,	789
SOLA-ICE, TRANSIENT COMPRESSIBLE FLUID FLOW	LASL	7600	F4	RS P	H	\$	723
SOLA-SURF, TRANSIENT FLUID FLOW ALGORITHM	LASL	7600B	F	RS P	H	\$SOLA,	651
SOLA-SURF, TRANSIENT FLUID FLOW ALGORITHM	LASL	7600B	F	RS P	H	\$	651
SOLAR DATA	SLA	6600	BCD	R L T Z	\$SOLATABQ62, ALBUQUERQUE 1962		693
SOLAR DATA	SLA	6600B	BIN	R L T Z	\$SOLATABQ62, ALBUQUERQUE 1962		693
SOLAR ENERGY SYSTEM SIMULATION PROGRAM	SLA	6600B	F4	RS PL T R	\$SOLSYS,		692
SOLATABQ62, ALBUQUERQUE 1962 SOLAR DATA	SLA	6600	BCD	R L T Z	\$		693
SOLATABQ62, ALBUQUERQUE 1962 SOLAR DATA	SLA	6600B	BIN	R L T Z	\$		693
SOLNS, PURD 6500 F4	RS P	CT P	\$2DEPEP, ELLIPTIC PARABOLIC & EIGENVALUE				806
SOLSYS, SOLAR ENERGY SYSTEM SIMULATION PROGRAM	SLA	6600B	F4	RS PL T R	\$		692
SOLVE ODE SYST WITH BANDED JACOBIAN	LLL	360	F4	RS P X T P	\$EPISODEB,		705
SOLVE ODE SYSTEM WITH BANDED JACOBIAN	LLL	360C	F4	RS P X T P	\$GEARB,		661
SOLVE ODE SYSTEM WITH BANDED JACOBIAN	LLL	6600C	F4	RS P X T P	\$GEARB,		661
SOLVENT EXTRACTION PROCESS SIMULATION	DP	360	F4	RS P	U	\$SOLVEX,	662
SOLVENT EXTRACTION SIMULATION	ORNL	360	F4	RS P	T U	\$SEPHIS/MOD4,	R690
SOLVER	ANL	360C	F4	RS P X	P	\$GEAR, ORDINARY DIFFERENTIAL EQN SYSTEM	592
SOLVER	LLL	360	F4	RS P X T P	P	\$EPISODE, ORDINARY DIFF EQUATION SYSTEM	675
SOLVER	LLL	6600C	F4	RS P X	P	\$GEAR, ORDINARY DIFFERENTIAL EQN SYSTEM	592
SOLVEX, SOLVENT EXTRACTION PROCESS SIMULATION	DP	360	F4	RS P	U	\$	662
SOMIX1, SODIUM SPRAY FIRES IN CYLINDRICAL CELL	AI	370	F4	RS P	T G	\$	R751
SORSDB, PRESSURE VESSEL STRESS AND FATIGUE	KAPL	6600	F4	RS	I	\$	R391
SOR3, STRESS ANALYSIS SHELLS OF REVOLUTION	KAPL	6600C	F4	RS P	T I	\$	R 80
SOURCE	ANL	GETS	F	R	R	\$PLETHS, ISOPLETH-AREA CALC FROM SINGLE	591
SOURCE BUILDUP FACTOR CALC	BAPL	6600	F+ASC	RS P	T J	\$ASPIS, GAMMA-RAY	R429
SOURCE DATA	NED	635	F4	RS P	T O	\$EXPN, ANALYSIS OF PULSED NEUTRON	258
SOURCE DATA ANALYSIS	CNEA	360	F4	RS P	E	\$STRIFIDO, PULSED NEUTRON	489
SPACE-DEPENDENT X-SECTION GENERATION	GEC	635	F4	RSBP	T B	\$GROUSE,	420
SPACE-INDEPENDENT INVERSE KINETICS CALC	ANL	360	F4	RS P	E	\$SR102,	168
SPACE-INDEPENDENT KINETICS KEX OPTIONS	ANL	360	F4	RS P	E	\$SR101,	255
SPACE-INDEPENDENT KINETICS W/FEEDBACK	AEB	360	F4	RS P	E	\$SAIREK3,	121
SPACE-INDEPENDENT REACTOR KINETICS	GGA	1108	F4	RS P	E	\$GAPOTKIN,	317
SPACE-INDEPENDENT REACTOR KINETICS CODE	ANL	360	F4	RS P	T E	\$ANCON,	486
SPACE-INDEPENDENT REACTOR KINETICS CODE	LASL	6600	F4	RS P	T E	\$ANCON,	486
SPACE-TIME DIFFUSION	ANL	360	F4	RS P	T F	\$TWIGGLE, 2-D 2-GP	R338
SPACE-TIME DIFFUSION FEEDBACK	BAPL	6600	F4	RS P	T F	\$TWIGL, 2-D 2-GP	R338
SPACE-TIME DIFFUSION FEEDBACK	BNL	6600	F4	RS P	T F	\$SNOAH, 1-D ONE-GP	405
SPACE-TIME DIFFUSION W/FEEDBACK	BAPL	6600	F4	RS P	T F	\$SWIGL3, 1-D	R708
SPACE-TIME DIFFUSION 3-GEOM	BAPL	6600	F4	RS P	T F	\$SWIGL2, 1-D 2-GP	R274
SPACE-TIME DIFFUSION 3-GEOM	GGA	1108	F4	RS P	T F	\$SWIGL2, 1-D 2-GP	R274
SPACE-TIME DIFFUSION 3-GEOM	UFCC	370	F4	RS P	T F	\$SWIGL2, 1-D 2-GP	R274
SPACE-TIME KINETICS	BCL	6400	F4	RS P	T F	\$ADEP, 1-D & 2-D FEW-GROUP	494
SPACE-TIME SYNTHESIS	KAPL	6600	F4	RS P	F	\$SSTINT3, SINGLE-CHANNEL	R389
SPAN4, A POINT-KERNEL SHIELD EVALUATION CODE	BAPL	6600B	F+ASC	RS P	T J	\$	R462
SPATIAL & COMPOSITION-DEPENDENT X-SECS	FBRD	835	F+GMP	RS P	XCT B	\$TDOWN,	505
SPATIAL REACTOR KINETICS CODE	ANL	360	F4	RS PL	CT F	\$SQX1, QUASISTATIC	474
SPATIALLY-DEPENDENT REACTOR KINETICS	AI	360	F4	RS P	T F	\$TSN,	309
SPEAKEASY MU+, LANGUAGE PROCESSOR TSO	OR BATCH	ANL	360	F+BAL	RSBP X T P	\$	593
SPEARMAN & KENDALL CORRELATION	ORNL	360	F4	RS P	T P	\$SPEKEN, PEARSON	781
SPEC, TIME-OF-FLIGHT DATA ANALYSIS	GGA	1108	F5	RS P	T O	\$SCAGE, BIRD,	476
SPECIAL FUNCTION ROUTINES	ANL	370B	F4	S P X	T P	\$FUNPACK2,	610
SPECIAL FUNCTION ROUTINES	ANL	1108B	F5	S P X	T P	\$FUNPACK2,	610
SPECIAL FUNCTION ROUTINES	ANL	6600B	F	S P X	T P	\$FUNPACK2,	610
SPECTRA	ORNL	360	F4	RS P	O	\$ALPHA-M, RESOLUTION OF GAMMA-RAY	413
SPECTRA	EG&G	360	F+P+A	RSBP	XCT W	\$GAUSS6, BATCH ANALYSIS OF GAMMA-RAY	622
SPECTRA	LASL	7600B	F+COM	RS PL	T A	\$GNASH, PARTICLE INDUCED X-SECTIONS &	757
SPECTRA	GGA	1108	F+BAL	RS P	T O	\$STOAD, PROCESSING OF ANALYZER GAMMA-RAY	333
SPECTRA	GGA	1108B	F4	RS PLXCT	B	\$GGC4, MULTI-GP X-SECTIONS FAST THERMAL	298
SPECTRA	KAPL	6600	F4	RS P	W	\$CONDYN, POLYA MODEL SECONDARY ELECTRON	786
SPECTRA	KSUN	360	F4	RS P	O	\$CORGAM, UNFOLDING OF COMPLEX GAMMA-RAY	390
SPECTRA	WANL	6600	F4	RS L	T B	\$GGC4, MULTI-GP X-SECTIONS FAST THERMAL	298

SPECTRA

STEAM

SPECTRA & MULTI-GP CONSTANTS	EG&G	360	F4	RS PL CT B	\$INCITE, THERMAL	565
SPECTRA & MULTIGP X-SECS ANL	370	F+BAL	RSBPL CT B	\$MC+2-2, FAST NEUTRON		355
SPECTRA & MULTIGP X-SECS ANL	7600	F+COM	RS PLXCT B	\$MC+2-2, FAST NEUTRON		355
SPECTRA ANALYSIS	KAPL	6600	F4	RS T O	\$GASPAR, COMPLEX GAMMA-RAY	R485
SPECTRA AND GROUP-AVERAGED X-SEC CALC	GGA	1108	F4	RS P X T B	\$GAF, GAR,	316
SPECTRA CALC	EG&G	360	F4	RS PLXCT B	\$PHROG, MULTI-GP CONSTANT & FAST	520
SPECTRA CODE	BNW	1108	F+BAL	RS P T O	\$GSSLRN1B, LEAST SQUARES PHOTOPEAK	457
SPECTRA ENDF/B DATA	ORNL	360	F4	RS P T B	\$PRICE, PRIMARY RECOIL ATOM	453
SPECTRA GE(LI)	EG&G	360	F4	RSBP XCT U	\$GAUSS5, ANALYSIS OF GAMMA-RAY	605
SPECTROMETRY	RFD	360	F4	RS P U	\$DYNAMIC ANALYSIS OF GASES BY MASS	645
SPECTRUM CALC WITH BURNUP CYL LATTICE				360B F4	RSBPLXCT B \$LASER,	249
SPECTRUM CALC WITH DEPLETION	JNC	1108B	F5	RS PLX T B	\$LEOPARD, SPOTS,	279
SPECTRUM CALC WITH DEPLETION	WAPD	360C	F4	RS PLXCT B	\$LEOPARD, SPOTS,	279
SPECTRUM X-SECTION CALC	BNW	1108	F5	RS PLX T B	\$BRT1, THERMAL	184
SPECTRUM X-SECTION CALC	OSUC	370	F4	RS PLXCT B	\$FORM, FAST NEUTRON	51
SPECTRUM X-SECTIONS	BHSC	360	F4	RS PL T B	\$STEMPEST2, THERMAL NEUTRON	50
SPECTRUM, MULTIGP CONSTANTS	BNW	1108	F4	RS PLX T B	\$HRG3, SLOWING-DOWN	467
SPECTRUM, MULTIGP CONSTANTS	TVA	360	F4	RS PLX T B	\$HRG3, SLOWING-DOWN	467
SPEKEN, PEARSON SPEARMAN & KENDALL CORRELATION	ORNL	360	F4	RS P T P	\$	781
SPH	EG&G	360	F4	RSBP CT C	\$MONA, 1-D MULTIGROUP DIFFUSION SLAB, CYL,	582
SPH, CYL	GGA	1108	F+BAL	RS P T C	\$GAZE2, 1-D MULTIGROUP DIFFUSION SLAB,	430
SPHERE	BNW	1107	F4	RS P T C	\$HFN, 1-D MULTI-GP DIFFUSION SLAB CYL	241
SPHERE	BNW	6600	F4	RS P X T C	\$HFN, 1-D MULTI-GP DIFFUSION SLAB CYL	241
SPHERE	OSUC	370	F4	RS PL CT C	\$AIM6, 1-D MULTI-GP DIFFUSION SLAB CYL	28
SPHERE	AEB	360	F4	RS L T C	\$FIRE5, 1-D AGE-DIFFUSION SLAB CYLINDER	9
SPHERE	MTS	360	F4	RSBPLXCT C	\$MACH1, 1-D MULTI-GP DIFFUSION SLAB CYL	262
SPHERE	PURD	6500	F4	RS PLX T C	\$MACH1, 1-D MULTI-GP DIFFUSION SLAB CYL	262
SPHERE	BC	625	F4	RS T C	\$FOG, 1-D FEW-GP DIFFUSION SLAB CYLINDER	28
SPHERE	BHSC	360	F4	RS P T C	\$FAIMOS, 1-D MULTI-GP DIFFUSION SLAB CYL	120
SPIRAL, FULL-TEXT STORAGE, SEARCH & RETRIEVAL	SLA	1108	F+BAL	RSBP T M	\$	R607
SPOOL-FIRE, SPRAY-POOL BURNING OF SODIUM	ANL	370	F+CSM	RS P G	\$	R714
SPOTS, SPECTRUM CALC WITH DEPLETION	JNC	1108B	F5	RS PLX T B	\$LEOPARD,	279
SPOTS, SPECTRUM CALC WITH DEPLETION	WAPD	360C	F4	RS PLXCT B	\$LEOPARD,	279
SPRAY FIRES IN CYLINDRICAL CELL	AI	370	F4	RS P T G	\$SOMIX1, SODIUM	R751
SPRAY RELEASE SAFETY ANALYSIS	HEDL	CY74	F4	RS P G	\$SPRAY3, SODIUM	716
SPRAY-POOL BURNING OF SODIUM	ANL	370	F+CSM	RS P G	\$SPOOL-FIRE,	R714
SPRAY3, SODIUM SPRAY RELEASE SAFETY ANALYSIS	HEDL	CY74	F4	RS P G	\$	716
SQ LENS DESIGN SYSTEM	LASL	6600	F+COM	RS P T P	\$LENSDES, NONLINEAR LEAST	602
SQ, NXN LATIN SQUARE EXPERIMENTAL DESIGN	MLMO	360	F4	RSBP C P	\$LATIN	630
SQUARE CELL COLLISION PROBABILITY CALC	ANL	360	F4	RS P T B	\$CLUP77,	526
SQUARE CELL COLLISION PROBABILITY CALC	JAER	230	F4	RS P T B	\$CLUP77,	526
SQUARE EXPERIMENTAL DESIGN	MLMO	360	F4	RSBP C P	\$LATIN SQ, NXN LATIN	630
SR	360	F4	RS P T I	\$SEALSHL2, SHELL STRESS ANALYSIS AXISYM LOAD	R282	
SS & TRANSIENT BEHAVIOR	BNW	6600	F4	RS P X T I	\$GAPCON-THERMAL3, FUEL	770
SSDC	370	F4	RS P H	\$HEATING2, TRANSIENT STEADY-STATE HEAT TRANSFER	198	
STABILITY ANALYSIS REACTOR KINETICS EQNS	GGA	1108	F4	RS P E	\$GASA,	290
STANDARD INTERFACE FILE PROCESSOR	LASL	360	F4	RS P CT M	\$LASIP3, CCCC	691
STATE ANALYSIS OXIDE FUEL RODS	EG&G	360	F+BAL	RS P X T H	\$FRAP-S1, STEADY	694
STATE ANALYSIS OXIDE FUEL RODS	EG&G	7600	F4	RS P T H	\$FRAP-S3, STEADY	694
STATE TWO-DIMENSIONAL FLUID FLOW	ANL	360	F4	RS P T H	\$EVITS, STEADY	792
STATIC & DYNAMIC STRUCTURAL ANALYSIS	EG&G	360	F4	RSBP CT I	\$STRAP,	539
STATION ELECTRICITY COSTS	UEC	6600	F4	RS P D	\$POWERCO, NUCLEAR	340
STATISTICAL MODEL REACTION X-SECTION	ENEA	360	F4	RS P A	\$THRES2,	504
STATISTICAL MODEL REACTION X-SECTIONS	BNL	6600B	F4	RS P A	\$THRES2,	504
STATISTICAL RESONANCE PARAMETER CALC	ENEA	360	F4	RS P A	\$PSEUDO,	292
STATISTICAL RESONANCE PARAMETER CALC	GGA	1108	F4	RS P A	\$PSEUDO,	292
STATISTICS	BKC	360	F4	RSBP P	\$HISTOGRAMS, QUALITY CONTROL SAMPLE	614
STEADY STATE ANALYSIS OXIDE FUEL RODS	EG&G	360	F+BAL	RS P X T H	\$FRAP-S1,	694
STEADY STATE ANALYSIS OXIDE FUEL RODS	EG&G	7600	F4	RS P T H	\$FRAP-S3,	694
STEADY STATE TWO-DIMENSIONAL FLUID FLOW	ANL	360	F4	RS P T H	\$EVITS,	792
STEADY-STATE AND TRANSIENT TEMP CALC	GGA	1108	F5	RS P T H	\$TAC2D,	408
STEADY-STATE FISSION PRODUCT FUEL MODEL	EG&G	360	F4	RSBP CT G	\$FFPM,	584
STEADY-STATE FLOW DISTRIBUTION	KAPL	6600	F4	RS P T H	\$SHAFMAT, SYSTEM	R616
STEADY-STATE FLOW, PRESSURE DISTRIBUTION	A&TS	370	F4	RS P C H	\$FLAC,	395
STEADY-STATE FLOW, PRESSURE DISTRIBUTION	GGA	1108	F5	RS P H	\$FLAC,	395
STEADY-STATE HEAT TRANSFER	SSDC	370	F4	RS P H	\$HEATING2, TRANSIENT	198
STEADY-STATE THERMAL-HYDRAULIC ANALYSIS	NED	635	F4	RS P T H	\$MANTA,	256
STEADY-STATE THERMAL-HYDRAULIC ANALYSIS	WARD	6600	F4	RS P T H	\$MANTA,	256
STEAM	GGA	1108	F4	RS P T H	\$DYNAM, DYNAMIC ANALYSIS BOILING FLOW	440
STEAM	BCAC	6600	F4	RS P T H	\$ASTEM, THERMODYNAMIC PROPERTIES WATER &	580
STEAM	EG-D	360B	F4	RS P X T H	\$ASTEM, THERMODYNAMIC PROPERTIES WATER &	580
STEAM AND WATER PROPERTIES	BG&E	360C	F4	RS T H	\$STEAM-67, 1967 ASME	487

STEAM

SUPERTO

STEAM GENERATOR SODIUM-WATER REACTION	CEND	7600	F4	RS	P	G	\$CEBUG,	548
STEAM TABLES 14.5-14.500PSIA 32-472DEGF	BAPL	6600	F4	RS		H	\$WATER,	R267
STEAM TABLES 14.5-2538 PSIA	BAPL	6600	F4	RS	P	H	\$M0899,HOH,	R294
STEAM TURBINE CYCLE ANALYSIS	ORNL	360B	F4	RS	P	T	\$SORCENT, NUCLEAR	703
STEAM-WATER MIX	KAPL	6600	F4	RS	P	H	\$SRAPP, HIGH-VELOCITY FLOW STUDY	R382
STEAM-67, 1967 ASME STEAM AND WATER PROPERTIES	BG&E	360C	F4	RS		T	\$H	487
STEEP4, THERMONUCLEAR REACTION RATES	LASL	7600	F4	RS	P	T	\$X	749
STEFEG, ANALYSIS OF PWR & BWR GASEOUS RELEASE	ORNL	360	F4	RS	P	C	\$G	583
STEM, MATRIX GENERATION FOR A SYSTEM OF BEAMS	KAPL	6600	F4	RS	P		\$I	R337
STFODE,COLODE, COLLOCATION SOLN OF STIFF ODE'S	ANL	360	F	RSBP		T	\$P	652
STFODE,COLODE, COLLOCATION SOLN OF STIFF ODE'S	SLA	6600	F	RS	P	T	\$P	652
STIFF ODE'S ANL	360	F	RSBP		T	P	\$STFODE,COLODE, COLLOCATION SOLN OF	652
STIFF ODE'S SLA	6600	F	RS	P	T	P	\$STFODE,COLODE, COLLOCATION SOLN OF	652
STINT3, SINGLE-CHANNEL SPACE-TIME SYNTHESIS	KAPL	6600	F4	RS	P		\$F	R389
STOCHASTIC MODEL OF NEUTRON SLOWING-DOWN	NPGS	360	F4	RS	P	X	\$T E \$M0D5,	491
STORAGE ALLOC	ORNL	360	BAL+F	RS	P	C	\$P \$GETCOR,FRECOR, FORTRAN DYNAMIC	644
STORAGE, SEARCH & RETRIEVAL	SLA	1108	F+BAL	RSBP		T	\$M \$SPIRAL, FULL-TEXT	R607
STRAIN & PELLET CRACKING	BAPL	6600	F4	RS	P		\$I \$STRIPE, FUEL ROD CLAD	R570
STRAIN-GAGE DATA	ORNL	360	F+BAL	RS	P	T	\$I \$LINDA, EVALUATION OF	657
STRAP, STATIC & DYNAMIC STRUCTURAL ANALYSIS	EG&G	360	F4	RSBP		CT	\$I	539
STRESS & DEFORMATION	AN-T	360B	F4	RSBP		CT	\$I \$CYGR03, OXIDE FUEL ROD	R449
STRESS & DEFORMATION	BAPL	6600	F4	RS	P	T	\$I \$CYGR03, OXIDE FUEL ROD	R449
STRESS & FLEXIBILITY CALC	ORNL	360	F+BAL	RS	P		\$I \$ELBOW-ORNL, PIPE	650
STRESS ANALYSIS	KAPL	6600	F4	RS	P		\$I \$TUBE, U-TUBE HEAT EXCHANGER	R378
STRESS ANALYSIS	GGA	1108	F4	RS	P	T	\$I \$SAFE-2D, PLANE & AXISYMMETRIC	379
STRESS ANALYSIS AXISYM LOAD	BAPL	6600	F4	RS	P	T	\$I \$SEALSHL2, SHELL	R282
STRESS ANALYSIS AXISYM LOAD	SR	360	F4	RS	P	T	\$I \$SEALSHL2, SHELL	R282
STRESS ANALYSIS AXISYM LOAD	WTSC	7600	F4	RS	P	T	\$I \$SEALSHL2, SHELL	R282
STRESS ANALYSIS CYL FUEL ELEMENT	BAPL	6600	F4	RS		T	\$I \$CYGR02,	R266
STRESS ANALYSIS MULTIANCHOR PIPE SYSTEM	AI	360	F4	RS	P	C	\$I \$PSA2,	542
STRESS ANALYSIS SHELLS OF REVOLUTION	KAPL	6600C	F4	RS	P	T	\$I \$SOR3,	R 80
STRESS ANALYSIS THIN SHELLS	GGA	1108	F4	RS	P		\$I \$SAFE-SHELL,	253
STRESS ANALYSIS, 2-D BODIES	BNL	6600	F4	RS	P	T	\$I \$SAFE-PLANE, PLANE	252
STRESS ANALYSIS, 2-D BODIES	GGA	1108	F4	RS	P		\$I \$SAFE-PLANE, PLANE	252
STRESS AND FATIGUE	KAPL	6600	F4	RS			\$I \$SORSD, PRESSUHE VESSEL	R391
STRESS FOR INTEGRAL ATTACHMENTS TO PIPE	ORNL	360	F4	RS	P		\$I \$SLUGS,	648
STRESS OF PIPING SYSTEM	BAPL	6600	F4	RS	P	T	\$I \$M0457,PIPE, ELASTIC	R329
STRESS STUDY	GGA	1108	F4	RS	P	T	\$I \$SAFE-3D, 3-D COMPOSITE STRUCTURE	332
STRESS STUDY	ORNL	360	F+BAL	RS	P	T	\$I \$SAFE-3D, 3-D COMPOSITE STRUCTURE	332
STRESS STUDY	BAPL	6600	F+COM	RS	P	T	\$I \$GAPL3, INELASTIC LARGE DEFLECTION	R397
STRIPE, FUEL ROD CLAD STRAIN & PELLET CRACKING	BAPL	6600	F4	RS	P		\$I	R570
STRUCTURAL ANALYSIS	ORNL	360	F4	RS	P	CT	\$I \$PLACRE, FEM INELASTIC	R740
STRUCTURAL ANALYSIS	GGA	1108	F5	RS	P	T	\$I \$SHELL5, THIN SHELL 3-D	452
STRUCTURAL ANALYSIS	EG&G	360	F4	RSBP		CT	\$I \$STRAP, STATIC & DYNAMIC	539
STRUCTURAL ANALYSIS	ORNL	360	F+BAL	RS	P	XCT	\$I \$SCREEP-PLAST2, 2D INELASTIC	R810
STRUCTURAL ANALYSIS	ORNL	360B	F+BAL	RS	P	XCT	\$I \$SCREEP-PLAST, 2-D INELASTIC	R707
STRUCTURAL ANALYSIS BOWED REACTOR CORES	ANL	360B	F4	RS	P		\$I \$NUBOW,	643
STRUCTURAL ANALYSIS OF LINEAR SYSTEMS	ANL	370D	F4	RS	P	CT	\$I \$SAP4,	641
STRUCTURAL DYNAMICS	BAPL	6600	F4	RS	P		\$I \$M0266, LINEAR ELASTIC	R383
STRUCTURE STRESS STUDY	GGA	1108	F4	RS	P	T	\$I \$SAFE-3D, 3-D COMPOSITE	332
STRUCTURE STRESS STUDY	ORNL	360	F+BAL	RS	P	T	\$I \$SAFE-3D, 3-D COMPOSITE	332
STRUCTURED FORTRAN	SLAC	360	F4	RSBP		XCT	\$P \$SMORTRAN2, MACRO-BASED	678
STRUCTURES	BAPL	6600	F4	RS	P		\$L \$LBL47, DRAFTING TOOL TO PLOT PLANE	R373
STRUCTURES	KAPL	6600	F4	RS	P	X	\$I \$FINEL, FINITE-ELEMENT STUDY 2,3-D	R404
STRUCTURES	BAPL	6600	F4	RS	P		\$I \$FUGIT, DYNAMIC RESPONSE OF ELASTIC	R537
SUBPROGRAMS AND MODULES	ANL	360	F+BAL	RSBP		CT	\$M \$ARC-SYSTEM, SYSTEM	522
SUBROUTINE LIB.	NED	635	F+GMP	RS			\$I \$GENED ENVIRONMENTAL ROUTINES,	515
SUBROUTINE LIB.	BAPL	6600A	F+ASC	RS		T	\$P \$BETTIS ENVIRONMENTAL ROUTINES,	478
SUBROUTINE LIBRARY CAT.	A-E	ANL	360B	F+P+A	RS		\$T P \$AMDLIBAE, ARGONNE	562
SUBROUTINE LIBRARY CAT.	F	ANL	360B	F+BAL	RS		\$T P \$AMDLIBF, ARGONNE	563
SUBROUTINE LIBRARY CAT.	G-Z	ANL	360B	F+P+A	RS		\$T P \$AMDLIBGZ, ARGONNE	564
SUBROUTINE LIBRARY ROUTINES	LASL	6600C	F+COM	RS		T	\$P \$SLASLIB, LOS ALAMOS	633
SUBROUTINE PACKAGE	ACRC	370	F4	RS	P	CT	\$N \$SPRPLOT, LINE PRINTER PLOT	773
SUBROUTINES	SLA	6600C	F+COM	RS	P	XCT	\$P \$SMATHLIB, SANDIA MATHEMATICAL	654
SUBROUTINES	AI	360	F+BAL	RS		T	\$P \$FIGS, IBM360&2250 FORTRAN GRAPHICS	484
SUBROUTINES	SLA	6600	F4	RS	P	T	\$P \$BESSEL FUNCTIONS, AIRY & LOG GAMMA	656
SUBSONIC MHD DIFFUSER PERFORMANCE	ANL	370	F4	RS	P		\$H \$DIFFUSER, 2D	737
SULCAL, MODEL OF SULFUR CHEMISTRY IN A PLUME	ORNL	360	F4	RS	P		\$R	788
SULFUR CHEMISTRY IN A PLUME	ORNL	360	F4	RS	P		\$R \$SULCAL, MODEL OF	788
SUM OF EXPONENTIALS	ANL	370	F4	RS	P		\$P \$FRANTIC, LEAST SQUARES FIT	324
SUMOR, S-WAVE NEUTRON X-SECTION CALCULATION	BAPL	6600	F4	RS	P	T	\$A	R399
SUPERTO, ENDF/B FINE-GP CONSTANTS GENERATION	ORNL	360	F4	RS	P	T	\$B	431

SUPPORT

THERMAL

SUPPORT, SOLUTION OF BOUNDARY-VALUE PROBLEMS	ANL	370B	F4	RS	P	T	P	\$	731	
SUPPORT, SOLUTION OF BOUNDARY-VALUE PROBLEMS	SLA	6600	F4	RS	P	T	P	\$	731	
SURFACE CODE	ANL	370	F+BAL	RS	P	T	G	\$PROSA1, PROBABLISTIC RESPONSE	R778	
SURFACES	ANL	370	F4	RS	P	H	\$SLGTR, SLAG TRANSPORT MODELS FOR DUCT		783	
SURVEY STUDY	BW	6600	F+COM	RS	P	X	T	D	\$FARED, 1-D FAST REACTOR DESIGN &	427
SWELLING & GAS RELEASE SIMULATION	BAPL	6600	F4	RS	P	I	\$BUBL1, FUEL		R468	
SWELLING TEMPERATURE STUDY	BAPL	6600	F4	RS	P	T	H	\$FIGRO, LWBR FUEL	R272	
SYN, 2D SYNTHESIS MULTIGP DIFF & 1GP DEPLETION	NED	635	F+GMP	RS	P	T	D	\$	495	
SYNTHESIS	KAPL	6600	F4	RS	P	F	\$STINT3, SINGLE-CHANNEL SPACE-TIME		R389	
SYNTHESIS CALC	NED	635	F4	RS	PL	T	C	\$BISYN, 2-D MULTI-GP DIFFUSION	287	
SYNTHESIS CALC	NED	1108	F4	RS	P	T	C	\$BISYN, 2-D MULTI-GP DIFFUSION	287	
SYNTHESIS DIFFUSION	ANL	370B	F+BAL	RS	P	XCT	C	\$SYN3D, SINGLE-CHANNEL FLUX	713	
SYNTHESIS DIFFUSION	ANL	7600	F+COM	RS	P	XCT	C	\$SYN3D, SINGLE-CHANNEL FLUX	713	
SYNTHESIS MULTIGP DIFF & 1GP DEPLETION	NED	635	F+GMP	RS	P	T	D	\$SYN, 2D	495	
SYN3D, SINGLE-CHANNEL FLUX SYNTHESIS DIFFUSION	ANL	370B	F+BAL	RS	P	XCT	C	\$	713	
SYN3D, SINGLE-CHANNEL FLUX SYNTHESIS DIFFUSION	ANL	7600	F+COM	RS	P	XCT	C	\$	713	
SYST WITH BANDED JACOBIAN	LLL	360	F4	RS	P	X	T	P	\$EPISODEB, SOLVE ODE	705
TABLE, FOR NON-BIAS ORDERING	MLMO	360	F+COB	RSBP	XC	M	\$RANDOM SAMPLING		679	
TABLES A1	360	F+BAL	RS	P	CT	A	\$U3R, UNRESOL RESONANCE XSEC PROBABILITY		553	
TABLES FOR PWR OPN	OPPD	6400	F4	S	P	H	\$PWR-PPM, BORATION-DILUTION		552	
TABLES 14.5-14.500PSIA 32-472DEGF	BAPL	6600	F4	RS		H	\$WATER, STEAM		R267	
TABLES 14.5-2538 PSIA	BAPL	6600	F4	RS	P	H	\$M0899, HOH, STEAM		R294	
TACAS1, ANALYSIS OF RESONANCE MEASUREMENTS	GGA	1108	F4	RS	P	T	A	\$	410	
TAC2D, STEADY-STATE AND TRANSIENT TEMP CALC	GGA	1108	F5	RS	P	T	H	\$	408	
TAC3D, TRANSIENT 3-D HEAT TRANSFER PROGRAM	GGA	1108	F5	RS	P	T	H	\$	414	
TAPE PROCESSING AND EDITING	ORNL	360B	F4	RS	PL	CT	M	\$EDITOR, ENDF/B	502	
TAPE PROCESSING AND EDITING	ORNL	6600	F4	RS	PL	T	M	\$EDITOR, ENDF/B	502	
TASK, 1-D MULTIGROUP REACTOR KINETICS PROGRAM	ORNL	360	F4	RS	P	XCT	E	\$	558	
TCB01, CREEP-BUCKLING OF TUBES UNDER PRESSURE	BAPL	6600	F4	RS	P	I	\$		R604	
TDIST2, COMMUNITY ENERGY CONSUMPTION ANALYSIS	MIT	370	F4	RS	P	T	T	\$	799	
TDOWN, SPATIAL & COMPOSITION-DEPENDENT X-SECS	FBRD	635	F+GMP	RS	P	XCT	B	\$	505	
TEES	ORNL	360B	F4	RS	P	CT	I	\$CORTES, THERMAL & MECHANICAL ANALYSIS OF	759	
TEMC07, TEMPERATURE COEFFICIENT CALCULATION	GGA	1108	F4	RS	P	T	C	\$	320	
TEMP CALC	GGA	1108	F5	RS	P	T	H	\$TAC2D, STEADY-STATE AND TRANSIENT	408	
TEMP FEEDBACK	GGA	1108	F4	RS	P	T	F	\$GAKIT, 1-D MULTIGP KINETICS WITH	370	
TEMPERATURE & DEFORMATION	BAPL	6600	F4	RS	P	T	I	\$PELEN, FUEL PELLET	R598	
TEMPERATURE ANALYSIS	FBRD	7600	F4	RS	P	T	H	\$PACT2, COOLANT & CLADDING	S796	
TEMPERATURE COEFFICIENT CALCULATION	GGA	1108	F4	RS	P	T	C	\$TEMC07,	320	
TEMPERATURE DIST	ORNL	360	F+BAL	RS	PLXCT	H	\$TRUMP, TRANSIENT & S-STATE		771	
TEMPERATURE DIST STUDY	AFB	360	F4	RS	P	E	\$BLAST, REACTOR KINETICS		363	
TEMPERATURE DIST.	ORNL	360	F4	RS	P	T	H	\$SORRIBLE, ROD BUNDLE FLOW &	629	
TEMPERATURE DISTRIBUTION PROGRAM	CHI	1108A	F4	RS	P	T	H	\$LION4, 3-D	R299	
TEMPERATURE DISTRIBUTION PROGRAM	FW	360	F4	RS	P	CT	H	\$LION4, 3-D	R299	
TEMPERATURE DISTRIBUTION PROGRAM	FW	1108B	F4	RS	P	T	H	\$LION4, 3-D	R299	
TEMPERATURE DISTRIBUTION PROGRAM	KAPL	6600B	F+ASC	RS	P	T	H	\$LION4, 3-D	R299	
TEMPERATURE FEEDBACK	BAPL	6600	F4	RS	P	F	\$NOWIG, 1-D 2-GP KINETICS		R371	
TEMPERATURE LMFBR FUEL PIN	ANL	360	F4	RS	P	H	\$MARGE/SLUMP, MAXIMUM		677	
TEMPERATURE PREDICTION	MIT	370	F4	RS	P	T	H	\$ENERGY, LMFBR COOLANT	696	
TEMPERATURE STUDY	BAPL	6600	F4	RS	P	T	H	\$FIGRO, LWBR FUEL SWELLING	R272	
TEMPEST2, THERMAL NEUTRON SPECTRUM X-SECTIONS	BHSC	360	F4	RS	PL	T	B	\$	50	
TEST FOR OUTLIERS	UCND	360	F4	RS	P	P	\$PCTEST, PRINCIPAL COMPONENT		769	
TGAN, NUCLEAR CRITICALITY SAFETY	DP	360	F4	RS	P	T	C	\$KEFF, MGBS,	617	
THEORY	GGA	1108	F4	RS	P	XCT	C	\$GAPER1D, 1-D TRANSPORT PERTURBATION	606	
THEORY	NED	635	F4	RS	P	T	C	\$DOT2DB, 2-D MULTIGROUP DIFFUSION & SN	459	
THEORY OF LATTICE DYNAMICS	ANL	360	F4	RS	P	T	Q	\$GROUP2, GROUP	620	
THEORY OF LATTICE DYNAMICS	LASL	6600	F4	RS	P	T	Q	\$GROUP2, GROUP	620	
THEORY XSEC CALC	KAPL	6600	F4	RS	P	A	\$MULTI, MULTI-LEVEL RESONANCE		R535	
THERMAL & MECHANICAL ANALYSIS OF TEES	ORNL	360B	F4	RS	P	CT	I	\$CORTES,	759	
THERMAL ANALYSIS	BCL	6400	F4	RS	P	T	G	\$NURLOC-1.0, LOSS-OF-COOLANT	328	
THERMAL DISCHARGE STUDY	HEDL	1108	F5	RS	P	T	R	\$TOPLYR2, POWER PLANT	599	
THERMAL LIBRARIES FROM ENDF/B DATA	WAPD	7600	F4	RS	P	T	B	\$ETOT2,	509	
THERMAL LIBRARY FORM	WAPD	7600	F4	RS	P	T	B	\$ETOT3, ENDF/B V3 DATA TO	628	
THERMAL NEUTRON SPECTRUM X-SECTIONS	BHSC	360	F4	RS	PL	T	B	\$TEMPEST2,	50	
THERMAL PERFORMANCE MODEL	HEDL	6600	F	RS	P	T	H	\$SIEEX, LMFBR FUEL PIN	673	
THERMAL RESPONSE LOCA	EG&G	360	F4	RSBP	X	T	G	\$THETA1-9, FUEL ROD	512	
THERMAL SCATTERING CRYSTALLINE MATERIALS	LASL	6600	F4	RS	P	T	A	\$TOR,	360	
THERMAL SCATTERING DATA	DP	360B	F4	RS	P	XCT	B	\$FLANGE2(71-1), ENDF/B	368	
THERMAL SCATTERING LAW CALCULATION	GGA	1108	F4	RS	P	A	\$GASKET,		263	
THERMAL SPECTRA	GGA	1108B	F4	RS	PLXCT	B	\$GGC4, MULTI-GP X-SECTIONS FAST		298	
THERMAL SPECTRA	WANL	6600	F4	RS	L	T	B	\$GGC4, MULTI-GP X-SECTIONS FAST	298	
THERMAL SPECTRA & MULTI-GP CONSTANTS	EG&G	360	F4	RS	PL	CT	B	\$INCITE,	565	
THERMAL SPECTRUM X-SECTION CALC	BNW	1108	F5	RS	PLX	T	B	\$BRT1,	184	

THERMAL-HYDRAULIC

TRANSIENT

THERMAL-HYDRAULIC ANALYSIS	ANL	360B	F4	RSBP	CT	H	\$COBRA3M, FUEL PIN	659	
THERMAL-HYDRAULIC ANALYSIS	NED	635	F4	RS	P	T	H \$MANTA, STEADY-STATE	256	
THERMAL-HYDRAULIC ANALYSIS	WARD	6600	F4	RS	P	T	H \$MANTA, STEADY-STATE	256	
THERMAL-HYDRAULIC MULTICHANNEL ANALYSIS	ANL	370	F4	RS	P	CT	H \$THI3D,	706	
THERMAL-HYDRAULIC STUDY	EG&G	360F	F+BAL	RSBPLXCT	G	\$RELAP4/MOD6, TRANSIENT		369	
THERMAL-HYDRAULIC STUDY	EG&G	7600D	F+COM	RS	PLX	T	G \$RELAP4/MOD6, TRANSIENT	369	
THERMAL-HYDRAULIC STUDY	EG&G	7600E	F+COM	RS	PLX	T	G \$RELAP4/MOD6, TRANSIENT	369	
THERMAL-HYDRAULIC WATER REACTOR DESIGN	BNW	1108	F5	RS	P	CT	H \$REPP,	483	
THERMAL-HYDRAULICS	BNW	7600D	F4	RS	P	XCT	H \$COBRA41, ROD BUNDLE & CORE	432	
THERMODYNAMIC PROPERTIES WATER & STEAM	BCAC	6600	F4	RS	P	T	H \$ASTEM,	580	
THERMODYNAMIC PROPERTIES WATER & STEAM	EG-D	360B	F4	RS	P	X	T	H \$ASTEM,	580
THERMODYNAMICS OF PRESSURIZERS	BAPL	6600	F4	RS	P	T	H \$TOPS, TRANSIENT	R348	
THERMONUCLEAR REACTION RATES	LASL	7600	F4	RS	P	T	X \$STEEP4,	749	
THERMOS LIBRARY, 30-GP ENDF/B SCAT KERNELS	DP	360	BCD	R	LX	T	Z \$	543	
THETA1-B, FUEL ROD THERMAL RESPONSE LOCA	EG&G	360	F4	RSBP	X	T	G \$	512	
THIN SHELL 3-D STRUCTURAL ANALYSIS	GGA	1108	F5	RS	P	T	I \$SHELL5,	452	
THIN SHELLS	GGA	1108	F4	RS	P	I	\$SAFE-SHELL, STRESS ANALYSIS	253	
THIN SHELLS	SLA	6600	F4	RS	P	T	I \$SLADE-D, DYNAMIC ANALYSIS OF	581	
THIN SHELLS	MIT	360	F4	RS	P	T	I \$SABOR4, DISCRETE-ELEMENT ANALYSIS	R402	
THI3D, THERMAL-HYDRAULIC MULTICHANNEL ANALYSIS	ANL	370	F4	RS	P	CT	H \$	706	
THREDES LIBRARY UTILITY ROUTINE	AI	360	F4	RSB	L	T	M \$CLIP, FORM OR	271	
THREDES, 1-D FEW-GP DIFFUSION DESIGN SYSTEM	AI	360	F4	RSBP	T	K	\$	273	
THREE FACTOR ANALYSIS OF VARIANCE	BKC	6600	F4	RS	P	P	\$ANOVA,	819	
THRES2, STATISTICAL MODEL REACTION X-SECTION	ENEA	360	F4	RS	P	A	\$	504	
THRES2, STATISTICAL MODEL REACTION X-SECTIONS	BNL	6600B	F4	RS	P	A	\$	504	
TIGIR2, MODULAR DOCUMENT INFORMATION SYSTEM	KAPL	6600B	F+ASC	RSB	X	T	M \$	R403	
TIME SYSTEM UNAVAILABILITY	NRC	370	F4	RS	P	XCT	G \$FRANTIC-NRC,	766	
TIME-DEP FUEL ELEM STUDY	NRC	370	F4	RSBP	CT	G	\$WREM-TOODEE2/MOD3, 2D	712	
TIME-DEP MULTIGP DISCRETE ORDINATES	LASL	360	F4	RS	P	T	F \$TIMEX, 1-D	756	
TIME-DEP MULTIGP DISCRETE ORDINATES	LASL	7600	F4	RS	P	T	F \$TIMEX, 1-D	756	
TIME-DEP 2-D MULTI-GP DIFFUSION	UMCC	360	F4	RS	P	T	C \$VARI-QUIR,	212	
TIME-DEP 2-D MULTI-GP DIFFUSION	WANL	6600	F4	RS	P	T	C \$VARI-QUIR,	212	
TIME-DEPENDENT DIFFUSION UFCC	370B	F4	RS	P	T	F	\$GAKIN2, 10 MULTIGROUP	310	
TIME-DEPENDENT DIFFUSION CALC	KAPL	6600	F4	RS	P	F	\$RAUMZEIT, 1-D	R352	
TIME-OF-FLIGHT DATA ANALYSIS	GGA	1108	F5	RS	P	T	O \$CAGE,BIRD,SPEC,	476	
TIME-SHARING PROGRAMMING LANGUAGE	KAPL	6600	F+ASC	RS	P	\$SIMPLE1,		R442	
TIMEX, 1-D TIME-DEP MULTIGP DISCRETE ORDINATES	LASL	360	F4	RS	P	T	F \$	756	
TIMEX, 1-D TIME-DEP MULTIGP DISCRETE ORDINATES	LASL	7600	F4	RS	P	T	F \$	756	
TLD CORRECTION CALC	AI	360	F4	RS	P	Q	\$RESPOND, DISSIMILAR MEDIA	566	
TOAD, PROCESSING OF ANALYZER GAMMA-RAY SPECTRA	GGA	1108	F+BAL	RS	P	T	O \$	333	
TOKAMAK FUSION REACTOR STUDY	ANL	360	F4	RS	P	X	\$TOKMINA/TOKMINA2,	561	
TOKMINA/TOKMINA2, TOKAMAK FUSION REACTOR STUDY	ANL	360	F4	RS	P	X	\$	561	
TOODY2, 2-D LAGRANGIAN EQNS OF MOTION SOLUTION	SLA	3600	F36	RS	P	T	I \$	627	
TOOL TO PLOT PLANE STRUCTURES	BAPL	6600	F4	RS	P	L	\$BL47, DRAFTING	R373	
TOPLYR2, POWER PLANT THERMAL DISCHARGE STUDY	HEDL	1108	F5	RS	P	T	R \$	599	
TOPS, TRANSIENT THERMODYNAMICS OF PRESSURIZERS	BAPL	6600	F4	RS	P	T	H \$	R348	
TOR OUTPUT DATA	LASL	6600	F4	RS	P	T	B \$GLEN, GROUP CONSTANT CALC FROM	361	
TOR, THERMAL SCATTERING CRYSTALLINE MATERIALS	LASL	6600	F4	RS	P	T	A \$	360	
TPT01, 2-D FEW-GROUP TRANSPORT WITH DEPLETION	BAPL	7600	F+COM	RS	P	T	D \$	R669	
TRACE-CONTAINMENT TRANSPORT	ORNL	360	F+BAL	RS	P	CT	R \$ODMOD, SOIL-WATER	789	
TRANSFER	GGA	1108	F+BAL	RS	P	T	E \$BLOOST6, COMBINED KINETICS 2-D HEAT	303	
TRANSFER SSDC	370	F4	RS	P	H	\$HEATING2, TRANSIENT STEADY-STATE HEAT		198	
TRANSFER CODE	EG&G	360B	F4	RSBP	XCT	H	\$MOXY/MOD032, BWR CORE HEAT	551	
TRANSFER IN POROUS MEDIA	BKY	7600	F4	RS	P	T	H \$SCHAF, HEAT & WATER	802	
TRANSFER PREDICTION	MIT	360	F4	RS	P	T	H \$REFLUX, LWR REFLOOD HEAT	763	
TRANSFER PROGRAM	GGA	1108	F5	RS	P	T	H \$TAC3D, TRANSIENT 3-D HEAT	414	
TRANSFER STUDY	SLL	6600	F4	RS	P	N	\$HEATMESH, GEOMETRICAL DATA HEAT	434	
TRANSFORMATION SYSTEM	SLA	6600B	FTN	RS	P	T	P \$SETS, SET EQUATION	623	
TRANSIENT & DEPLETION	KAPL	6600	F4	RS	P	T	D \$3DXT,DEP3, 3-D XENON	R477	
TRANSIENT & S-STATE TEMPERATURE DIST	ORNL	360	F+BAL	RS	PLXCT	H	\$TRUMP,	771	
TRANSIENT ANALYSIS	BAPL	6600	F4	RS	P	T	H \$FLOT1,M0219, PWR FLOW	R331	
TRANSIENT ANALYSIS	EG&G	360	F+BAL	RSBPL	CT	G	\$PARET, WATER-COOLED CORE	555	
TRANSIENT ANALYSIS	LASL	7600	F4	RS	P	T	H \$TVENT, VENTILATION SYSTEM	809	
TRANSIENT ANALYSIS	WARD	7600	F4	RS	P	T	K \$DEMO4, CRBR REACTOR & PLANT	R676	
TRANSIENT ANALYSIS OF OXIDE FUEL RODS	EG&G	360	F+BAL	RSBP	XCT	G	\$FRAP-T,	658	
TRANSIENT ANALYSIS OF OXIDE FUEL RODS	EG&G	7600	F4	RSBP	XCT	G	\$FRAP-T3,	658	
TRANSIENT BEHAVIOR	BNW	6600	F4	RS	P	X	T	I \$GAPCON-THERMAL3, FUEL SS &	770
TRANSIENT CODE	BNL	7600	F4	RS	P	T	G \$RELAP3B/MOD110, REACTOR SYSTEM	733	
TRANSIENT COMPRESSIBLE FLUID FLOW	LASL	7600	F4	RS	P	H	\$SOLA-ICE,	723	
TRANSIENT FLOW IN VENTED FLUID SYSTEM	LASL	7600	F4	RS	P	T	H \$COMPARE,	702	
TRANSIENT FLOW IN VENTED FLUID SYSTEM	NRC	370	F4	RS	P	T	H \$COMPARE,	702	
TRANSIENT FLOW W/SINKS & DOORS	LASL	7600	F4	RS	P	T	H \$COMPARE-MOD1,	776	

TRANSIENT

TSO

TRANSIENT FLUID FLOW ALGORITHM	LASL	7600B	F	RS P	H	\$SOLA, SOLA-SURF.	651
TRANSIENT FLUID FLOW ANALYSIS	WARD	7600	F+COM	RS P	XCT	H \$VARR2, CRBRP 2-D	755
TRANSIENT FUEL MECHANICS	FBRD	7600	F4	RS P	T	H \$SBEHAVE-SST, OVERPOWER	768
TRANSIENT HEAT CONDUCTION PROGRAM	BAPL	6600	F4	RS P	T	H \$SHOT2, 2-D	R286
TRANSIENT OVERPOWER STUDY	HEDL	6600	F4	RS P	CT	F \$SMELT3, FAST REACTOR	700
TRANSIENT RESPONSE TO ACCIDENT	BNL	7600	F+COM	RS P	T	G \$NALAP, LMFBR	780
TRANSIENT SIMULATION	BAPL	7600	F4	RS P	T	G \$FLASH6, FULLY-IMPLICIT	R448
TRANSIENT SIMULATION	MA-G	360	F4	RSBP	CT	G \$FLASH4, FULLY-IMPLICIT	R448
TRANSIENT STEADY-STATE HEAT TRANSFER	SSDC	370	F4	RS P	H	\$SHEATING2,	198
TRANSIENT TEMP CALC	GGA	1108	F5	RS P	T	H \$TAC2D, STEADY-STATE AND	408
TRANSIENT THERMAL-HYDRAULIC STUDY	EG&G	360F	F+BAL	RSBP	LXCT	G \$SRELAP4/MOD6,	369
TRANSIENT THERMAL-HYDRAULIC STUDY	EG&G	7600D	F+COM	RS	PLX	T G \$SRELAP4/MOD6,	369
TRANSIENT THERMAL-HYDRAULIC STUDY	EG&G	7600E	F+COM	RS	PLX	T G \$SRELAP4/MOD6,	363
TRANSIENT THERMODYNAMICS OF PRESSURIZERS	BAPL	6600	F4	RS P	T	H \$STOPS,	R348
TRANSIENT 2-DIMENSIONAL 2-FLUID FLOW	LASL	7600	F4	RS P	X	T H \$SK-FIX,	727
TRANSIENT 3-D HEAT TRANSFER PROGRAM	GGA	1108	F5	RS P	T	H \$TAC3D,	414
TRANSIENTS	ANL	360	F4	RS P	T	F \$SAS1A, FAST REACTOR POWER AND FLOW	400
TRANSIENTS	ANL	6600	F4	RS P	T	F \$SAS1A, FAST REACTOR POWER AND FLOW	400
TRANSIENTS	BAPL	6600	F4	RS P	T	H \$SCHIC-KIN, FAST + INTERMEDIATE POWER	R473
TRANSFORMATION ANALYSIS	BNW	1108	F5	RS P	T	D \$DBUFIT1, LEAST SQUARES	456
TRANSPORT	BAPL	6600	F4	RS P	T	J \$M0756, LETO, 1-D SLAB GAMMA-RAY	R343
TRANSPORT	EG&G	360	F+BAL	RSBP	CT	B \$SRAFFLE2/MOD2, MONTE CARLO NEUTRON	631
TRANSPORT	FNAL	370	F+BAL	RS P	T	W \$SCASIM, SIMULATES HADRONIC CASCADE	742
TRANSPORT	ORNL	360	F+BAL	RS P	CT	R \$SODMOD, SOIL-WATER TRACE-CONTAINMENT	789
TRANSPORT & DIFFUSION MODEL	ORNL	360	F+BAL	RS P	T	R \$SATM, ATMOSPHERIC	787
TRANSPORT CODES	WANL	6600	F4	RS	L	T B \$SGAMB1T, X-SEC GENERATION FOR	547
TRANSPORT MODEL	ORNL	360	F+BAL	RS P	CT	R \$SWHTM, WISCONSIN HYDROLOGIC	808
TRANSPORT MODEL	ORNL	360	F+BAL	RS P	CT	R \$SCHNSD, SEDIMENT & CONTAINMENT	793
TRANSPORT MODELS FOR DUCT SURFACES	ANL	370	F4	RS P	H	\$SLGTR, SLAG	783
TRANSPORT PERTURBATION THEORY	GGA	1108	F4	RS P	XCT	C \$SGAPERID, 1-D	606
TRANSPORT PROGRAM	LASL	360	F4	RSBP	CT	C \$STRIPLET, 2-D TRIANGULAR MESH	608
TRANSPORT PROGRAM	LASL	6600	F4	RS P	T	C \$STRIPLET, 2-D TRIANGULAR MESH	608
TRANSPORT PROGRAM	LASL	7600	F4	RS P	T	C \$STRIPLET, 2-D TRIANGULAR MESH	608
TRANSPORT STUDY	ANL	370	F4	RS P	G	\$DISPER1, AEROSOL PARTICLE	554
TRANSPORT TRIANGULAR MESH	LASL	360	F+BAL	RS P	CT	C \$STRIDENT, 2D MULTIGP	741
TRANSPORT TRIANGULAR MESH	LASL	7600	F4	RS P	T	C \$STRIDENT, 2D MULTIGP	741
TRANSPORT WITH DEPLETION	BAPL	7600	F+COM	RS P	T	D \$STPT01, 2-D FEW-GROUP	R669
TRANSPORT WITH OPTIMIZATION	ORNL	360	F+BAL	RS P	CT	R \$SOPTRM, HYDROLOGIC	794
TRANSPORT WITH SLOWING DOWN	BAPL	6600	F4	RS	C	\$M0648, 1-D SLAB	R342
TRANSPORT XY RZ RTH	LASL	7600	F4	RS P	T	C \$STWOTRAN-PNVW, 2-D PARTICLE	573
TRANSPORT XY RZ RTHETA	LASL	360D	F4	RSBP	CT	C \$STWOTRAN2, 2-D MULTI-GP	358
TRANSPORT XY RZ RTHETA	LASL	6600D	F4	RS P	T	C \$STWOTRAN2, 2-D MULTI-GP	358
TRANSPORT XY RZ RTHETA	LASL	7600D	F4	RS P	T	C \$STWOTRAN2, 2-D MULTI-GP	358
TRANSPORT, DESIGN OF CHARGED PARTICLE BEAMS	SLAC	370	F4	RS P	T	V \$	791
TRAPPING	DP	360	F4	RSBP	Q	\$XDTRAP, HYDROGEN PERMEATION WITH	655
TREE ANALYSIS SYSTEM				ARHC	6600	F+COM RS P CT G \$FTA, FAULT	666
TREE EVALUATION CODES	EG&G	360	F4	RSBP	CT	G \$SPREP, KITT, SYSTEM FAULT	528
TREE EVALUATION CODES	EG&G	1108	F4	RS P	T	G \$SPREP, KITT, SYSTEM FAULT	528
TREE SIMULATION CODE	NEA	360	F4	RS P	G	\$SAFTAC, MONTE CARLO FAULT	674
TREE SIMULATION CODE	UNI	1108	F+SLE	RS P	G	\$SAFTAC, MONTE CARLO FAULT	674
TREES	EG&G	360	F4	RSBP	CT	G \$SMOCUS, MINIMAL SETS FROM FAULT	653
TRI-MESH	GGA	1108	F+BAL	RS P	T	D \$BUGTRI, 2D MULTIGP DIFFUSION & BURNUP	439
TRIAL, 3-D REACTION RATES FROM 2-D FLUX SETS	FBRD	6000	F4	RS P	C	C \$	585
TRIANGULAR MESH	LASL	360	F+BAL	RS P	CT	C \$STRIDENT, 2D MULTIGP TRANSPORT	741
TRIANGULAR MESH	LASL	7600	F4	RS P	T	C \$STRIDENT, 2D MULTIGP TRANSPORT	741
TRIANGULAR MESH	GGA	1108	F+BAL	RS P	T	C \$SGAMTRI, 2-D MULTI-GP DIFFUSION	401
TRIANGULAR MESH TRANSPORT PROGRAM	LASL	360	F4	RSBP	CT	C \$STRIPLET, 2-D	608
TRIANGULAR MESH TRANSPORT PROGRAM	LASL	6600	F4	RS P	T	C \$STRIPLET, 2-D	608
TRIANGULAR MESH TRANSPORT PROGRAM	LASL	7600	F4	RS P	T	C \$STRIPLET, 2-D	608
TRIDENT, 2D MULTIGP TRANSPORT TRIANGULAR MESH	LASL	360	F+BAL	RS P	CT	C \$	741
TRIDENT, 2D MULTIGP TRANSPORT TRIANGULAR MESH	LASL	7600	F4	RS P	T	C \$	741
TRIFIDO, PULSED NEUTRON SOURCE DATA ANALYSIS	CNEA	360	F4	RS P	E	\$	489
TRIPLET, 2-D TRIANGULAR MESH TRANSPORT PROGRAM	LASL	360	F4	RSBP	CT	C \$	608
TRIPLET, 2-D TRIANGULAR MESH TRANSPORT PROGRAM	LASL	6600	F4	RS P	T	C \$	608
TRIPLET, 2-D TRIANGULAR MESH TRANSPORT PROGRAM	LASL	7600	F4	RS P	T	C \$	608
TRITIUM DISPERSION	DP	360	CSMP	S	R	\$STRITMOD, ADVECTION MODEL OF	814
TRITMOD, ADVECTION MODEL OF TRITIUM DISPERSION	DP	360	CSMP	S	R	\$	814
TROUT, MUG MULTIGROUP XSEC LIBRARY MAINTENANCE	NED	635	F4	RS P	T	M \$	493
TROUT, MUG MULTIGROUP XSEC LIBRARY MAINTENANCE	NED	1108	F5	RS P	T	M \$	493
THUMP, TRANSIENT & S-STATE TEMPERATURE DIST	ORNL	360	F+BAL	RS	PLXCT	H \$	771
TSN, SPATIALLY-DEPENDENT REACTOR KINETICS	AI	360	F4	RS P	T	F \$	309
TSO OR BATCH	ANL	360	F+BAL	RSBP	X	T P \$SPEAKEASY MU+, LANGUAGE PROCESSOR	593

TUBE

VENTURE

TUBE	BNW	6600	F4	RS P	T I	SCOVE1, CREEP COLLAPSE FOR OVAL FUEL PIN	817
TUBE	BNW	6600C	F4	RS P	I	SBUCKLE, CREEP BUCKLING OF INITIALLY OVAL	667
TUBE ANALYSIS	SLAC	360	F4	RS P	T V	SSLACKLY, 1D MULTICAVITY KLYSTRON	807
TUBE, U-TUBE HEAT EXCHANGER STRESS ANALYSIS	KAPL	6600	F4	RS P	I	\$	R378
TUBES OR ELBOWS & ATTACHED PIPES	ORNL	360	F+BAL	RS P	XCT I	\$CURT2, CURVED	R750
TUBES UNDER PRESSURE	BAPL	6600	F4	RS P	I	\$TCB01, CREEP-BUCKLING OF	R604
TURBINE CYCLE ANALYSIS	ORNL	360B	F4	RS P	T H	\$ORCENT, NUCLEAR STEAM	703
TURBULENT FLOW IN LMFBF ROD BUNDLE	NED	635	F4	RS P	T H	\$VELVET2,	458
TVA	360	F4	RS PLX T B	\$HRG3, SLOWING-DOWN SPECTRUM, MULTIGP CONSTANTS			467
TVA	360B	F4	RSBPLXCT B	\$LASER, SPECTRUM CALC WITH BURNUP CYL LATTICE			249
TVA	370	F4	RS P CT D	\$SAGE-WASP, OPTIMAL ELECTRIC UTILITY EXPANSION			S744
TVENT, VENTILATION SYSTEM TRANSIENT ANALYSIS	LASL	7600	F4	RS P	T H	\$	809
TWIGGLE, 2-D 2-GP SPACE-TIME DIFFUSION	ANL	360	F4	RS P	T F	\$	R338
TWIGL, 2-D 2-GP SPACE-TIME DIFFUSION FEEDBACK	BAPL	6600	F4	RS P	T F	\$	R338
TWO-DIMENSIONAL FLUID FLOW	ANL	360	F4	RS P	T H	\$EVITS, STEADY STATE	792
TWO-PHASE FLOW	BAPL	7600B	F4	RS P	T H	\$FLOW3, NETWORK ANALYSIS OF 3-D	R664
TWOTRAN-PNVW, 2-D PARTICLE TRANSPORT XY RZ RTH	LASL	7600	F4	RS P	T C	\$	573
TWOTRAN2, 2-D MULTI-GP TRANSPORT XY RZ RTHETA	LASL	360D	F4	RSBP	CT C	\$	358
TWOTRAN2, 2-D MULTI-GP TRANSPORT XY RZ RTHETA	LASL	6600D	F4	RS P	T C	\$	358
TWOTRAN2, 2-D MULTI-GP TRANSPORT XY RZ RTHETA	LASL	7600D	F4	RS P	T C	\$	358
U-TUBE HEAT EXCHANGER STRESS ANALYSIS	KAPL	6600	F4	RS P	I	\$TUBE,	R378
UCND	360	F4	RS P	P	\$PCTEST, PRINCIPAL COMPONENT TEST FOR OUTLIERS		769
UCND	360B	F+BAL	RS P	O	\$PMS1, FAST NEUTRON POLARIZATION EXPERIMENT		469
UCND	370	COBOL	RS	CT M	\$NMMSS, NUCLEAR MATERIALS MANAGEMENT SYSTEM		695
UEC	6600	F4	RS P	D	\$NPRFCCP, FUEL CYCLE COSTS PERFORMANCE DATA		146
UEC	6600	F4	RS P	D	\$POWERCO, NUCLEAR STATION ELECTRICITY COSTS		340
UEC	6600	F4	RS P	D	\$WAMPUM, FUEL CYCLE COSTS PERFORMANCE STUDY		224
UFCC	370	F4	RS P	T F	\$WIGL2, 1-D 2-GP SPACE-TIME DIFFUSION 3-GEOM		R274
UFCC	370B	F4	RS P	T F	\$GAKIN2, 10 MULTIGROUP TIME-DEPENDENT DIFFUSION		310
UICS	360	F4	RS P	A	\$CODILLI, LEAST SQUARES ANALYSIS RESONANCE DATA		347
UICS	360	F4	RS P CT D	\$GEM, ANALYSIS OF NUCLEAR FUEL CYCLE ECONOMICS			576
UMCC	360	F4	RS P	T C	\$VARI-QUIR, TIME-DEP 2-D MULTI-GP DIFFUSION		212
UNAVAILABILITY	NRC	370	F4	RS P	XCT G	\$FRANTIC-NRC, TIME SYSTEM	766
UNBIASED MONTECARLO SLAB SHIELD CODE	LSU	360	F4	RS P	J	\$DEMONR,	754
UNCONSTRAINED OPTIMIZATION	ANL	360	F4	RS P	T P	\$OCOPTR, DR'JOCR,	753
UNDER PRESSURE	BAPL	6600	F4	RS P	I	\$TCB01, CREEP-BUCKLING OF TUBES	R604
UNFOLDING OF COMPLEX GAMMA-RAY SPECTRA	KSUN	360	F4	RS P	O	\$SCORGAM,	390
UNI	1108	F+SLE	RS P	G	\$SAFTAC, MONTE CARLO FAULT TREE SIMULATION CODE		674
UNITS	MLMO	360	F4	RS P	XC P	\$MTRC0001, SI METRIC TO U.S. CUSTOMARY	812
UNITS	RDYN	370B	F4	RS P	T P	\$METRICATION, CONVERSION TO OR FROM SI	G668
UNITS	DUCC	635	F4	RS	G	\$ANVENT, LOCA ANALYSIS DUKE POWER MCGUIRE	529
UNRESOL RESONANCE XSEC PROBABILITY TABLES	AI	360	F+BAL	RS P	CT A	\$U3R,	553
UNRESOLVED REGION AVERAGE X-SEC CALC	BNL	6600	F4	RS P	A	\$AVERAGE,	376
UNRESOLVED RESONANCE INTEGRALS X-SECS	BAPL	6600	F4	RS P	T A	\$PUN1,	R359
UNRESOLVED RESONANCE X-SECTION CALC	GGA	1108B	F4	RS P	A	\$GANDY3,	341
UNRESOLVED RESONANCES	BAPL	6600	F4	RS P	A	\$GRAMP, R-M PARAMETERS OF	R470
UPTAKE MODEL	DP	360	CSMP	RS	R	\$POLUTE, FOREST AIR POLLUTANT	774
USE	ORNL	360	F4	RS P	X R	\$MOBY, MOBILE HOME HEATING & COOLING ENERGY	724
USER PROGRAM PERFORMANCE MONITOR	SLAC	360B	F+BAL	RSB	CT P	\$PROGLOOK,	642
USER-ORIENTED MEMORY DUMP UTILITY	BKY	7600	F+COM	RS P	T P	\$DUMP,	698
USING DTF4 FLUXES	LASL	6600	F4	RS P	N	\$DAC1, SN PERTURBATION CODE	455
UTILITIES EG&G	360B	F+BAL	RSB	T P	\$NRTS ENVIRONMENTAL ROUTINES, FORTRAN		613
UTILITY	BKY	7600	F+COM	RS P	T P	\$DUMP, USER-ORIENTED MEMORY DUMP	698
UTILITY EXPANSION	TVA	370	F4	RS P	CT D	\$SAGE-WASP, OPTIMAL ELECTRIC	S744
UTILITY GENERATION PLANNING	ORNL	360	F+BAL	RS P	X T D	\$ORSIM, OPTIMIZING	699
UTILITY PLOT MODULES F(X) & F(X,Y)	KAPL	6600B	F+COM	RS P	T P	\$DATATRAN2,	407
UTILITY ROUTINE	AI	360	F4	RSB	L T M	\$CLIP, FORM OR THREDES LIBRARY	271
UTILITY ROUTINE	ANL	360D	BAL	RS	X T P	\$COPYCAT, IBM OS SYSTEM CATALOG	646
UVAC	6400	F4	RS PLX T B	\$GAMTEC2, MULTI-GP CONSTANT CALC 0 TO 10 MEV			185
U3R, UNRESOL RESONANCE XSEC PROBABILITY TABLES	AI	360	F+BAL	RS P	CT A	\$	553
VALUE DISTRIBUTION DATA ANALYSIS	BAPL	6600	F4	RS P	P	\$BH99, EXTREME	R621
VARI-QUIR, TIME-DEP 2-D MULTI-GP DIFFUSION	UMCC	360	F4	RS P	T C	\$	212
VARI-QUIR, TIME-DEP 2-D MULTI-GP DIFFUSION	WANL	6600	F4	RS P	T C	\$	212
VARI-1D, 1-D VARIATIONAL SENSITIVITY	ANL	360	F4	RSBP	CT C	\$	625
VARIANCE	BKC	6600	F4	RS P	P	\$ANOVA, THREE FACTOR ANALYSIS OF	819
VARIATIONAL SENSITIVITY	ANL	360	F4	RSBP	CT C	\$VARI-1D, 1-D	625
VARR2, CRBRP 2-D TRANSIENT FLUID FLOW ANALYSIS	WARD	7600	F+COM	RS P	XCT H	\$	755
VELVET2, TURBULENT FLOW IN LMFBF ROD BUNDLE	NED	635	F4	RS P	T H	\$	458
VENTED FLUID SYSTEM	LASL	7600	F4	RS P	T H	\$COMPARE, TRANSIENT FLOW IN	702
VENTED FLUID SYSTEM	NRC	370	F4	RS P	T H	\$COMPARE, TRANSIENT FLOW IN	702
VENTILATION SYSTEM TRANSIENT ANALYSIS	LASL	7600	F4	RS P	T H	\$TVENT,	809
VENTURE, 1, 2, OR 3-D MULTIGROUP DIFFUSION	ORNL	360	F+BAL	RSBP	CT C	\$	686

VENUS

X-SEC

VENUS, 2-D LMFBR POWER EXCURSION DISASSEMBLY	ANL	360	F4	RS P	XCT F S	511
VERSION 4.0 VS SOFTWARE MONITOR	SLAC	370	BAL	RSB	CT P \$SLACMON/370,	635
VERSUS LEASE ANALYSIS	SLA	360	COBOL	RSBP	CT M \$BECOM, AEC DP PURCHASE	R589
VERSUS LEASE ANALYSIS	SLA	1108	COBOL	RS P	M \$BECOM, AEC DP PURCHASE	R589
VESSEL STRESS AND FATIGUE	KAPL	6600	F4	RS	I \$SORSDB, PRESSURE	R391
VIBRATING SYSTEMS	KAPL	6600	F+ASC	RS P	T I \$GEM, EIGENVALUE PROBLEM FOR	R344
VIBRATION NEUTRON SCATTERING CODES	EG&G	360	F4	RS P	CT W \$MACS LATTICE	574
VIEW FACTOR CALC FOR CYLINDRICAL PINS	EG&G	360	F4	RSBP	CT J \$VIEWPIN,	569
VIEW FACTOR SHIELDING CODE CAVITY GEOM	GGA	1108	F4	RS P	T J \$MUSCAT,	259
VIEWPIN, VIEW FACTOR CALC FOR CYLINDRICAL PINS	EG&G	360	F4	RSBP	CT J S	569
VIM1, MONTE CARLO CRITICAL ASSEMBLY ANALYSIS	AI	7600	F4	RS	PLX T C S	510
VIM1X, MONTE CARLO CRITICAL ASSEMBLY ANALYSIS	AI-A	360	F4	RSBP	PLXCT C S	510
VISCOELASTIC ANALYSIS CONCRETE	GGA	1108	F4	RS P	I \$SAFE-CREEP,	300
VISCOELASTIC ANALYSIS OF CONCRETE	GGA	1108	F5	RS P	T I \$SAFE-CRACK,	451
VOID X-SECTION CALCULATION	GEC	625	F4	RS P	B \$AVOID, ANNULAR	276
VS SOFTWARE MONITOR	SLAC	370	BAL	RSB	CT P \$SLACMON/370, VERSION 4.0	635
VTE21, DESALINATION PLANT OPTIMIZATION	ORNL	360	F+BAL	RS P	T D \$SMSF21,	798
V1 PROC BNL 6600B F4	RS	T M	\$CHECKER, CRECT, DAMMET, PLOTFB, ...	ENDF/B		384
V2 PROC BNL 6600B F4	RS	T M	\$SCRECT, CHECKER, RIGEL, PLOTFB, ...	ENDF/B		475
V2 PROCESSING CODES	ANL	360	F4	RS P	T M \$SCRECT, CHECKER, ENDF/B	475
V3 DATA PROCESSING CODE	ANL	360	F4	RS	T M \$RIGEL, ENDF/B	571
V3 DATA TO THERMAL LIBRARY FORM	WAPD	7600	F4	RS P	T B \$SETOT3, ENDF/B	628
V3 PROCESSING CODES	BNL	6600	F4	RS	T M \$CHECK3, RIGEL3, ENDF/B	571
V4 PROCESSING CODES	BNL	6600B	F4	RS	T M \$RIGEL4, CHECK4, ... ENDF/B	638
W/CONFIDENCE LIMITS	BKC	360	F4	RSBP	P \$GRAPH, LINEAR REGRESSION	624
W/SINKS & DOORS	LASL	7600	F4	RS P	T H \$COMPARE-MOD1, TRANSIENT FLOW	776
WAMPUM, FUEL CYCLE COSTS PERFORMANCE STUDY	UEC	6600	F4	RS P	D S	224
WANL 6600 F4	RS	L T B	\$GAMB1T, X-SEC GENERATION FOR TRANSPORT CODES			547
WANL 6600 F4	RS	L T B	\$GGC4, MULTI-GP X-SECTIONS FAST THERMAL SPECTRA			298
WANL 6600 F4	RS	P T C	\$VARI-QUIR, TIME-DEP 2-D MULTI-GP DIFFUSION			212
WAPD 360C F4	RS	PLXCT B	\$LEOPARD, SPOTS, SPECTRUM CALC WITH DEPLETION			279
WAPD 6600 BCD	R	L T Z	\$SETOG1 DATA LIBRARIES, MUFT4 OR 5, GAM1 OR 2			447
WAPD 6600 F4	RS	P T B	\$SETOM1, ENDF/B FORMAT TO MUFT FORMAT X-SECTIONS			436
WAPD 6600 F4	RS	P T D	\$SCINCAS, NUCLEAR FUEL CYCLE COST AND ECONOMICS			354
WAPD 6600 F4	RS	PL T B	\$SETOG1, ENDF/B TO MUFT, GAM, ANISN X-SEC FORMAT			437
WAPD 7600 F4	RS	P T B	\$SETOG3, ENDF/B TO MUFT, GAM, ANISN X-SEC FORMAT			538
WAPD 7600 F4	RS	P T B	\$SETOT2, THERMAL LIBRARIES FROM ENDF/B DATA			509
WAPD 7600 F4	RS	P T B	\$SETOT3, ENDF/B V3 DATA TO THERMAL LIBRARY FORM			628
WARD 6600 F4	RS	P T H	\$MANTA, STEADY-STATE THERMAL-HYDRAULIC ANALYSIS			256
WARD 7600 F+COM	RS	P XCT H	\$SVARR2, CRBRP 2-D TRANSIENT FLUID FLOW ANALYSIS			755
WARD 7600 F4	RS	P T K	\$DEMO4, CRBR REACTOR & PLANT TRANSIENT ANALYSIS			R676
WARD 7600 F4	RS	P T L	\$SEURCYL1, CYL-CYL INTERSECTION MESH GENERATOR			R746
WASP2, WATER PROPERTIES FOR SAFETY ANALYSIS	BAPL	7600	F4	RS P	T H S	R396
WATER & STEAM	BCAC	6600	F4	RS P	T H \$ASTEM, THERMODYNAMIC PROPERTIES	580
WATER & STEAM	EG-D	360B	F4	RS P	X T H \$ASTEM, THERMODYNAMIC PROPERTIES	580
WATER PROPERTIES	BG&E	360C	F4	RS	T H \$STEAM-67, 1967 ASME STEAM AND	487
WATER PROPERTIES FOR SAFETY ANALYSIS	BAPL	7600	F4	RS P	T H \$WASP2,	R396
WATER REACTOR DESIGN	BNW	1108	F5	RS P	CT H \$SREPP, THERMAL-HYDRAULIC	483
WATER TRANSFER IN POROUS MEDIA	BKY	7600	F4	RS P	T H \$SCHAFF, HEAT &	802
WATER-COOLED CORE TRANSIENT ANALYSIS	EG&G	360	F+BAL	RSBP	CT G \$SPARET,	555
WATER-LOGGED FUEL ELEMENT ANALYSIS	BAPL	6600	F4	RS P	T H \$GLUB1,	R424
WATER, STEAM TABLES 14.5-14,500PSIA 32-472DEGF	BAPL	6600	F4	RS	H S	R267
WELWING, MATERIAL BUCKLING CYL FUEL ELEMENTS	AEB	360	F4	RS P	B S	362
WFLLL2B, WIRE CONFIGURATION FREQUENCY DOMAIN	LLL	7600	F4	RS P	T T S	721
WHAM6, LIQUID-FILLED PIPING SYSTEM ANALYSIS	ANL	7600B	F4	RS P	T G S	278
WHAM6, LIQUID-FILLED PIPING SYSTEM ANALYSIS	EG&G	360B	F+BAL	RS P	T G S	278
WHTM, WISCONSIN HYDROLOGIC TRANSPORT MODEL	ORNL	360	F+BAL	RS P	CT R S	808
WIGL2, 1-D 2-GP SPACE-TIME DIFFUSION 3-GEOM	BAPL	6600	F4	RS P	T F S	R274
WIGL2, 1-D 2-GP SPACE-TIME DIFFUSION 3-GEOM	GGA	1108	F4	RS P	T F S	R274
WIGL2, 1-D 2-GP SPACE-TIME DIFFUSION 3-GEOM	UFCC	370	F4	RS P	T F S	R274
WIGL3, 1-D SPACE-TIME DIFFUSION W/FEEDBACK	BAPL	6600	F4	RS P	T F S	R708
WIRE CONFIGURATION FREQUENCY DOMAIN	LLL	7600	F4	RS P	T T \$WFLLL2B,	721
WISCONSIN HYDROLOGIC TRANSPORT MODEL	ORNL	360	F+BAL	RS P	CT R \$WHTM,	808
WORKSTATION PKG	ANL	360B	F+ASM	RSB	CT P \$WSP-HASP/DOS, DOS-MFT REMOTE	541
WREM-TOODEE2/MOD3, 2D TIME-DEP FUEL ELEM STUDY	NRC	370	F4	RSBP	CT G S	712
WSP-HASP/DOS, DOS-MFT REMOTE WORKSTATION PKG	ANL	360B	F+ASM	RSB	CT P S	541
WTSC 7600 F4	RS	P T I	\$SEALSHLL2, SHELL STRESS ANALYSIS AXISYM LOAD			R282
X-SEC	BNL	6600	F4	RS P	A \$BESFIT, DIFFRACTION MODEL ELASTIC SCAT	524
X-SEC & POLARIZATION CALC	KAPL	6600	F4	RS P	A \$PHASER, PHASE SHIFT	R507
X-SEC CALC	BNL	6600	F4	RS P	A \$SIGPLOT, RESOLVED MULTILEVEL B-W	377
X-SEC CALC	KAPL	6600	F4	RS P	T A \$JP1XR, COUPLED-CHANNEL SCATTERING	R506
X-SEC CALC	BNL	6600	F4	RS P	A \$AVERAGE, UNRESOLVED REGION AVERAGE	376

X-SEC

1-D

X-SEC CALC BNW	1108	F4	RS P T B	SFCC4, FUNDAMENTAL MODE FAST REACTOR	306
X-SEC CALC GGA	1108	F4	RS P X T B	\$GAF, GAR, SPECTRA AND GROUP-AVERAGED	316
X-SEC CALC ORNL	360	F+BAL	RS P D	\$ISOSEARCH, ISOTOPE PRODUCTION FLUX,	322
X-SEC EVALUATION	ENEA	360	F4 RS P CT A	\$JUPITOR1, COUPLED CHANNEL	308
X-SEC EVALUATION AI	360	F+BAL	RSB L CT M	\$SCORE3, SCISRS ENDF/B GRAPHIC	375
X-SEC FORMAT WAPD	6600	F4	RS PL T B	\$ETOG1, ENDF/B TO MUFT, GAM, ANISN	437
X-SEC FORMAT WAPD	7600	F4	RS P T B	\$ETOG3, ENDF/B TO MUFT, GAM, ANISN	538
X-SEC GENERATION FOR TRANSPORT CODES	WANL	6600	F4 RS L T B	\$GAMB1T,	547
X-SECS BAPL	6600	F4	RS P T A	\$SPUN1, UNRESOLVED RESONANCE INTEGRALS	R359
X-SECS FBRD	635	F+GMP	RS P XCT B	\$TDOWN, SPATIAL & COMPOSITION-DEPENDENT	505
X-SECS ANL	370	F+BAL	RSBPL CT B	\$MC**2-2, FAST NEUTRON SPECTRA & MULTIGP	355
X-SECS ANL	7600	F+COM	RS PLXCT B	\$MC**2-2, FAST NEUTRON SPECTRA & MULTIGP	355
X-SECS BAPL	6600	F4	RS B	\$M0807, 2-D DIFFUSION ABSORPTION REMOVAL	R280
X-SECTION ENEA	360	F4	RS P A	\$THRES2, STATISTICAL MODEL REACTION	504
X-SECTION CALC BNW	1108	F5	RS PLX T B	\$SBRT1, THERMAL SPECTRUM	184
X-SECTION CALC OSUC	370	F4	RS PLXCT B	\$FORM, FAST NEUTRON SPECTRUM	51
X-SECTION CALC GGA	1108B	F4	RS P A	\$GANDY3, UNRESOLVED RESONANCE	341
X-SECTION CALC ELASTIC SCAT RESONANCES	AI	360	F4 RS PLX T B	\$AILMOE,	147
X-SECTION CALC MODERATOR	GGA	1108	F4 RS P A	\$GAKER, INELASTIC SCAT	289
X-SECTION CALCULATION	GEC	625	F4 RS P B	\$SAVOID, ANNULAR VOID	276
X-SECTION CALCULATION	BAPL	6600	F4 RS P T A	\$SUMOR, S-WAVE NEUTRON	R399
X-SECTION CALCULATION	GGA	1108	F5 RS P A	\$FLANGE1, SCATTERING LAW	247
X-SECTION GENERATION	ANL	360	F+BAL	\$RBP XCT B \$1DX, 1-D DIFFUSION FAST	374
X-SECTION GENERATION	BNW	1108	F4 RS P X T B	\$1DX, 1-D DIFFUSION FAST	374
X-SECTION GENERATION	GEC	635	F4 RSBP T B	\$GROUSE, SPACE-DEPENDENT	420
X-SECTION GENERATION CODE	BAPL	6600	F+COM RS P X T B	\$PAX03, HARMONY-PDQ	R426
X-SECTION LIBRARY GENERATION	BAPL	6600	F+COM RS P T B	\$RECAP-0, RECAP-12	R671
X-SECTION LIBRARY PREPARATION	GGA	1108	F4 RS P X T L	\$GAND, GAFGAR	345
X-SECTION MANIPULATION	ANL	360	F4 RSBPL CT L	\$ARC-XSEC1, MICROSCOPIC	594
X-SECTIONS BHSC	360	F4	RS PL T B	\$STEMPEST2, THERMAL NEUTRON SPECTRUM	50
X-SECTIONS BNL	6600	F4	RS P A	\$RAMP1, REICH-MOORE RESOLVED REGION	492
X-SECTIONS BNL	6600B	F4	RS P A	\$THRES2, STATISTICAL MODEL REACTION	504
X-SECTIONS GGA	1108	F5	RS P T B	\$ENDFB2, GAND2, GFE2, ENDF/B TO GAFGAR	596
X-SECTIONS NED	635	F4	RS P T B	\$REAX, RESOLVED RESONANCE EPITHERMAL	257
X-SECTIONS WAPD	6600	F4	RS P T B	\$ETOM1, ENDF/B FORMAT TO MUFT FORMAT	436
X-SECTIONS & SPECTRA	LASL	7600B	F+COM RS PL T A	\$GNASH, PARTICLE INDUCED	757
X-SECTIONS FAST THERMAL SPECTRA	GGA	1108B	F4 RS PLXCT B	\$GGC4, MULTI-GP	298
X-SECTIONS FAST THERMAL SPECTRA	WANL	6600	F4 RS L T B	\$GGC4, MULTI-GP	298
X-SECTIONS HEX LATTICE	GGA	1108	F4 RS B	\$HEXSCAT, ELASTIC SCAT	291
XDTRAP, HYDROGEN PERMEATION WITH TRAPPING			DP 360 F4 RSBP Q	\$	655
XENON OSCILLATION	CEND	360	F4 RS P X T F	\$CEXE, INCXE, 1-GP 3-D XYZ	415
XENON TRANSIENT & DEPLETION	KAPL	6600	F4 RS P T D	\$3DXT, DEP3, 3-D	R477
XRAY DIFFRACTION POWDER PATTERN INDEXING	LASL	6600	F+COM RS P Q	\$INDX,	609
XSEC CALC KAPL	6600	F4	RS P A	\$MULTI, MULTI-LEVEL RESONANCE THEORY	R535
XSEC LIBRARY MAINTENANCE	NED	635	F4 RS P T M	\$STROUT, MUG MULTIGROUP	493
XSEC LIBRARY MAINTENANCE	NED	1108	F5 RS P T M	\$STROUT, MUG MULTIGROUP	493
XSEC PROBABILITY TABLES	AI	360	F+BAL RS P CT A	\$U3R, UNRESOL RESONANCE	553
XSEC SETS, SN 18- 24- AND 25-GROUP SETS	LASL	6600	BCD R LX T Z	\$LASL	532
XSECS. FROM B-W PARAMETERS	GGA	1108	F5 RS P CT A	\$FSDP3, POINTWISE	216
XSECTION CODES	BNL	6600B	F4 RS P T A	\$RESEND, ADLER, ENDF/B RESONANCE	465
XY RZ GEOMETRY	GGA	1108	F+BAL RS P T C	\$GAMBLES, 2-D MULTI-GP DIFFUSION	222
XY RZ RTH	LASL	7600	F4 RS P T C	\$TWOTRAN-PNVW, 2-D PARTICLE TRANSPORT	573
XY RZ RTHETA	LASL	360D	F4 RSBP CT C	\$TWOTRAN2, 2-D MULTI-GP TRANSPORT	358
XY RZ RTHETA	LASL	6600D	F4 RS P T C	\$TWOTRAN2, 2-D MULTI-GP TRANSPORT	358
XY RZ RTHETA	LASL	7600D	F4 RS P T C	\$TWOTRAN2, 2-D MULTI-GP TRANSPORT	358
XY RZ RTHETA GEOMETRY	BNW	1108	F4 RS P C	\$PERT4, 2-D PERTURBATION	304
XY, RZ GGA	1108	F+BAL	RS P T D	\$BUG2, 2-D MULTIGROUP DIFFUSION & BURNUP	438
XYZ R-THETA-Z	LASL	6600	F4 RS P T D	\$3DDT, 3-D MULTIGROUP DIFFUSION	463
XYZ XENON OSCILLATION	CEND	360	F4 RS P X T F	\$CEXE, INCXE, 1-GP 3-D	415
Y) KAPL	6600B	F+COM	RS P T P	\$DATATRAN2, UTILITY PLCT MODULES F(X) & F(X,	407
YIELD FROM REACTION OR DECAY	LMSC	1100	F5 RS P D	\$ISOTOPES, MAXIMUM	179
ZONE, 2-D FINITE ELEMENT MESH GENERATOR	LLL	7600	F RS P T N	\$	765
ZPR-III ASSEMBLY 48 GAFGAR ENDF/B DATA TAPES	GGA	1108	BIN R L T Z	\$	356
1- & 2-CELL ANALYSIS	AI	360	F4 RS P G	\$SOFIRE2, SODIUM POOL FIRE	559
1-D & 2-D FEW-GROUP SPACE-TIME KINETICS	BCL	6400	F4 RS P T F	\$ADEP,	494
1-D AGE-DIFFUSION SLAB CYLINDER SPHERE	AEB	360	F4 RS L T C	\$FIRES,	9
1-D BURNUP POWER DISTRIBUTION SEARCH	GGA	1108	F4 RS P T C	\$GASP7,	319
1-D DIFFUSION FAST X-SECTION GENERATION	ANL	360	F+BAL RSBP XCT B	\$1DX,	374
1-D DIFFUSION FAST X-SECTION GENERATION	BNW	1108	F4 RS P X T B	\$1DX,	374
1-D FAST REACTOR DESIGN & SURVEY STUDY	BW	6600	F+COM RS P X T D	\$FARED,	427
1-D FEW-GP DIFFUSION DEPLETION PROGRAM	EG&G	360	F4 RSBP CT D	\$DWARF,	579
1-D FEW-GP DIFFUSION DESIGN SYSTEM	AI	360	F4 RSBP T K	\$THREDES,	273

1-D FEW-GP DIFFUSION SLAB CYLINDER SPHERE	BC	625	F4	RS	T	C	SFOG,	28
1-D MULTI-GP DIFFUSION & INVENTORY	ANL	360	F4	RSBP	CT	C	\$ARC-DIF1D,	626
1-D MULTI-GP DIFFUSION & LIB.	AI	360	F4	RSBPLX	T	C	\$CAESAR4,LIBLST,	270
1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	BNW	1107	F4	RS	P	T	C	\$HFN,
1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	BNW	6600	F4	RS	P	X	T	C
1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	OSUC	370	F4	RS	PL	CT	C	\$AIM6,
1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	MTS	360	F4	RSBPLXCT	C			\$MACH1,
1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	PURD	6500	F4	RS	PLX	T	C	\$MACH1,
1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	BHSC	360	F4	RS	P	T	C	\$FAIMOS,
1-D MULTI-GP DISCRETE ORDINATE PROGRAM	ANL	360	F+BAL	RS	P	T	C	\$DTF4,
1-D MULTI-GP DISCRETE ORDINATE PROGRAM	BC	625	F+MAP	RS	P	T	C	\$DTF4,
1-D MULTI-GP DISCRETE ORDINATE PROGRAM	LASL	6600	F4	RS	P	T	C	\$DTF4,
1-D MULTI-GP KINETICS WITH TEMP FEEDBACK	GGA	1108	F4	RS	P	T	F	\$GAKIT,
1-D MULTIGROUP DIFFUSION AND DEPLETION	GGA	1108	F4	RS	P	T	D	\$FEVER7,
1-D MULTIGROUP DIFFUSION DEPLETION	AI	360	F4	RSBP	X	T	D	\$SIZZLE,
1-D MULTIGROUP DIFFUSION SLAB, CYL, SPH	EG&G	360	F4	RSBP	CT	C		\$MONA,
1-D MULTIGROUP DIFFUSION SLAB, SPH, CYL	GGA	1108	F+BAL	RS	P	T	C	\$GAZE2,
1-D MULTIGROUP REACTOR KINETICS PROGRAM	ORNL	360	F4	RS	P	XCT	E	\$TASK,
1-D ONE-GP SPACE-TIME DIFFUSION FEEDBACK	BNL	6600	F4	RS	P	T	F	\$NOAH,
1-D PERTURBATION FOR AIM AND FOG CODES	BHSC	360	F4	RS	P		C	\$PERT,
1-D PIPING	ANL	360	F4	RS	P			
1-D SLAB GAMMA-RAY TRANSPORT	BAPL	6600	F4	RS	P	T	J	\$M0756,LETO,
1-D SLAB TRANSPORT WITH SLOWING DOWN	BAPL	6600	F4	RS				\$M0648,
1-D SPACE-TIME DIFFUSION W/FEEDBACK	BAPL	6600	F4	RS	P	T	F	\$WIGL3,
1-D TIME-DEP MULTIGP DISCRETE ORDINATES	LASL	360	F4	RS	P	T	F	\$TIMEX,
1-D TIME-DEP MULTIGP DISCRETE ORDINATES	LASL	7600	F4	RS	P	T	F	\$TIMEX,
1-D TIME-DEPENDENT DIFFUSION CALC	KAPL	6600	F4	RS	P		F	\$RAUMZEIT,
1-D TRANSPORT PERTURBATION THEORY	GGA	1108	F4	RS	P	XCT	C	\$GAPER1D,
1-D VARIATIONAL SENSITIVITY	ANL	360	F4	RSBPL	CT	C		\$VARI-1D,
1-D 2-GP KINETICS TEMPERATURE FEEDBACK	BAPL	6600	F4	RS	P		F	\$NOWIG,
1-D 2-GP SPACE-TIME DIFFUSION 3-GEOM	BAPL	6600	F4	RS	P	T	F	\$WIGL2,
1-D 2-GP SPACE-TIME DIFFUSION 3-GEOM	GGA	1108	F4	RS	P	T	F	\$WIGL2,
1-D 2-GP SPACE-TIME DIFFUSION 3-GEOM	UFCC	370	F4	RS	P	T	F	\$WIGL2,
1-GP 3-D XYZ XENON OSCILLATION	CEND	360	F4	RS	P	X	T	\$CEXE,INCXE,
1D & 2D SYSTEMS	ANL	360	F4	RS	P	T	G	\$NATRAN2, FLUID HAMMER ANALYSIS
1D HIGH-TEMPERATURE COAL COMBUSTOR MODEL	ANL	370	PL1	RS	P	T	R	\$SCOMB,
1D MULTICAVITY KLYSTRON TUBE ANALYSIS	SLAC	360	F4	RS	P	T	V	\$SLACKLY,
1DX HEDL	360	F4	RSBP	XCT	B			\$ETOX3, MULTI-GP CONSTANTS FROM ENDF/B FOR
1DX HEDL	1108B	F4	RS	P	X	T	B	\$ETOX3, MULTI-GP CONSTANTS FROM ENDF/B FOR
1DX, 1-D DIFFUSION FAST X-SECTION GENERATION	ANL	360	F+BAL	RSBP	XCT	B		\$S
1DX, 1-D DIFFUSION FAST X-SECTION GENERATION	BNW	1108	F4	RS	P	X	T	\$B
1GP DEPLETION NED	635	F+GMP	RS	P	T	D		\$SYN, 2D SYNTHESIS MULTIGP DIFF &
1ST FLIGHT COLLISION PROBABILITIES MC	ORNL	360B	F+BAL	RS	P	T	B	\$RAFFLE,
10 MEV	BC	625	F4	RS	PLX	T	B	\$GAMTEC2, MULTI-GP CONSTANT CALC 0 TO
10 MEV	BNW	1107	F4	RS	PL	T	B	\$GAMTEC2, MULTI-GP CONSTANT CALC 0 TO
10 MEV	UVAC	6400	F4	RS	PLX	T	B	\$GAMTEC2, MULTI-GP CONSTANT CALC 0 TO
10 MULTIGROUP TIME-DEPENDENT DIFFUSION	UFCC	370B	F4	RS	P	T	F	\$GAKIN2,
1100	F5	RS	P	D				\$ISOTOPES, MAXIMUM YIELD FROM REACTION OR DECAY LMSC
1107	F4	RS	P	T	C			\$HFN, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE
1107	F4	RS	PL	T	B			\$GAMTEC2, MULTI-GP CONSTANT CALC 0 TO 10 MEV
1108	BIN	R	L	T	Z			\$ZPR-III ASSEMBLY 48 GAFGAR ENDF/B DATA TAPES
1108	COBOL	RS	P	M				\$BECOM, AEC DP PURCHASE VERSUS LEASE ANALYSIS
1108	F+BAL	RS	P	T	C			\$GAMBLES, 2-D MULTI-GP DIFFUSION XY RZ GEOMETRY
1108	F+BAL	RS	P	T	C			\$GAMTRI, 2-D MULTI-GP DIFFUSION TRIANGULAR MESH
1108	F+BAL	RS	P	T	C			\$GAZE2, 1-D MULTIGROUP DIFFUSION SLAB, SPH, CYL
1108	F+BAL	RS	P	T	D			\$BUGTRI, 2D MULTIGP DIFFUSION & BURNUP TRI-MESH
1108	F+BAL	RS	P	T	D			\$BUG2, 2-D MULTIGROUP DIFFUSION & BURNUP XY, RZ
1108	F+BAL	RS	P	T	E			\$BLOOST6, COMBINED KINETICS 2-D HEAT TRANSFER
1108	F+BAL	RS	P	T	O			\$GSSLRN1B, LEAST SQUARES PHOTOPEAK SPECTRA CODE
1108	F+BAL	RS	P	T	O			\$TOAD, PROCESSING OF ANALYZER GAMMA-RAY SPECTRA
1108	F+BAL	RSBP	T	M				\$SPIRAL, FULL-TEXT STORAGE, SEARCH & RETRIEVAL
1108	F+BAL	RSBP	T					\$ACCEL(MOD2), DESIGN OF PRINTED-CIRCUIT BOARDS
1108	F+SLE	RS	P	G				\$SAFTAC, MONTE CARLO FAULT TREE SIMULATION CODE
1108	F+SLE	RS	P	XCT	R			\$HERMES, REGIONAL RADIOLOGICAL EFFECTS ANALYSIS
1108	F4	S	T	D				\$GAFFE, EQUILIBRIUM FUEL CYCLE CALCULATION
1108	F4	RS		B				\$HEXSCAT, ELASTIC SCAT X-SECTIONS HEX LATTICE
1108	F4	RS		T	G			\$GADOSE,DOSET, HTGR ACCIDENT ANALYSIS DOSE CALC
1108	F4	RS	P	A				\$GAKER, INELASTIC SCAT X-SECTION CALC MODERATOR
1108	F4	RS	P	A				\$GASKET, THERMAL SCATTERING LAW CALCULATION
1108	F4	RS	P	A				\$PSEUDO, STATISTICAL RESONANCE PARAMETER CALC
1108	F4	RS	P	C				\$PERT4, 2-D PERTURBATION XY RZ RTHETA GEOMETRY
1108	F4	RS	P	D				\$FREVP6, HTGR METALLIC FISSION PRODUCT RELEASE

1108

2-D

1108	F4	RS P	E	SGAPOTKIN, SPACE-INDEPENDENT REACTOR KINETICS	GGA	317
1108	F4	RS P	E	SGASA, STABILITY ANALYSIS REACTOR KINETICS EQNS	GGA	290
1108	F4	RS P	G	SSOCOL2, SODIUM-FUEL INTERACTION ANALYSIS	HEDL	521
1108	F4	RS P	I	SSAFE-CREEP, VISCOELASTIC ANALYSIS CONCRETE	GGA	300
1108	F4	RS P	I	SSAFE-PLANE, PLANE STRESS ANALYSIS, 2-D BODIES	GGA	252
1108	F4	RS P	I	SSAFE-SHELL, STRESS ANALYSIS THIN SHELLS	GGA	253
1108	F4	RS P	L	SGROWRK, GRID GENERATION FOR SAFE PROGRAMS	GGA	296
1108	F4	RS P	T A	STACAS1, ANALYSIS OF RESONANCE MEASUREMENTS	GGA	410
1108	F4	RS P	T B	SFCC4, FUNDAMENTAL MODE FAST REACTOR X-SEC CALC	BNW	306
1108	F4	RS P	T C	SBISYN, 2-D MULTI-GP DIFFUSION SYNTHESIS CALC	NED	287
1108	F4	RS P	T C	SGASP7, 1-D BURNUP POWER DISTRIBUTION SEARCH	GGA	319
1108	F4	RS P	T C	SGATT, 3-D FEW-GP DIFFUSION CALC HEX-Z MESH	GGA	380
1108	F4	RS P	T C	STEMCO7, TEMPERATURE COEFFICIENT CALCULATION	GGA	320
1108	F4	RS P	T D	SFEVER7, 1-D MULTIGROUP DIFFUSION AND DEPLETION	GGA	318
1109	F4	RS P	T D	SGAUGE, 2-D FEW-GP HEX GEOM DIFFUSION DEPLETION	GGA	339
1108	F4	RS P	T D	SPWCOST, REACTOR FUEL CYCLE COST CALCULATION	GGA	441
1108	F4	RS P	T D	S2DB, 2-D MULTIGROUP DIFFUSION AND DEPLETION	BNW	325
1108	F4	RS P	T D	S3DB, 3-D MULTIGROUP DIFFUSION BURNUP ANALYSIS	HEDL	567
1108	F4	RS P	T F	SGAKIT, 1-D MULTIGP KINETICS WITH TEMP FEEDBACK	GGA	370
1108	F4	RS P	T F	SWIGL2, 1-D 2-GP SPACE-TIME DIFFUSION 3-GEOM	GGA	R274
1108	F4	RS P	T G	SPREP,KITT, SYSTEM FAULT TREE EVALUATION CODES	EG&G	528
1108	F4	RS P	T H	SDYNAM, DYNAMIC ANALYSIS BOILING FLOW STEAM	GGA	440
1108	F4	RS P	T I	SSAFE-2D, PLANE & AXISYMMETRIC STRESS ANALYSIS	GGA	379
1108	F4	RS P	T I	SSAFE-3D, 3-D COMPOSITE STRUCTURE STRESS STUDY	GGA	332
1108	F4	RS P	T J	SMUSCAT, VIEW FACTOR SHIELDING CODE CAVITY GEOM	GGA	259
1108	F4	RS P	CT D	SOPUS, POWER PLANT PERFORMANCE AND PRICE STUDY	GGA	226
1108	F4	RS P	X A	SCOHBE, COHERENT INELASTIC SCATTERING LAW CALC	GGA	385
1108	F4	RS P	X T B	SGAF,GAR, SPECTRA AND GROUP-AVERAGED X-SEC CALC	GGA	316
1108	F4	RS P	X T B	S1DX, 1-D DIFFUSION FAST X-SECTION GENERATION	BNW	374
1108	F4	RS P	X T L	SGAND, GAFGAR X-SECTION LIBRARY PREPARATION	GGA	345
1108	F4	RS P	XCT C	SGAPER1D, 1-D TRANSPORT PERTURBATION THEORY	GGA	606
1108	F4	RS P	XCT D	SCONCEPT3, POWER PLANT CONCEPTUAL COST ESTIMATE	GGA	498
1108	F4	RS P	XT B	SHRG3, SLOWING-DOWN SPECTRUM, MULTIGP CONSTANTS	BNW	467
1108	F5	RS P	A	SFLANGE1, SCATTERING LAW X-SECTION CALCULATION	GGA	247
1108	F5	RS P	H	SFLAC, STEADY-STATE FLOW, PRESSURE DISTRIBUTION	GGA	395
1108	F5	RS P	T B	SENDFB2,GAND2,GFE2, ENDF/B TO GAFGAR X-SECTIONS	GGA	596
1108	F5	RS P	T C	S2DF, 2-D MULTI-GP DISCRETE ORDINATE CODE	GGA	173
1108	F5	RS P	T D	SDBUFIT1, LEAST SQUARES TRANSMUTATION ANALYSIS	BNW	456
1108	F5	RS P	T H	STAC2D, STEADY-STATE AND TRANSIENT TEMP CALC	GGA	408
1108	F5	RS P	T H	STAC3D, TRANSIENT 3-D HEAT TRANSFER PROGRAM	GGA	414
1108	F5	RS P	T I	SSAFE-CRACK, VISCOELASTIC ANALYSIS OF CONCRETE	GGA	451
1108	F5	RS P	T I	SSHELL5, THIN SHELL 3-D STRUCTURAL ANALYSIS	GGA	452
1108	F5	RS P	T M	STROUT, MUG MULTIGROUP XSEC LIBRARY MAINTENANCE	NED	493
1108	F5	RS P	T N	SGAPER2D, 2-D PERTURBATION CALC FROM 2DF OUTPUT	GGA	471
1108	F5	RS P	T O	SCAGE,BIRD,SPEC, TIME-OF-FLIGHT DATA ANALYSIS	GGA	476
1108	F5	RS P	T R	STOPLYR2, POWER PLANT THERMAL DISCHARGE STUDY	HEDL	599
1108	F5	RS P	CT A	SFSDP3, POINTWISE XSECS. FROM B-W PARAMETERS	GGA	216
1108	F5	RS P	CT H	SREPP, THERMAL-HYDRAULIC WATER REACTOR DESIGN	BNW	483
1108	F5	RS P	X T D	SPACTOLUS,CLOTHO, NUCLEAR POWER PLANT COST CODE	HEDL	540
1108	F5	RS P	X T F	SNOISY1, AUTO- AND CROSS-SPECTRAL DENSITIES	BNW	488
1108	F5	RS P	XT B	SBRT1, THERMAL SPECTRUM X-SECTION CALC	BNW	184
1108	F5	RSBPL	T D	SISOGN, RADIONUCLIDE GENERATION AND DECAY	BNW	367
1108A	F4	RS P	T H	SLION4, 3-D TEMPERATURE DISTRIBUTION PROGRAM	CHI	R299
1108B	F4	RS P	A	SGANDY3, UNRESOLVED RESONANCE X-SECTION CALC	GGA	341
1108B	F4	RS P	T H	SLION4, 3-D TEMPERATURE DISTRIBUTION PROGRAM	FW	R299
1108B	F4	RS P	X T B	SETOX3, MULTI-GP CONSTANTS FROM ENDF/B FOR 1DX	HEDL	388
1108B	F4	RS P	XLCT B	SGGC4, MULTI-GP X-SECTIONS FAST THERMAL SPECTRA	GGA	298
1108B	F5	RS P	X T P	SFUNCTION2, SPECIAL FUNCTION ROUTINES	ANL	610
1108B	F5	RS P	XT B	SLEOFARD,SPOTS, SPECTRUM CALC WITH DEPLETION	JNC	279
1108B	F4	RS P	X T P	SEISPACK2, MATRIX EIGENVALUE/VECTOR PACKAGE	ANL	534
14.5-14,500PSIA	32-472DEGF	BAPL	6600 F4 RS	H SWATER, STEAM TABLES		R267
14.5-2538 PSIA		BAPL	6600 F4 RS P	H SM0899,HOH, STEAM TABLES		R294
18- 24- AND 25-GROUP SETS		LASL	6600 BCD R	LX T Z SLASL XSEC SETS, SN		532
1962 SOLAR DATA		SLA	6600 BCD R	L T Z SSOLDATABQ62, ALBUQUERQUE		693
1962 SOLAR DATA		SLA	6600B BIN R	L T Z SSOLDATABQ62, ALBUQUERQUE		693
1967 ASME STEAM AND WATER PROPERTIES		BG&E	360C F4 RS	T H SSTEAM-67, &		487
2-CELL ANALYSIS	AI	360 F4 RS P	G	SSOFIRE2, SODIUM POOL FIRE 1- &		559
2-D AXISYMMETRIC & PLANE ELASTIC-PLASTIC		BAPL	6600 F+COM RS P	T I SDUZZ2, &		R503
2-D BODIES	BNL	6600 F4 RS P	T I	SSAFE-PLANE, PLANE STRESS ANALYSIS,		252
2-D BODIES	GGA	1108 F4 RS P	I	SSAFE-PLANE, PLANE STRESS ANALYSIS,		252
2-D CONTOUR PLOTS & AREA CALCULATION		SLA	6600 F4 RS P	P SPLOTR, &		R578
2-D DIFFUSION ABSORPTION REMOVAL X-SECS		BAPL	6600 F4 RS	B SM0807, &		R280

2-D

25-GROUP

2-D DIFFUSION BURNUP REFUELING HISTORY	LASL	6600	F4	RS P T D	\$PHENIX,	454	
2-D FEW-GP HEX GEOM DIFFUSION DEPLETION	GGA	1108	F4	RS P T D	\$GAUGE,	339	
2-D FEW-GROUP SPACE-TIME KINETICS	BCL	6400	F4	RS P T F	\$ADEP, 1-D &	494	
2-D FEW-GROUP TRANSPORT WITH DEPLETION	BAPL	7600	F+COM	RS P T D	\$TPT01,	R669	
2-D FINITE ELEMENT MESH GENERATOR	LLL	7600	F	RS P T N	\$ZONE,	765	
2-D FLUX SETS	FBRD	6000	F4	RS P C	\$TRIAL, 3-D REACTION RATES FROM	585	
2-D HEAT TRANSFER	GGA	1108	F+BAL	RS P T E	\$BLOOST6, COMBINED KINETICS	303	
2-D HETEROGENEOUS REACTOR CALCULATION	DP	360B	F4	RSBP CT C	\$HERESY3,	136	
2-D HYDRODYNAM RESPONSE TO EXCURSION	ANL	360	F4	RS P CT F	\$REXCO-H,	550	
2-D HYDRODYNAM RESPONSE TO EXCURSION	ANL	360	F4	RS P CT F	\$REXCO-H2,	R615	
2-D INELASTIC STRUCTURAL ANALYSIS	ORNL	360B	F+BAL	RS P X T I	\$SCREEP-PLAST,	R707	
2-D INPUT GEN KAPL 6600B F+C	RS P T L			\$DATATRAN2, RAD	GEOMETRY MODULES	406	
2-D LAGRANGIAN EQNS OF MOTION SOLUTION	SLA	3600	F36	RS P T I	\$TOODY2,	627	
2-D LMFBR POWER EXCURSION DISASSEMBLY	ANL	360	F4	RS P XCT F	\$VENUS,	511	
2-D MONTE CARLO CELL CALCULATION	AI	360	F+BAL	RS P X T B	\$HWOCR-SAFE,	307	
2-D MULTI-GP DIFFUSION	UMCC	360	F4	RS P T C	\$VARI-QUIR, TIME-DEP	212	
2-D MULTI-GP DIFFUSION	WANL	6600	F4	RS P T C	\$VARI-QUIR, TIME-DEP	212	
2-D MULTI-GP DIFFUSION PROGRAM	BC	625	F4	RS T C	\$EXTERMINATOR2,	156	
2-D MULTI-GP DIFFUSION PROGRAM	CEND	6600	F4	RS P T C	\$EXTERMINATOR2,	156	
2-D MULTI-GP DIFFUSION PROGRAM	ORNL	360	F4	RS P T C	\$EXTERMINATOR2,	156	
2-D MULTI-GP DIFFUSION SYNTHESIS CALC	NED	635	F4	RS PL T C	\$BISYN,	287	
2-D MULTI-GP DIFFUSION SYNTHESIS CALC	NED	1108	F4	RS P T C	\$BISYN,	287	
2-D MULTI-GP DIFFUSION TRIANGULAR MESH	GGA	1108	F+BAL	RS P T C	\$GAMTRI,	401	
2-D MULTI-GP DIFFUSION XY RZ GEOMETRY	GGA	1108	F+BAL	RS P T C	\$GAMBLE5,	222	
2-D MULTI-GP DISCRETE ORDINATE CODE	GGA	1108	F5	RS P T C	\$2DF,	173	
2-D MULTI-GP TRANSPORT XY RZ RTHETA	LASL	360D	F4	RSBP CT C	\$TWOTRAN2,	358	
2-D MULTI-GP TRANSPORT XY RZ RTHETA	LASL	6600D	F4	RS P T C	\$TWOTRAN2,	358	
2-D MULTI-GP TRANSPORT XY RZ RTHETA	LASL	7600D	F4	RS P T C	\$TWOTRAN2,	358	
2-D MULTIGROUP DIFFUSION & BURNUP XY, RZ	GGA	1108	F+BAL	RS P T D	\$BUG2,	438	
2-D MULTIGROUP DIFFUSION & SN THEORY	NED	635	F4	RS P T C	\$DOT2DB,	459	
2-D MULTIGROUP DIFFUSION AND DEPLETION	BNW	1108	F4	RS P T D	\$2DB,	325	
2-D MULTIGROUP DIFFUSION AND DEPLETION	LASL	6600	F4	RS P T D	\$2DB,	325	
2-D NONLINEAR ANALYSIS	SLL	6600	F+COM	RS P T I	\$GNATS, MESH2, GPRINT,	682	
2-D PARTICLE TRANSPORT XY RZ RTH	LASL	7600	F4	RS P T C	\$TWOTRAN-PNVW,	573	
2-D PERTURBATION CALC FROM 2DF OUTPUT	GGA	1108	F5	RS P T N	\$GAPER2D,	471	
2-D PERTURBATION XY RZ RTHETA GEOMETRY	BNW	1108	F4	RS P C	\$PERT4,	304	
2-D TRANSIENT FLUID FLOW ANALYSIS	WARD	7600	F+COM	RS P XCT H	\$VARR2, CRBRP	755	
2-D TRANSIENT HEAT CONDUCTION PROGRAM	BAPL	6600	F4	RS P T H	\$SHOT2,	R286	
2-D TRIANGULAR MESH TRANSPORT PROGRAM	LASL	360	F4	RSBP CT C	\$TRIPILET,	608	
2-D TRIANGULAR MESH TRANSPORT PROGRAM	LASL	6600	F4	RS P T C	\$TRIPILET,	608	
2-D TRIANGULAR MESH TRANSPORT PROGRAM	LASL	7600	F4	RS P T C	\$TRIPILET,	608	
2-D 2-GP SPACE-TIME DIFFUSION	ANL	360	F4	RS P T F	\$TWIGGLE,	R338	
2-D 2-GP SPACE-TIME DIFFUSION FEEDBACK	BAPL	6600	F4	RS P T F	\$TWIGL,	R338	
2-D 2-PHASE FLOW	MSS	360	F4	RS P H	\$FLOW-MODEL, MULTI-CHANNEL	246	
2-DIMENSIONAL HEAT CONDUCTION	ORNL	360	F4	RS P X T H	\$ORTHIS, ORTHAT,	525	
2-DIMENSIONAL 2-FLUID FLOW	LASL	7600	F4	RS P X T H	\$K-FIX, TRANSIENT	727	
2-FLUID FLOW	LASL	7600	F4	RS P X T H	\$K-FIX, TRANSIENT 2-DIMENSIONAL	727	
2-GP KINETICS TEMPERATURE FEEDBACK	BAPL	6600	F4	RS P F	\$NOWIG, 1-D	R371	
2-GP SPACE-TIME DIFFUSION	ANL	360	F4	RS P T F	\$TWIGGLE, 2-D	R338	
2-GP SPACE-TIME DIFFUSION FEEDBACK	BAPL	6600	F4	RS P T F	\$TWIGL, 2-D	R338	
2-GP SPACE-TIME DIFFUSION 3-GEOM	BAPL	6600	F4	RS P T F	\$WIGL2, 1-D	R274	
2-GP SPACE-TIME DIFFUSION 3-GEOM	GGA	1108	F4	RS P T F	\$WIGL2, 1-D	R274	
2-GP SPACE-TIME DIFFUSION 3-GEOM	UFCC	370	F4	RS P T F	\$WIGL2, 1-D	R274	
2-PASS ASSEMBLER FOR THE PDP-11 ON	360	EG&G	360	PL1	RS P T P	\$PTAC11,	516
2-PHASE COOLANT BEHAVIOR	AAEC	360	F+BAL	RSBP XCT G	\$NAIAD, COMPRESSIBLE	726	
2-PHASE FLOW	MSS	360	F4	RS P H	\$FLOW-MODEL, MULTI-CHANNEL 2-D	246	
2D INELASTIC STRUCTURAL ANALYSIS	ORNL	360	F+BAL	RS P XCT I	\$SCREEP-PLAST2,	R810	
2D MULTIGP DIFFUSION & BURNUP TRI-MESH	GGA	1108	F+BAL	RS P T D	\$BUGTRI,	439	
2D MULTIGP TRANSPORT TRIANGULAR MESH	LASL	360	F+BAL	RS P CT C	\$STRIDENT,	741	
2D MULTIGP TRANSPORT TRIANGULAR MESH	LASL	7600	F4	RS P T C	\$STRIDENT,	741	
2D SUBSONIC MHD DIFFUSER PERFORMANCE	ANL	370	F4	RS P H	\$DIFFUSER,	737	
2D SYNTHESIS MULTIGP DIFF & 1GP DEPLETION	NED	635	F+GMP	RS P T D	\$SYN,	495	
2D SYSTEMS	ANL	360	F4	RS P T G	\$NATRAN2, FLUID HAMMER ANALYSIS 1D &	719	
2D TIME-DEP FUEL ELEM STUDY	NRC	370	F4	RSBP CT G	\$SWREM-TOODEE2/MOD3,	712	
2DB, 2-D MULTIGROUP DIFFUSION AND DEPLETION	BNW	1108	F4	RS P T D	\$	325	
2DB, 2-D MULTIGROUP DIFFUSION AND DEPLETION	LASL	6600	F4	RS P T D	\$	325	
2DEPEP, ELLIPTIC PARABOLIC & EIGENVALUE SOLNS.	PURD	6500	F4	RS P CT P	\$	806	
2DF OUTPUT	GGA	1108	F5	RS P T N	\$GAPER2D, 2-D PERTURBATION CALC FROM	471	
2DF, 2-D MULTI-GP DISCRETE ORDINATE CODE	GGA	1108	F5	RS P T C	\$	173	
230 F4	RS P T B	\$CLUP77, SQUARE CELL COLLISION PROBABILITY CALC	JAER			526	
24- AND 25-GROUP SETS	LASL	6600	BCD	R LX T Z	\$LASL XSEC SETS, SN 18-	532	
25-GROUP SETS	LASL	6600	BCD	R LX T Z	\$LASL XSEC SETS, SN 18- 24- AND	532	

3-D

360

3-D COMPOSITE STRUCTURE STRESS STUDY	GGA	1108	F4	RS P T I	SSAFE-3D,	332
3-D COMPOSITE STRUCTURE STRESS STUDY	ORNL	360	F+BAL	RS P T I	SSAFE-3D,	332
3-D DIFFUSION DEPLETION MULTI-GP	ORNL	3601	F4	RS P T K	SCITATION, 1,2,	387
3-D FEW-GP DIFFUSION CALC HEX-Z MESH	GGA	1108	F4	RS P T C	\$GATT,	380
3-D FEW-GP DIFFUSION DEPLETION	BAPL	7600B	F+COM	RS P T D	\$PDQ8, 1,2 OR	R275
3-D FEW-GP DIFFUSION DEPLETION	BCSS	6600D	F+ASC	R B T D	\$PDQ7, 1,2 OR	R275
3-D FEW-GP DIFFUSION DEPLETION	EG&G	360G	F+BAL	RSBP XCT D	\$PDQ7, 1,2 OR	R275
3-D FEW-GP DIFFUSION DEPLETION	EG&G	7600	FTN	RS LXCT D	\$PDQ7, 1,2 OR	R275
3-D FINITE-ELEMENT ELASTIC ANALYSIS	BAPL	6600	F+COM	RS P X T I	\$MATUS,	R597
3-D HEAT CONDUCTION PROGRAM	ORNL	360	F4	RS P T H	\$HEATING5, 1,2, OR	517
3-D HEAT TRANSFER PROGRAM	GGA	1108	F5	RS P T H	\$TAC3D, TRANSIENT	414
3-D MULTIGROUP DIFFUSION	ORNL	360	F+BAL	RSBP CT C	\$VENTURE, 1, 2, OR	686
3-D MULTIGROUP DIFFUSION BURNUP ANALYSIS	ANL	360	F4	RS P CT D	\$3DB,	567
3-D MULTIGROUP DIFFUSION BURNUP ANALYSIS	HEDL	1108	F4	RS P T D	\$3DB,	567
3-D MULTIGROUP DIFFUSION XYZ R-THETA-Z	LASL	6600	F4	RS P T D	\$3DDT,	463
3-D PLOTS ON IBM2280 OR CALCOMP780	ANL	360	F4	RS P T N	\$PLOT-3D,	544
3-D REACTION RATES FROM 2-D FLUX SETS	FBRD	6000	F4	RS P C C	\$TRIAL,	585
3-D REACTIVITY AND POWER DISTRIBUTION	AINS	7600	F4	RS P T C	\$FLARE,	167
3-D REACTIVITY AND POWER DISTRIBUTION	MSS	360	F4	RS P CT C	\$FLARE,	167
3-D REACTIVITY AND POWER DISTRIBUTION	NED	635	F4	RS P T C	\$FLARE,	167
3-D STRUCTURAL ANALYSIS	GGA	1108	F5	RS P T I	\$SHELL5, THIN SHELL	452
3-D STRUCTURES	KAPL	6600	F4	RS P X I	\$FINEL, FINITE-ELEMENT STUDY 2,	R40-
3-D TEMPERATURE DISTRIBUTION PROGRAM	CHI	1108A	F4	RS P T H	\$LION4,	R299
3-D TEMPERATURE DISTRIBUTION PROGRAM	FW	360	F4	RS P CT H	\$LION4,	R299
3-D TEMPERATURE DISTRIBUTION PROGRAM	FW	1108B	F4	RS P T H	\$LION4,	R299
3-D TEMPERATURE DISTRIBUTION PROGRAM	KAPL	6600B	F+ASC	RS P T H	\$LION4,	R299
3-D TWO-PHASE FLOW	BAPL	7600B	F4	RS P T H	\$FLOW3, NETWORK ANALYSIS OF	R664
3-D XENON TRANSIENT & DEPLETION	KAPL	6600	F4	RS P T D	\$3DXT,DEP3,	R477
3-D XYZ XENON OSCILLATION	CEND	360	F4	RS P X T F	\$CEXE,INCEXE, 1-GP	415
3-GEOM	BAPL	6600	F4	RS P T F	\$WIGL2, 1-D 2-GP SPACE-TIME DIFFUSION	R274
3-GEOM	GGA	1108	F4	RS P T F	\$WIGL2, 1-D 2-GP SPACE-TIME DIFFUSION	R274
3-GEOM	UFCC	370	F4	RS P T F	\$WIGL2, 1-D 2-GP SPACE-TIME DIFFUSION	R274
3D REGION NYU	6600	F4	RS P T P	\$DPOLE, HELMHOLTZ EQUATION ON GENERAL	816	
3DB, 3-D MULTIGROUP DIFFUSION BURNUP ANALYSIS	ANL	360	F4	RS P CT D	\$	567
3DB, 3-D MULTIGROUP DIFFUSION BURNUP ANALYSIS	HEDL	1108	F4	RS P T D	\$	567
3DDT, 3-D MULTIGROUP DIFFUSION XYZ R-THETA-Z	LASL	6600	F4	RS P T D	\$	463
3DXT,DEP3, 3-D XENON TRANSIENT & DEPLETION	KAPL	6600	F4	RS P T D	\$	R477
30-GP ENDF/B SCAT KERNELS	DP	360	BCD	R LX T Z	\$THERMOS LIBRARY,	543
32-472DEGF	BAPL	6600	F4	RS H	\$WATER, STEAM TABLES 14.5-14,500PSIA	R267
360 BAL	RS	CT	P	\$SLACMON 2.2, OS360 MVT/MFT PERFORMANCE MONITOR	SLAC	635
360 BAL	RSB	T	P	\$NRITS-RJE, OS/360 MVT REMOTE JOB ENTRY SYSTEM	EG&G	519
360 BAL+F	RS P C	P		\$GETCOR,FRECOR, FORTRAN DYNAMIC STORAGE ALLOC	ORNL	644
360 BCD	R LX T Z			\$THERMOS LIBRARY, 30-GP ENDF/B SCAT KERNELS	DP	543
360 C+BAL	RS PL CT	M		\$JOURNAL CONTROL, LIBRARY JOURNAL MANAGEMENT	ORNL	660
360 COBOL	RS P	M		\$AEC-ALO FAU, RADIO FREQUENCY MANAGEMENT SYSTEM	ALCO	587
360 COBOL	RS P T	M		\$GLOVE CHANGE ANALYSIS SYSTEM, GLOVE DATA BASE	RFD	813
360 COBOL	RSBP CT	M		\$BECOM, AEC DP PURCHASE VERSUS LEASE ANALYSIS	SLA	R589
360 CSMP	S	R		\$TRITMOD, ADVECTION MODEL OF TRITIUM DISPERSION	DP	814
360 CSMP	RS	R		\$POLUTE, FOREST AIR POLLUTANT UPTAKE MODEL	DP	774
360 F	RSBP T	P		\$STFODE,COLODE, COLLOCATION SOLN OF STIFF ODE'S	ANL	652
360 F+BAL	S X T	B		\$RAHAB, JOSHUA SYSTEM LATTICE PHYSICS MODULES	DP	536
360 F+BAL	RS	T P		\$FIGS, IBM360&2250 FORTRAN GRAPHICS SUBROUTINES	AI	484
360 F+BAL	RS P	D		\$ISOSEARCH, ISOTOPE PRODUCTION FLUX, X-SEC CALC	ORNL	322
360 F+BAL	RS P	D		\$OMCST, POWER PLANT NON-FUEL O & M COST STUDY	ORNL	608
360 F+BAL	RS P	I		\$ELBOW-ORNL, PIPE STRESS & FLEXIBILITY CALC	ORNL	650
360 F+BAL	RS P T A			\$COMNUC,CASCADE, COMPOUND NUCLEUS REACTION	AI	482
360 F+BAL	RS P T C			\$DTF4, 1-D MULTI-GP DISCRETE ORDINATE PROGRAM	ANL	209
360 F+BAL	RS P T D			\$CINDER,M0102, POINT DEPLETION FISSION PRODUCT	DP	313
360 F+BAL	RS P T D			\$MSF21,VTE21, DESALINATION PLANT OPTIMIZATION	ORNL	798
360 F+BAL	RS P T D			\$ORCOST2, POWER PLANT CAPITAL COST ESTIMATING	ORNL	588
360 F+BAL	RS P T E			\$AIROS2A, SIMULATION OF REACTOR DYNAMICS	AI	326
360 F+BAL	RS P T G			\$COMCAN, SYSTEM SAFETY COMMON CAUSE ANALYSIS	EG&G	704
360 F+BAL	RS P T I			\$LINDA, EVALUATION OF STRAIN-GAGE DATA	ORNL	657
360 F+BAL	RS P T I			\$SAFE-3D, 3-D COMPOSITE STRUCTURE STRESS STUDY	ORNL	332
360 F+BAL	RS P T R			\$ATM, ATMOSPHERIC TRANSPORT & DIFFUSION MODEL	ORNL	787
360 F+BAL	RS P CT A			\$U3R, UNRESOL RESONANCE XSEC PROBABILITY TABLES	AI	553
360 F+BAL	RS P CT C			\$TRIDENT, 2D MULTIGP TRANSPORT TRIANGULAR MESH	LASL	741
360 F+BAL	RS P CT H			\$6KILER, CORE HEATUP CODE FOR BWR/6 ANALYSIS	EI	636
360 F+BAL	RS P CT R			\$CHNSED, SEDIMENT & CONTAINMENT TRANSPORT MODEL	ORNL	793
360 F+BAL	RS P CT R			\$ODMOD, SOIL-WATER TRACE-CONTAINMENT TRANSPORT	ORNL	789
360 F+BAL	RS P CT R			\$OPTRM, HYDROLOGIC TRANSPORT WITH OPTIMIZATION	ORNL	794
360 F+BAL	RS P CT R			\$WHTM, WISCONSIN HYDROLOGIC TRANSPORT MODEL	ORNL	808

360	F+BAL	RS P X T B	SHWOCR-SAFE, 2-D MONTE CARLO CELL CALCULATION	AI	307
360	F+BAL	RS P X T D	SCONCEPT5, POWER PLANT CONCEPTUAL COST ESTIMATE	ORNL	498
360	F+BAL	RS P X T D	SORSIM, OPTIMIZING UTILITY GENERATION PLANNING	ORNL	699
360	F+BAL	RS P X T H	SFRAP-S1, STEADY STATE ANALYSIS OXIDE FUEL RODS	EG&G	694
360	F+BAL	RS P XCT B	SHAAMER,LITHE,HELP, CRITICAL ANALYSIS SYSTEM	DP	277
360	F+BAL	RS P XCT I	SCREEP-PLAST2, 2D INELASTIC STRUCTURAL ANALYSIS	ORNL	R810
360	F+BAL	RS P XCT I	SCURT2, CURVED TUBES OR ELBOWS & ATTACHED PIPES	ORNL	R750
360	F+BAL	RS PLXCT H	STRUMP, TRANSIENT & S-STATE TEMPERATURE DIST	ORNL	771
360	F+BAL	RSB L CT M	SSCORE3, SCISRS ENDF/B GRAPHIC X-SEC EVALUATION	AI	375
360	F+BAL	RSBP CT C	SVENTURE, 1, 2, OR 3-D MULTIGROUP DIFFUSION	ORNL	686
360	F+BAL	RSBP CT M	SARC-SYSTEM, SYSTEM SUBPROGRAMS AND MODULES	ANL	522
360	F+BAL	RSBP X T P	SSPEAKEASY MU+, LANGUAGE PROCESSOR TSO OR BATCH	ANL	593
360	F+BAL	RSBP XCT B	S1DX, 1-D DIFFUSION FAST X-SECTION GENERATION	ANL	374
360	F+BAL	RSBP XCT G	SFRAP-T, TRANSIENT ANALYSIS OF OXIDE FUEL RODS	EG&G	658
360	F+BAL	RSBPL CT B	SRAFFLE2/MOD2, MONTE CARLO NEUTRON TRANSPORT	EG&G	631
360	F+BAL	RSBPL CT C	SESP, MONTE CARLO REACTOR ANALYSIS CALCULATION	ORNL	523
360	F+BAL	RSBPL CT G	SPARET, WATER-COOLED CORE TRANSIENT ANALYSIS	EG&G	555
360	F+BAL	RSBPLXCT G	SNAIAD, COMPRESSIBLE 2-PHASE COOLANT BEHAVIOR	AAEC	726
360	F+C+R	RSBP T M	SRALCRTPH, RESOURCE ALLOCATION PROJECT PLANNING	MLMO	G603
360	F+COB	RSBP XC M	SRANDOM SAMPLING TABLE, FOR NON-BIAS ORDERING	MLMO	679
360	F+P+A	RSBP XCT W	SGAUSS6, BATCH ANALYSIS OF GAMMA-RAY SPECTRA	EG&G	622
360	F4	RS T M	SRIGEL, ENDF/B V3 DATA PROCESSING CODE	ANL	571
360	F4	RS L T C	SFIRES5, 1-D AGE-DIFFUSION SLAB CYLINDER SPHERE	AEB	9
360	F4	RS P A	SCODILLI, LEAST SQUARES ANALYSIS RESONANCE DATA	UICS	347
360	F4	RS P A	SPOLLA, CONVERTS R-MATRIX RESONANCE PARAMETERS	ORNL	639
360	F4	RS P A	SPSEUDO, STATISTICAL RESONANCE PARAMETER CALC	ENEA	292
360	F4	RS P A	STHRES2, STATISTICAL MODEL REACTION X-SECTION	ENEA	504
360	F4	RS P B	SWELWING, MATERIAL BUCKLING CYL FUEL ELEMENTS	AEB	362
360	F4	RS P C	SPERT, 1-D PERTURBATION FOR AIM AND FOG CODES	BHSC	30
360	F4	RS P D	SNPRFCOP, FUEL CYCLE COSTS PERFORMANCE DATA	ANL	146
360	F4	RS P D	SPRP, PRODUCT PRICE CALCULATED BY DCF METHOD	ORNL	739
360	F4	RS P E	SAIREK3, SPACE-INDEPENDENT KINETICS W/FEEDBACK	AEB	121
360	F4	RS P E	SBLAST, REACTOR KINETICS TEMPERATURE DIST STUDY	AEB	363
360	F4	RS P E	SR101, SPACE-INDEPENDENT KINETICS KEX OPTIONS	ANL	255
360	F4	RS P E	SR102, SPACE-INDEPENDENT INVERSE KINETICS CALC	ANL	168
360	F4	RS P E	STRIFIDO, PULSED NEUTRON SOURCE DATA ANALYSIS	CNEA	489
360	F4	RS P G	SCLOUD, GAMMA-RAY DOSE RATE FROM A CLOUD	DP	47
360	F4	RS P G	SEGAD, CALC OF EXTERNAL GAMMA DOSE INTEGRALS	DP	600
360	F4	RS P G	SINTEG,INSPEC, MARKOV SIMULATION OF REACTOR OPN	DP	590
360	F4	RS P G	SNAHAMMER, FLUID HAMMER ANALYSIS PIPING SYSTEM	ANL	717
360	F4	RS P G	SNATTRANSIENT, FLUID HAMMER ANALYSIS 1-D PIPING	ANL	718
360	F4	RS P G	SAAFTAC, MONTE CARLO FAULT TREE SIMULATION CODE	NEA	674
360	F4	RS P G	SSOCOOL2, SODIUM-FUEL INTERACTION ANALYSIS	ANL	521
360	F4	RS P G	SSOFIRE2, SODIUM POOL FIRE 1- & 2-CELL ANALYSIS	AI	559
360	F4	RS P H	SFLOW-MODEL, MULTI-CHANNEL 2-D 2-PHASE FLOW	MSS	246
360	F4	RS P H	SMARGE/SLUMP, MAXIMUM TEMPERATURE LMFBR FUELPIN	ANL	677
360	F4	RS P H	SPLENUM, FLOW DIST. IN CYL COOLANT INLET PLENUM	DP	586
360	F4	RS P I	SLUGS, STRESS FOR INTEGRAL ATTACHMENTS TO PIPE	ORNL	648
360	F4	RS P J	SDEMONR, UNBIASED MONTECARLO SLAB SHIELD CODE	LSU	754
360	F4	RS P L	SGENRD, FREE-FORMAT CARD INPUT PROCESSOR	LASL	530
360	F4	RS P O	SALPHA-M, RESOLUTION OF GAMMA-RAY SPECTRA	ORNL	413
360	F4	RS P O	SCORGAM, UNFOLDING OF COMPLEX GAMMA-RAY SPECTRA	KSUN	390
360	F4	RS P O	SDYNO1, PHOTOMULTIPLIER ELECTRON DISTRIBUTION	ANL	R464
360	F4	RS P P	SARSTEC, NONLINEAR MIXED INTEGER OPTIMIZATION	EG&G	738
360	F4	RS P P	SCOMQC, QUALITY CONTROL DATA ANALYSIS ROUTINES	BKC	649
360	F4	RS P P	SKEELE, LINEARLY-CONSTRAINED OPTIMIZATION	ORNL	556
360	F4	RS P P	SNIXLIN, LEAST SQUARES FIT TO NONLINEAR FORMS	DP	709
360	F4	RS P P	SPCTEST, PRINCIPAL COMPONENT TEST FOR OUTLIERS	UCND	769
360	F4	RS P P	SSOERP, SECOND-ORDER ERROR PROPAGATION CODE	EG&G	764
360	F4	RS P Q	SRESPOND, DISSIMILAR MEDIA TLD CORRECTION CALC	AI	566
360	F4	RS P R	SSULCAL, MODEL OF SULFUR CHEMISTRY IN A PLUME	ORNL	788
360	F4	RS P T	SF0355, SHAPER CUTTER CONTOUR GENERATOR	ANL	697
360	F4	RS P U	SDYNAMIC ANALYSIS OF GASES BY MASS SPECTROMETRY	RFD	645
360	F4	RS P U	SSOLVEX, SOLVENT EXTRACTION PROCESS SIMULATION	DP	662
360	F4	RS P W	SMMM3, COORDINATE ANALYSES SEMI-RIGID MOLECULES	EG&G	632
360	F4	RS P X	STOKMINA/TOKMINA2, TOKAMAK FUSION REACTOR STUDY	ANL	561
360	F4	RS P T A	SATHENA4, INELASTIC SCATTERING FORM FACTORS	ORNL	417
360	F4	RS P T B	SCLUP77, SQUARE CELL COLLISION PROBABILITY CALC	ANL	526
360	F4	RS P T B	SPRICE, PRIMARY RECOIL ATOM SPECTRA ENDF/B DATA	ORNL	453
360	F4	RS P T B	SSUPERTOG, ENDF/B FINE-GP CONSTANTS GENERATION	ORNL	431
360	F4	RS P T C	SEXTERMINATOR2, 2-D MULTI-GP DIFFUSION PROGRAM	ORNL	156
360	F4	RS P T C	SFAIMOS, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	BHSC	120

360	F4	RS	P	T	C	\$KEFF,MGBS,TGAN, NUCLEAR CRITICALITY SAFETY	DP	617
360	F4	RS	P	T	C	\$VARI-QUIR, TIME-DEP 2-D MULTI-GP DIFFUSION	UMCC	212
360	F4	RS	P	T	D	\$CINCAS, NUCLEAR FUEL CYCLE COST AND ECONOMICS	CWE	354
360	F4	RS	P	T	E	\$ANCON, SPACE-INDEPENDENT REACTOR KINETICS CODE	ANL	486
360	F4	RS	P	T	F	\$SAS1A, FAST REACTOR POWER AND FLOW TRANSIENTS	ANL	400
360	F4	RS	P	T	F	\$TIMEX, 1-D TIME-DEP MULTIGP DISCRETE ORDINATES	LASL	756
360	F4	RS	P	T	F	\$TSN, SPATIALLY-DEPENDENT REACTOR KINETICS	AI	309
360	F4	RS	P	T	F	\$TWIGGLE, 2-D 2-GP SPACE-TIME DIFFUSION	ANL	R338
360	F4	RS	P	T	G	\$AISITE2, PARAMETRIC SITE REQUIREMENT STUDY	AI	172
360	F4	RS	P	T	G	\$CHART, IODINE DECAY HEAT ON CHARCOAL ADSORBERS	ORNL	804
360	F4	RS	P	T	G	\$EMERALD REV. 1, PWR ACCIDENT ACTIVITY RELEASE	PGE	546
360	F4	RS	P	T	G	\$EMERALD-NORMAL, PWR ACTIVITY RELEASE AND DOSE	PGE	685
360	F4	RS	P	T	G	\$NATRAN2, FLUID HAMMER ANALYSIS 1D & 2D SYSTEMS	ANL	719
360	F4	RS	P	T	H	\$EVITS, STEADY STATE TWO-DIMENSIONAL FLUID FLOW	ANL	792
360	F4	RS	P	T	H	\$HEATING5, 1,2, OR 3-D HEAT CONDUCTION PROGRAM	ORNL	517
360	F4	RS	P	T	H	\$HETRAP, FUEL ROD RESPONSE LOCA EXPERIMENTS	ORNL	730
360	F4	RS	P	T	H	\$LOCK, FEW-CHANNEL COOLANT-FLOW BLOCKAGE STUDY	PNC	732
360	F4	RS	P	T	H	\$ORRIBLE, ROD BUNDLE FLOW & TEMPERATURE DIST.	ORNL	629
360	F4	RS	P	T	H	\$REFLUX, LWR REFLOOD HEAT TRANSFER PREDICTION	MIT	763
360	F4	RS	P	T	I	\$SABOR4, DISCRETE-ELEMENT ANALYSIS THIN SHELLS	MIT	R402
360	F4	RS	P	T	I	\$SEALSHELL2, SHELL STRESS ANALYSIS AXISYM LOAD	SR	R282
360	F4	RS	P	T	M	\$RECT.CHECKER, ENDF/B V2 PROCESSING CODES	ANL	475
360	F4	RS	P	T	N	\$PLOT-3D, 3-D PLOTS ON IBM2280 OR CALCOMP780	ANL	544
360	F4	RS	P	T	P	\$COCOPTR, DRVOCR, UNCONSTRAINED OPTIMIZATION	ANL	753
360	F4	RS	P	T	P	\$SPEKEN, PEARSON SPEARMAN & KENDALL CORRELATION	ORNL	781
360	F4	RS	P	T	Q	\$GROUP2, GROUP THEORY OF LATTICE DYNAMICS	ANL	620
360	F4	RS	P	T	R	\$SITE2, ENERGY FACILITY SITING ASSESSMENT	ANL	687
360	F4	RS	P	T	U	\$SEPHIS/MOD4, SOLVENT EXTRACTION SIMULATION	ORNL	R690
360	F4	RS	P	T	V	\$SLACKLY, 1D MULTICAVITY KLYSTRON TUBE ANALYSIS	SLAC	807
360	F4	RS	P	C	G	\$STEFEG, ANALYSIS OF PWR & BWR GASEOUS RELEASE	ORNL	583
360	F4	RS	P	C	I	\$PSA2, STRESS ANALYSIS MULTIANCHOR PIPE SYSTEM	AI	542
360	F4	RS	P	CT	A	\$JUPITOR1, COUPLED CHANNEL X-SEC EVALUATION	ENEAL	308
360	F4	RS	P	CT	C	\$FLARE, 3-D REACTIVITY AND POWER DISTRIBUTION	MSS	167
360	F4	RS	P	CT	D	\$GEM, ANALYSIS OF NUCLEAR FUEL CYCLE ECONOMICS	UICS	576
360	F4	RS	P	CT	D	\$3DB, 3-D MULTIGROUP DIFFUSION BURNUP ANALYSIS	ANL	567
360	F4	RS	P	CT	F	\$REXCO-H, 2-D HYDRODYNAM RESPONSE TO EXCURSION	ANL	550
360	F4	RS	P	CT	F	\$REXCO-H2, 2-D HYDRODYNAM RESPONSE TO EXCURSION	ANL	R615
360	F4	RS	P	CT	H	\$LION4, 3-D TEMPERATURE DISTRIBUTION PROGRAM	FW	R299
360	F4	RS	P	CT	I	\$PLACRE, FEM INELASTIC STRUCTURAL ANALYSIS	ORNL	R740
360	F4	RS	P	CT	L	\$QMESH,RENUM, SELF-ORGANIZING MESH GENERATION	ANL	612
360	F4	RS	P	CT	M	\$LASIP3, CCCC STANDARD INTERFACE FILE PROCESSOR	LASL	691
360	F4	RS	P	CT	N	\$GRFPAK, PLOT PACKAGE FOR CORTES FEM PROGRAMS	ORNL	760
360	F4	RS	P	CT	P	\$DRAFTMAN, DRAW FIGURES & GRAPHS WITH DISSPLA	ANL	748
360	F4	RS	P	CT	T	\$FFEARS, LAPLACE EQUATION ISOTROPIC DIELECTRICS	ANL	577
360	F4	RS	P	CT	W	\$MACS LATTICE VIBRATION NEUTRON SCATTERING CODES	EG&G	574
360	F4	RS	P	CT	W	\$MNSCAT, SLOW NEUTRON MULTIPLE SCATTERING CALC	ANL	575
360	F4	RS	P	X	G	\$BURST1, HYDRODYNAMIC ANALYSIS DURING BLOWDOWN	PPCO	435
360	F4	RS	P	X	R	\$MOBY, MOBILE HOME HEATING & COOLING ENERGY USE	ORNL	724
360	F4	RS	P	X	T	\$MOD5, STOCHASTIC MODEL OF NEUTRON SLOWING-DOWN	NPGS	491
360	F4	RS	P	X	T	\$CEXE,INCEXE, 1-GP 3-D XYZ XENON OSCILLATION	CEND	415
360	F4	RS	P	X	T	\$FORE2, FAST REACTOR EXCURSION CALCULATIONS	ANL	174
360	F4	RS	P	X	T	\$ORTHIS,ORTHAT, 2-DIMENSIONAL HEAT CONDUCTION	ORNL	525
360	F4	RS	P	X	T	\$EPISODE, ORDINARY DIFF EQUATION SYSTEM SOLVER	LLL	675
360	F4	RS	P	X	T	\$EPISODEB, SOLVE ODE SYST WITH BANDED JACOBIAN	LLL	705
360	F4	RS	P	X	C	\$MTRC0001, SI METRIC TO U.S. CUSTOMARY UNITS	MLMO	812
360	F4	RS	P	X	C	\$TASK, 1-D MULTIGROUP REACTOR KINETICS PROGRAM	ORNL	558
360	F4	RS	P	X	C	\$VENUS, 2-D LMFBR POWER EXCURSION DISASSEMBLY	ANL	511
360	F4	RS	PL	T	B	\$TEMPEST2, THERMAL NEUTRON SPECTRUM X-SECTIONS	BHSC	50
360	F4	RS	PL	CT	B	\$INCITE, THERMAL SPECTRA & MULTI-GP CONSTANTS	EG&G	565
360	F4	RS	PL	CT	F	\$QX1, QUASISTATIC SPATIAL REACTOR KINETICS CODE	ANL	474
360	F4	RS	PL	CT	P	\$SERREST, LOCA ROD BUNDLE CHF DATA ANALYSIS	EG&G	518
360	F4	RS	PL	X	T	\$AILMOE, X-SECTION CALC ELASTIC SCAT RESONANCES	AI	147
360	F4	RS	PL	X	T	\$HRG3, SLOWING-DOWN SPECTRUM, MULTIGP CONSTANTS	TVA	467
360	F4	RS	PL	X	C	\$PHROG, MULTI-GP CONSTANT & FAST SPECTRA CALC	EG&G	520
360	F4	RS	B	L	T	\$CLIP, FORM OR THREDES LIBRARY UTILITY ROUTINE	AI	271
360	F4	RS	B	P		\$GRAPH, LINEAR REGRESSION W/CONFIDENCE LIMITS	BKC	624
360	F4	RS	B	P		\$HISTOGRAMS, QUALITY CONTROL SAMPLE STATISTICS	BKC	614
360	F4	RS	B	P		\$XDTRAP, HYDROGEN PERMEATION WITH TRAPPING	DP	655
360	F4	RS	B	P		\$THREDES, 1-D FEW-GP DIFFUSION DESIGN SYSTEM	AI	273
360	F4	RS	B	P		\$LATIN SQ, NXN LATIN SQUARE EXPERIMENTAL DESIGN	MLMO	630
360	F4	RS	B	P		\$ARC-DIFID, 1-D MULTI-GP DIFFUSION & INVENTORY	ANL	626
360	F4	RS	B	P		\$MONA, 1-D MULTIGROUP DIFFUSION SLAB, CYL, SPH	EG&G	582

360

360	F4	RSBP	CT	C	\$TRIPLET, 2-D TRIANGULAR MESH TRANSPORT PROGRAM	LASL	608
360	F4	RSBP	CT	D	\$DWARF, 1-D FEW-GP DIFFUSION DEPLETION PROGRAM	EG&G	579
360	F4	RSBP	CT	G	\$FLASH4, FULLY-IMPLICIT TRANSIENT SIMULATION	MA-G	P448
360	F4	RSBP	CT	G	\$FPPM, STEADY-STATE FISSION PRODUCT FUEL MODEL	EG&G	584
360	F4	RSBP	CT	G	\$MOCUS, MINIMAL SETS FROM FAULT TREES	EG&G	653
360	F4	RSBP	CT	G	\$PREP.KITT, SYSTEM FAULT TREE EVALUATION CODES	EG&G	528
360	F4	RSBP	CT	I	\$STRAP, STATIC & DYNAMIC STRUCTURAL ANALYSIS	EG&G	539
360	F4	RSBP	CT	J	\$VIEWPIN, VIEW FACTOR CALC FOR CYLINDRICAL PINS	EG&G	569
360	F4	RSBP	CT	L	\$ARC-NUI002, BCD INPUT DATA PROCESSING MODULE	ANL	533
360	F4	RSBP	X	T	\$SIZZLE, 1-D MULTIGROUP DIFFUSION DEPLETION	AI	58
360	F4	RSBP	X	T	\$THETA1-B, FUEL ROD THERMAL RESPONSE LOCA	EG&G	512
360	F4	RSBP	XCT	B	\$ETOX3, MULTI-GP CONSTANTS FROM ENDF/B FOR 1DX	HEDL	388
360	F4	RSBP	XCT	P	\$MORTAN2, MACRO-BASED STRUCTURED FORTRAN	SLAC	678
360	F4	RSBP	XCT	U	\$GAUSS5, ANALYSIS OF GAMMA-RAY SPECTRA GE(LI)	EG&G	605
360	F4	RSBPL	CT	C	\$VARI-1D, 1-D VARIATIONAL SENSITIVITY	ANL	625
360	F4	RSBPL	CT	L	\$ARC-XSEC1, MICROSCOPIC X-SECTION MANIPULATION	ANL	594
360	F4	RSBPLX	T	C	\$CAESAR4,LIBLST, 1-D MULTI-GP DIFFUSION & LIB.	AI	270
360	F4	RSBPLXCT	C	C	\$MACH1, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	MTS	262
360	F4	RSBPLXCT	C	C	\$VIM1X, MONTE CARLO CRITICAL ASSEMBLY ANALYSIS	AI-A	510
360	PL1	RS	P	T	\$PTAC11, 2-PASS ASSEMBLER FOR THE PDP-11 ON 360	EG&G	516
360	EG&G	360	PL1	RS	\$PTAC11, 2-PASS ASSEMBLER FOR THE PDP-11 ON		516
360B	EBCDC	R	L	T	\$GAMTAB, RADIOACTIVE-DECAY GAMMA-RAY CATALOG	DP	637
360B	F+ASM	RSB	CT	P	\$WSP-HASP/DOS, DOS-MFT REMOTE WORKSTATION PKG	ANL	541
360B	F+BAL	RS	T	P	\$AMDLIBF, ARGONNE SUBROUTINE LIBRARY CAT. F	ANL	563
360B	F+BAL	RS	P	O	\$PMS1, FAST NEUTRON POLARIZATION EXPERIMENT	UCND	469
360B	F+BAL	RS	P	T	\$RAFFLE, 1ST FLIGHT COLLISION PROBABILITIES MC	ORNL	392
360B	F+BAL	RS	P	T	\$WHAM6, LIQUID-FILLED PIPING SYSTEM ANALYSIS	EG&G	278
360B	F+BAL	RS	P	X	\$SCREEP-PLAST, 2-D INELASTIC STRUCTURAL ANALYSIS	ORNL	R707
360B	F+BAL	RSB	T	P	\$NRTS ENVIRONMENTAL ROUTINES, FORTRAN UTILITIES	EG&G	613
360B	F+BAL	RSB	CT	P	\$PROGLOOK, USER PROGRAM PERFORMANCE MONITOR	SLAC	642
360B	F+BAL	RSBP	CT	C	\$KENO2, MONTE CARLO MULTIGROUP CRITICALITY CODE	DP	450
360B	F+BAL	RSBPL	CT	D	\$REBUS2, FUEL CYCLE ANALYSIS FOR FAST REACTORS	ANL	634
360B	F+BAL	RSBPLXCT	G	G	\$CONTEMPT-LT/026, PRESSURE-TEMPERATURE RESPONSE	EG&G	433
360B	F+P+A	RS	T	P	\$AMDLIBAE, ARGONNE SUBROUTINE LIBRARY CAT. A-E	ANL	562
360B	F+P+A	RS	T	P	\$AMDLIBGZ, ARGONNE SUBROUTINE LIBRARY CAT. G-Z	ANL	564
360B	F4	RS	P	I	\$NUBOW, STRUCTURAL ANALYSIS BOWED REACTOR CORES	ANL	643
360B	F4	RS	P	T	\$ORCENT, NUCLEAR STEAM TURBINE CYCLE ANALYSIS	ORNL	703
360B	F4	RS	P	T	\$FLANGE-ORNL, ANALYSIS OF FLANGED JOINTS	ORNL	689
360B	F4	RS	P	C	\$ISOTAB, PU POWER OUTPUT FROM MIXED ISOTOPES	MLMO	R619
360B	F4	RS	P	CT	\$CORTES, THERMAL & MECHANICAL ANALY' S OF TEES	ORNL	759
360B	F4	RS	P	X	\$ASTEM, THERMODYNAMIC PROPERTIES WATER & STEAM	EG-D	580
360B	F4	RS	P	XCT	\$FLANGE2(71-1), ENDF/B THERMAL SCATTERING DATA	DP	368
360B	F4	RS	PL	CT	\$EDITOR, ENDF/B TAPE PROCESSING AND EDITING	ORNL	502
360B	F4	RSBP	CT	C	\$HERESY3, 2-D HETEROGENEOUS REACTOR CALCULATION	DP	136
360B	F4	RSBP	CT	G	\$RSAC, RADIOLOGICAL SAFETY ANALYSIS PROGRAM	EG&G	265
360B	F4	RSBP	CT	H	\$COBRA3M, FUEL PIN THERMAL-HYDRAULIC ANALYSIS	ANL	659
360B	F4	RSBP	CT	I	\$CYGR03, OXIDE FUEL ROD STRESS & DEFORMATION	AN-T	R449
360B	F4	RSBP	XCT	H	\$MOXY/MOD032, BWR CORE HEAT TRANSFER CODE	EG&G	551
360B	F4	RSBP	XCT	P	\$EISPACK2, MATRIX EIGENVALUE/VECTOR PACKAGE	ANL	534
360B	F4	RSBPLXCT	B	B	\$LASER, SPECTRUM CALC WITH BURNUP CYL LATTICE	TVA	249
360B	PL1	S	P	CT	\$SLOP,CROSS, IBM360 FORTRAN H PROGRAM CHECKER	ANL	647
360C	F+BAL	RS	P	X	\$MARLOWE, BINARY COLLISION CASCADE SIMULATION	ORNL	680
360C	F+BAL	RSBPLXCT	C	C	\$KENO4, MONTE CARLO MULTIGROUP CRITICALITY CODE	ORNL	450
360C	F4	RS	T	H	\$STEAM-67, 1967 ASME STEAM AND WATER PROPERTIES	BG&E	487
360C	F4	RS	P	X	\$GEAR, ORDINARY DIFFERENTIAL EQN SYSTEM SOLVER	ANL	592
360C	F4	RS	P	X	\$GEARB, SOLVE ODE SYSTEM WITH BANDED JACOBIAN	LLL	661
360C	F4	RS	PLXCT	B	\$LEOPARD,SPOTS, SPECTRUM CALC WITH DEPLETION	WAPD	279
360D	BAL	RS	X	T	\$COPYCAT, IBM OS SYSTEM CATALOG UTILITY ROUTINE	ANL	646
360D	F4	RS	P	X	\$DE/STEP,INTRP, SOLN OF ORDINARY DIFF EQUATIONS	SLA	640
360D	F4	RSBP	CT	C	\$TWOTRAN2, 2-D MULTI-GP TRANSPORT XY RZ RTHETA	LASL	358
360F	F+BAL	RSBPLXCT	G	G	\$RELAP4/MOD6, TRANSIENT THERMAL-HYDRAULIC STUDY	EG&G	369
360G	F+BAL	RSBP	XCT	D	\$PDQ7, 1,2 OR 3-D FEW-GP DIFFUSION DEPLETION	EG&G	R275
360I	F4	RS	P	T	\$CITATION, 1,2,3-D DIFFUSION DEPLETION MULTI-GP	ORNL	387
3600	F36	RS	P	T	\$TOODY2, 2-D LAGRANGIAN EQNS OF MOTION SOLUTION	SLA	627
370	BAL	RSB	CT	P	\$SLACMON/370, VERSION 4.0 VS SOFTWARE MONITOR	SLAC	635
370	BAL	RSBP	CT	P	\$FORTIO, FORTRAN INTERFACE TO IBM370 MACROS	ANL	772
370	COBOL	RS	CT	M	\$NMMSS, NUCLEAR MATERIALS MANAGEMENT SYSTEM	UCND	695
370	F	RS	P	T	\$HAA3B, AEROSOL BEHAVIOR LOGNORMAL MODEL	AI	443
370	F+BAL	RS	P	T	\$PROSA1, PROBABLISTIC RESPONSE SURFACE CODE	ANL	R778
370	F+BAL	RS	P	T	\$CASIM, SIMULATES HADRONIC CASCADE TRANSPORT	FNAL	742
370	F+BAL	RS	P	CT	\$BIOSSIM, BIOCHEMICAL KINETIC SIMULATION SYSTEM	CUP1	736
370	F+BAL	RS	P	XCT	\$DYNSDK, OPTIMAL DISK DATA SET REORDERING	DP	729

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370	F+8AL	RSBPL	CT	B	SMC**2-2, FAST NEUTRON SPECTRA & MULTIGP X-SECS	ANL	355
370	F+C+A	RS	XC	P	\$JCLCROSS, DSN CROSS-REF LIST FROM JCL PROCLIBS	HCI	725
370	F+CSM	RS	P	G	\$SPOOL-FIRE, SPRAY-POOL BURNING OF SODIUM	ANL	R714
370	F4	RS	P	G	\$DISPER1, AEROSOL PARTICLE TRANSPORT STUDY	ANL	554
370	F4	RS	P	H	\$DIFFUSER, 2D SUBSONIC MHD DIFFUSER PERFORMANCE	ANL	737
370	F4	RS	P	H	\$HEATING2, TRANSIENT STEADY-STATE HEAT TRANSFER	SSDC	198
370	F4	RS	P	H	\$SLGTR, SLAG TRANSPORT MODELS FOR DUCT SURFACES	ANL	783
370	F4	RS	P	I	\$NUBOW2D-INELASTIC, BOWED REACTOR CORE ANALYSIS	ANL	790
370	F4	RS	P	P	\$FRANTIC, LEAST SQUARES FIT SUM OF EXPONENTIALS	ANL	324
370	F4	RS	P	T	\$DOPSEL, SELF-SHIELDING IN THE RESONANCE REGION	RRC	805
370	F4	RS	P	T	\$WIGL2, 1-D 2-GP SPACE-TIME DIFFUSION 3-GEOM	UFCC	R274
370	F4	RS	P	T	\$COMRADEX4, ACCIDENT RELEASED RADIOLOGICAL DOSE	AI	663
370	F4	RS	P	T	\$IMPORTANCE, FTA BASIC EVENT & CUT SET RANKING	ANL	779
370	F4	RS	P	T	\$PTA1, PIPE SYSTEM PRESSURE ANALYSIS	ANL	R761
370	F4	RS	P	T	\$SOMIX1, SODIUM PRAY FIRES IN CYLINDRICAL CELL	AI	R751
370	F4	RS	P	T	\$COMPARE, TRANSIENT FLOW IN VENTED FLUID SYSTEM	NRC	702
370	F4	RS	P	T	\$ENERGY, LMFBR COOLANT TEMPERATURE PREDICTION	MIT	696
370	F4	RS	P	T	\$TDIST2, COMMUNITY ENERGY CONSUMPTION ANALYSIS	MIT	799
370	F4	RS	P	T	\$TRANSPORT, DESIGN OF CHARGED PARTICLE BEAMS	SLAC	791
370	F4	RS	P	C	\$FLAC, STEADY-STATE FLOW, PRESSURE DISTRIBUTION	A&TS	395
370	F4	RS	P	C	\$SLIDES, FOR DISSPLA-LETTERED SLIDES & POSTERS	ANL	728
370	F4	RS	P	CT	\$SAGE-WASP, OPTIMAL ELECTRIC UTILITY EXPANSION	TVA	S744
370	F4	RS	P	CT	\$THI3D, THERMAL-HYDRAULIC MULTICHANNEL ANALYSIS	ANL	706
370	F4	RS	P	CT	\$LIFE3, MIXED-OXIDE FUEL ELEMENT PERFORMANCE	ANL	R460
370	F4	RS	P	CT	\$PRPLOT, LINE PRINTER PLOT SUBROUTINE PACKAGE	ACRC	773
370	F4	RS	P	X	\$DSNP, DYNAMIC SIMULATION NUCLEAR POWER PLANTS	ANL	784
370	F4	RS	P	X	\$LINPACK, SIMULTANEOUS LINEAR ALGEBRAIC EQUATNS	ANL	800
370	F4	RS	P	XCT	\$FRANTIC-NRC, TIME SYSTEM UNAVAILABILITY	NRC	766
370	F4	RS	PL	C	\$SCURIE, FISSION PRODUCT INVENTORY DECAY HISTORY	ANL	196
370	F4	RS	PL	CT	\$AIM6, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	OSUC	29
370	F4	RS	PLX	T	\$SCRAC, CALC OF REACTOR ACCIDENT CONSEQUENCES	NRC	722
370	F4	RS	PLXCT	B	\$FORM, FAST NEUTRON SPECTRUM X-SECTION CALC	OSUC	51
370	F4	RSBP	CT	G	\$WREM-TOODEE2/MOD3, 2D TIME-DEP FUEL ELEM STUDY	NRC	712
370	PL1	RS	P	T	\$COMB, 1D HIGH-TEMPERATURE COAL COMBUSTOR MODEL	ANL	811
370B	F+8AL	RS	P	XCT	\$SYN3D, SINGLE-CHANNEL FLUX SYNTHESIS DIFFUSION	ANL	713
370B	F4	S	P	X	\$FUNPACK2, SPECIAL FUNCTION ROUTINES	ANL	610
370B	F4	RS	P	T	\$GAKIN2, 10 MULTIGROUP TIME-DEPENDENT DIFFUSION	UFCC	310
370B	F4	RS	P	T	\$METRICATION, CONVERSION TO OR FROM SI UNITS	RDYN	G668
370B	F4	RS	P	T	\$SUPOUT, SOLUTION OF BOUNDARY-VALUE PROBLEMS	ANL	731
370C	F4	RS	P	CT	\$NUFUEL, NUCLEAR FUEL CYCLE REQUIREMENTS	ERDA	683
370D	F4	RS	P	CT	\$SAP4, STRUCTURAL ANALYSIS OF LINEAR SYSTEMS	ANL	641
48	GAFGAR	ENDF/B	DATA	TAPES	GGA 1108 BIN R L T Z \$ZPR-III ASSEMBLY		356
500PSIA	32-472DEGF	BAPL	6600	F4	RS H \$WATER, STEAM TABLES 14.5-14,		R267
6KILER,	CORE	HEATUP	CODE	FOR	BWR/6 ANALYSIS EI 360 F+8AL RS P CT H \$		636
6000	F4	RS	P	T	\$SCOROPT, OPTIMIZING LMFBR MIXED-OXIDE CORES	FBRD	S752
6000	F4	RS	P	C	\$TRIAL, 3-D REACTION RATES FROM 2-D FLUX SETS	FBRD	585
625	F+MAP	RS	P	T	\$DTF4, 1-D MULTI-GP DISCRETE ORDINATE PROGRAM	BC	209
625	F4	RS	T	C	\$EXTERMINATOR2, 2-D MULTI-GP DIFFUSION PROGRAM	BC	156
625	F4	RS	T	C	\$FOG, 1-D FEW-GP DIFFUSION SLAB CYLINDER SPHERE	BC	28
625	F4	RS	P	B	\$AVOID, ANNULAR VOID X-SECTION CALCULATION	GEC	276
625	F4	RS	PLX	T	\$GAMTEC2, MULTI-GP CONSTANT CALC 0 TO 10 MEV	BC	185
635	F+GMP	RS	T	P	\$GENED ENVIRONMENTAL ROUTINES, SUBROUTINE LIB.	NED	515
635	F+GMP	RS	P	T	\$SYN, 2D SYNTHESIS MULTIGP DIFF & 1GP DEPLETION	NED	495
635	F+GMP	RS	P	XCT	\$ENDRUN2, MULTIGROUP CONSTANTS FROM ENDF/B DATA	FBRD	501
635	F+GMP	RS	P	XCT	\$TDOWN, SPATIAL & COMPOSITION-DEPENDENT X-SECS	FBRD	505
635	F4	RS			\$SANVENT, LOCA ANALYSIS DUKE POWER MCGUIRE UNITS	DUCO	529
635	F4	RS	P	D	\$RAPFU, FUEL CYCLE PARAMETERS FAST BREEDERS	NED	372
635	F4	RS	P	T	\$REAX, RESOLVED RESONANCE EPITHERMAL X-SECTIONS	NED	257
635	F4	RS	P	T	\$DOT2DB, 2-D MULTIGROUP DIFFUSION & SN THEORY	NED	459
635	F4	RS	P	T	\$FLARE, 3-D REACTIVITY AND POWER DISTRIBUTION	NED	167
635	F4	RS	P	T	\$FUMBLE, FAST REACTOR FUEL BURNUP & MANAGEMENT	NED	480
635	F4	RS	P	T	\$FREADM1, FAST REACTOR CORE ACCIDENT ANALYSIS	NED	479
635	F4	RS	P	T	\$MANTA, STEADY-STATE THERMAL-HYDRAULIC ANALYSIS	NED	256
635	F4	RS	P	T	\$VELVET2, TURBULENT FLOW IN LMFBR ROD BUNDLE	NED	458
635	F4	RS	P	T	\$TROUT, MUG MULTIGROUP XSEC LIBRARY MAINTENANCE	NED	493
635	F4	RS	P	T	\$BURNUP, HEAVY ELEMENT ISOTOPIC BURNUP ANALYSIS	NED	311
635	F4	RS	P	T	\$EXPAN, ANALYSIS OF PULSED NEUTRON SOURCE DATA	NED	258
635	F4	RS	P	CT	\$BEHAVE2, OXIDE FUEL PERFORMANCE FINITE-ELEMENT	FBRD	R568
635	F4	RS	P	X	\$FORE2, FAST REACTOR EXCURSION CALCULATIONS	NED	174
635	F4	RS	PL	T	\$BISYN, 2-D MULTI-GP DIFFUSION SYNTHESIS CALC	NED	287
635	F4	RSBP		D	\$CHAINS, ANALYSIS OF RADIOACTIVE DECAY CHAINS	GEC	418
635	F4	RSBP		D	\$DOS, NEUTRON FLUX-DOSIMETER ACTIVITY RELATION	GEC	423

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635	F4	RSBP	O	SMICHRD, MICROHARDNESS MEASUREMENT ANALYSIS	GEC	421
635	F4	RSBP	T B	SGROUSE, SPACE-DEPENDENT X-SECTION GENERATION	GEC	420
6400	F4	S P	H	SPWR-PPM, BORATION-DILUTION TABLES FOR PWR OPN	OPPD	552
6400	F4	RS P	G	SBOIL1, BOILOFF ACCIDENT CORE HEATUP & MELTDOWN	BCL	734
6400	F4	RS P	G	SFRCRL2, LOCA FISSION PRODUCT RELEASE ANALYSIS	BCL	500
6400	F4	RS P	T F	SADEP, 1-D & 2-D FEW-GROUP SPACE-TIME KINETICS	BCL	494
6400	F4	RS P	T G	SCORRAL2, RADIONUCLIDE CONTAINMENT AFTER LOCA	BCL	745
6400	F4	RS P	T G	SECCSA4, LOSS-OF-COOLANT & EMERGENCY COOLING	BCL	330
6400	F4	RS P	T G	SHAARM3, AEROSOL BEHAVIOR LOG-NORMAL DIST MODEL	BCL	797
6400	F4	RS P	T G	SNURLOC-1.0, LOSS-OF-COOLANT THERMAL ANALYSIS	BCL	328
6400	F4	RS P	T I	SPIRAX2, SIMPLIFIED INELASTIC PIPING ANALYSIS	BCL	R735
6400	F4	RS P	CT M	SSKILLS INVENTORY, PERSONNEL INFORMATION SYSTEM	H&N	801
6400	F4	RS P	X T G	SMUCHA-T, MUCHA2, MULTIPLE CHANNEL ANALYSIS ECC	BCL	508
6400	F4	RS	PLX T B	SGAMTEC2, MULTI-GP CONSTANT CALC 0 TO 10 MEV	UVAC	185
6400B	F4	RS P	X T G	SMIRAB, MIRAP, CONTAINMENT SYSTEM IODINE REMOVAL	BCL	499
6500	F4	RS P	B	SPART1, OPTIMAL GROUP OR MESH COLLAPSING	RW	416
6500	F4	RS P	CT P	S2DEPEP, ELLIPTIC PARABOLIC & EIGENVALUE SOLNS.	PURD	806
6500	F4	RS	PLX T C	SMACH1, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE	PURD	262
6600	BCD	R	L T Z	SETOG1 DATA LIBRARIES, MUFT4 OR 5, GAM1 OR 2	WAPD	447
6600	BCD	R	L T Z	SSOLDATABG62, ALBUQUERQUE 1962 SOLAR DATA	SLA	693
6600	BCD	R	LX T Z	SLASL XSEC SETS, SN 18- 24- AND 25-GROUP SETS	LASL	532
6600	F	RS P	T H	SSIEX, LMFBR FUEL PIN THERMAL PERFORMANCE MODEL	HEDL	673
6600	F	RS P	T P	SSTFODE, COLODE, COLLOCATION SOLN OF STIFF ODE'S	SLA	652
6600	F+ASC	RS	P	SSIMPLE1, TIME-SHARING PROGRAMMING LANGUAGE	KAPL	R442
6600	F+ASC	RS P	T I	SGEM, EIGENVALUE PROBLEM FOR VIBRATING SYSTEMS	KAPL	R344
6600	F+ASC	RS P	T J	SASPI5, GAMMA-RAY SOURCE BUILDUP FACTOR CALC	BAPL	R429
6600	F+ASC	RS P	T P	SCURFIT, CURVE FITTING EXPERIMENTAL DATA POINTS	KAPL	R 43
6600	F+ASC	RS P	T P	SDOGGY, DESK CALCULATOR FORM SHEET DP PACKAGE	KAPL	R428
6600	F+ASC	RS P	T P	SLIZARD, NONLINEAR DIFFERENTIAL EQNS. SOLUTION	KAPL	R445
6600	F+ASC	RS P	T P	SSNEQ, NONLINEAR ALGEBRAIC EQN SOLN CURVE PLOT	KAPL	R364
6600	F+ASC	RS P	X T B	SRESQ2, RESQ0, DBF1, RESONANCE INTEGRAL HEX CELL	BAPL	R285
6600	F+COM	RS	T P	SBETTIS PROGRAMMING ENVIRONMENT LIBRARY	BAPL	R665
6600	F+COM	RS	T P	SKAPLPLOT, KAPL CALCOMP PLOTTING ROUTINES	KAPL	R496
6600	F+COM	RS P	H	SHYMAS, HYDRODYNAMIC MASS MATRIX GENERATION	BAPL	R560
6600	F+COM	RS P	Q	SINDX, XRAY DIFFRACTION POWDER PATTERN INDEXING	LASL	609
6600	F+COM	RS P	T B	SRECAP-0, RECAP-12 X-SECTION LIBRARY GENERATION	BAPL	R671
6600	F+COM	RS P	T I	SOUZ2, 2-D AXISYMMETRIC & PLANE ELASTIC-PLASTIC	BAPL	R503
6600	F+COM	RS P	T I	SGAPL3, INELASTIC LARGE DEFLECTION STRESS STUDY	BAPL	R397
6600	F+COM	RS P	T I	SGNATS, MESH2, GPRINT, 2-D NONLINEAR ANALYSIS	SLL	682
6600	F+COM	RS P	T P	SLENDES, NONLINEAR LEAST SQ LENS DESIGN SYSTEM	LASL	602
6600	F+COM	RS P	T T	SACCEL(MOD2), DESIGN OF PRINTED-CIRCUIT BOARDS	SLA	881
6600	F+COM	RS P	CT G	SFTA, FAULT TREE ANALYSIS SYSTEM	ARHC	666
6600	F+COM	RS P	X T B	SPAX03, HARMONY-PDQ X-SECTION GENERATION CODE	BAPL	R426
6600	F+COM	RS P	X T D	SFARED, 1-D FAST REACTOR DESIGN & SURVEY STUDY	BW	427
6600	F+COM	RS P	X T I	SMATUS, 3-D FINITE-ELEMENT ELASTIC ANALYSIS	BAPL	R597
6600	FTN	RS P	T I	SCHILES, LINEAR ELASTIC SINGULARITY MODELING	SLA	611
6600	F4	RS	B	SAPRFX1, 99-GP DLC-2B LIBRARY GROUP-COLLAPSING	APG	466
6600	F4	RS	B	SM0807, 2-D DIFFUSION ABSORPTION REMOVAL X-SECS	BAPL	R280
6600	F4	RS	C	SM0648, 1-D SLAB TRANSPORT WITH SLOWING DOWN	BAPL	R342
6600	F4	RS	H	SWATER, STEAM TABLES 14.5-14,500PSIA 32-472DEGF	BAPL	R267
6600	F4	RS	I	SSORSDB, PRESSURE VESSEL STRESS AND FATIGUE	KAPL	R391
6600	F4	RS	T I	SCYGR02, STRESS ANALYSIS CYL FUEL ELEMENT	BAPL	R266
6600	F4	RS	T M	SCHK3, RIGEL3, ENDF/B V3 PROCESSING CODES	BNL	571
6600	F4	RS	T O	SGASPAR, COMPLEX GAMMA-RAY SPECTRA ANALYSIS	KAPL	R485
6600	F4	RS	L T B	SGAMBIT, X-SEC GENERATION FOR TRANSPORT CODES	WANL	547
6600	F4	RS	L T B	SGGC4, MULTI-GP X-SECTIONS FAST THERMAL SPECTRA	WANL	298
6600	F4	RS P	A	SAVERAGE, UNRESOLVED REGION AVERAGE X-SEC CALC	BNL	376
6600	F4	RS P	A	SBESFIT, DIFFRACTION MODEL ELASTIC SCAT X-SEC	BNL	524
6600	F4	RS P	A	SCLEM, ANGULAR DISTRIBUTION LEGENDRE FITTING	KAPL	R531
6600	F4	RS P	A	SGRAMP, R-M PARAMETERS OF UNRESOLVED RESONANCES	BAPL	R470
6600	F4	RS P	A	SMULTI, MULTI-LEVEL RESONANCE THEORY XSEC CALC	KAPL	R535
6600	F4	RS P	A	SPHASER, PHASE SHIFT X-SEC & POLARIZATION CALC	KAPL	R507
6600	F4	RS P	A	SRAMP1, REICH-MOJRE RESOLVED REGION X-SECTIONS	BNL	492
6600	F4	RS P	A	SSIGLOT, RESOLVED MULTILEVEL B-W X-SEC CALC	BNL	377
6600	F4	RS P	D	SCINDER, M0102, POINT DEPLETION FISSION PRODUCT	BAPL	313
6600	F4	RS P	D	SNPRFCOP, FUEL CYCLE COSTS PERFORMANCE DATA	UEC	146
6600	F4	RS P	D	SPOWERCO, NUCLEAR STATION ELECTRICITY COSTS	UEC	340
6600	F4	RS P	D	SWAMPUM, FUEL CYCLE COSTS PERFORMANCE STUDY	UEC	224
6600	F4	RS P	F	SNOWIG, 1-D 2-GP KINETICS TEMPERATURE FEEDBACK	BAPL	R371
6600	F4	RS P	F	SRAUMZEIT, 1-D TIME-DEPENDENT DIFFUSION CALC	KAPL	R352
6600	F4	RS P	F	STINT3, SINGLE-CHANNEL SPACE-TIME SYNTHESIS	KAPL	R389
6600	F4	RS P	H	SBETTY, ENTRAINMENT PARTICLES SAMPLING STUDY	BAPL	R545

6600

6600	F4	RS	P	H	\$M0899, HOH, STEAM TABLES 14.5-2538 PSIA	BAPL	R294
6600	F4	RS	P	H	\$RAPP, HIGH-VELOCITY FLOW STUDY STEAM-WATER MIX	KAPL	R382
6600	F4	RS	P	I	\$BUBL1, FUEL SWELLING & GAS RELEASE SIMULATION	BAPL	R468
6600	F4	RS	P	I	\$FUGIT, DYNAMIC RESPONSE OF ELASTIC STRUCTURES	BAPL	R537
6600	F4	RS	P	I	\$M0266, LINEAR ELASTIC STRUCTURAL DYNAMICS	BAPL	R383
6600	F4	RS	P	I	\$M0552, DYNAMIC ANALYSIS LINEAR ELASTIC SYSTEMS	BAPL	R283
6600	F4	RS	P	I	\$STEM, MATRIX GENERATION FOR A SYSTEM OF BEAMS	KAPL	R337
6600	F4	RS	P	I	\$STRIPE, FUEL ROD CLAD STRAIN & PELLET CRACKING	BAPL	R570
6600	F4	RS	P	I	\$TCB01, CREEP-BUCKLING OF TUBES UNDER PRESSURE	BAPL	R604
6600	F4	RS	P	I	\$TUBE, U-TUBE HEAT EXCHANGER STRESS ANALYSIS	KAPL	R378
6600	F4	RS	P	L	\$BL47, DRAFTING TOOL TO PLOT PLANE STRUCTURES	BAPL	R373
6600	F4	RS	P	L	\$GENRD, FREE-FORMAT CARD INPUT PROCESSOR	LASL	530
6600	F4	RS	P	N	\$DAC1, SN PERTURBATION CODE USING DTF4 FLUXES	LASL	455
6600	F4	RS	P	N	\$HEATMESH, GEOMETRICAL DATA HEAT TRANSFER STUDY	SLL	434
6600	F4	RS	P	N	\$LARCA, FLUX-WEIGHTING OF DTF4 CROSS SECTIONS	LASL	409
6600	F4	RS	P	O	\$DYN01, PHOTOMULTIPLIER ELECTRON DISTRIBUTION	KAPL	R464
6600	F4	RS	P	O	\$JITER, FLUCTUATION EXPERIMENT ANALYSIS	BAPL	R394
6600	F4	RS	P	O	\$REDUX, REACTOR FLUCTUATION EXPERIMENT ANALYSIS	BAPL	R425
6600	F4	RS	P	P	\$ANOVA, THREE FACTOR ANALYSIS OF VARIANCE	BKC	819
6600	F4	RS	P	P	\$BH99, EXTREME VALUE DISTRIBUTION DATA ANALYSIS	BAPL	R621
6600	F4	RS	P	P	\$DAFT1, LEAST SQUARES FIT FISSILE NUCLIDE DATA	BAPL	R327
6600	F4	RS	P	P	\$ERF, ERF, ERROR & COMPLEMENTARY ERROR FUNCTION	SLA	601
6600	F4	RS	P	P	\$MOST, A MULTIDIMENSIONAL OPTIMIZATION SCHEME	KAPL	R446
6600	F4	RS	P	P	\$PLOT, 2-D CONTOUR PLOTS & AREA CALCULATION	SLA	R578
6600	F4	RS	P	P	\$RELO1, RELIABILITY FOR A SINGLE FAILURE MODE	BAPL	R497
6600	F4	RS	P	P	\$ROPE, FINDING ROOTS OF A POLYNOMIAL	KAPL	R444
6600	F4	RS	P	T	\$F0355, SHAPER CUTTER CONTOUR GENERATOR	BKC	697
6600	F4	RS	P	W	\$CONDYN, POLYA MODEL SECONDARY ELECTRON SPECTRA	KAPL	786
6600	F4	RS	P	T A	\$JP1XR, COUPLED-CHANNEL SCATTERING X-SEC CALC	KAPL	R506
6600	F4	RS	P	T A	\$PUN1, UNRESOLVED RESONANCE INTEGRALS X-SECS	BAPL	R359
6600	F4	RS	P	T A	\$SUMOR, S-WAVE NEUTRON X-SECTION CALCULATION	BAPL	R399
6600	F4	RS	P	T A	\$TOR, THERMAL SCATTERING CRYSTALLINE MATERIALS	LASL	360
6600	F4	RS	P	T B	\$EPOCH, NEUTRON AGE CALCULATION OF ENDF/B DATA	BAPL	R461
6600	F4	RS	P	T B	\$ETOM1, ENDF/B FORMAT TO MUFT FORMAT X-SECTIONS	WAPD	436
6600	F4	RS	P	T B	\$GLEN, GROUP CONSTANT CALC FROM TOR OUTPUT DATA	LASL	361
6600	F4	RS	P	T C	\$BE21, FEW-GP DISCRETE ORDINATES SLAB GEOMETRY	BAPL	R398
6600	F4	RS	P	T C	\$DTF4, 1-D MULTI-GP DISCRETE ORDINATE PROGRAM	LASL	209
6600	F4	RS	P	T C	\$EXTERMINATOR2, 2-D MULTI-GP DIFFUSION PROGRAM	CEND	156
6600	F4	RS	P	T C	\$TRIPLT, 2-D TRIANGULAR MESH TRANSPORT PROGRAM	LASL	608
6600	F4	RS	P	T C	\$VARI-QUIR, TIME-DEP 2-D MULTI-GP DIFFUSION	WANL	212
6600	F4	RS	P	T D	\$CINCAS, NUCLEAR FUEL CYCLE COST AND ECONOMICS	WAPD	354
6600	F4	RS	P	T D	\$GEOCOST-BC, BINARY CYCLE GEOTHERMAL COST STUDY	BNW	711
6600	F4	RS	P	T D	\$GEOCOST, GEOTHERMAL ENERGY COST ANALYSIS	BNW	684
6600	F4	RS	P	T D	\$PHENIX, 2-D DIFFUSION BURNUP REFUELING HISTORY	LASL	454
6600	F4	RS	P	T D	\$2DB, 2-D MULTIGROUP DIFFUSION AND DEPLETION	LASL	325
6600	F4	RS	P	T D	\$3DDT, 3-D MULTIGROUP DIFFUSION XYZ R-THETA-Z	LASL	463
6600	F4	RS	P	T D	\$3DXT, DEP3, 3-D XENON TRANSIENT & DEPLETION	KAPL	R477
6600	F4	RS	P	T E	\$ANCON, SPACE-INDEPENDENT REACTOR KINETICS CODE	LASL	486
6600	F4	RS	P	T F	\$NOAH, 1-D ONE-GP SPACE-TIME DIFFUSION FEEDBACK	BNL	405
6600	F4	RS	P	T F	\$SASIA, FAST REACTOR POWER AND FLOW TRANSIENTS	ANL	400
6600	F4	RS	P	T F	\$TWIGL, 2-D 2-GP SPACE-TIME DIFFUSION FEEDBACK	BAPL	R338
6600	F4	RS	P	T F	\$WIGL2, 1-D 2-GP SPACE-TIME DIFFUSION 3-GEOM	BAPL	R274
6600	F4	RS	P	T F	\$WIGL3, 1-D SPACE-TIME DIFFUSION W/FEEDBACK	BAPL	R708
6600	F4	RS	P	T G	\$CACECO, LMFBR CONTAINMENT ACCIDENT ANALYSIS	HEDL	R762
6600	F4	RS	P	T G	\$FLASH3, LOSS-OF-COOLANT ACCIDENT ANALYSIS	BAPL	R295
6600	F4	RS	P	T G	\$HAMOC, FLUID HAMMER ANALYSIS OF PIPING SYSTEM	HEDL	710
6600	F4	RS	P	T G	\$M0555, ACT1, LOSS-OF-COOLANT ACCIDENT ANALYSIS	BAPL	R284
6600	F4	RS	P	T H	\$ASTEM, THERMODYNAMIC PROPERTIES WATER & STEAM	BCAC	580
6600	F4	RS	P	T H	\$CHIC-K:N, FAST + INTERMEDIATE POWER TRANSIENTS	BAPL	R473
6600	F4	RS	P	T H	\$FIGRO, LWBR FUEL SWELLING TEMPERATURE STUDY	BAPL	R272
6600	F4	RS	P	T H	\$FLOT1, M0219, PWR FLOW TRANSIENT ANALYSIS	BAPL	R331
6600	F4	RS	P	T H	\$GLUB1, WATER-LOGGED FUEL ELEMENT ANALYSIS	BAPL	R424
6600	F4	RS	P	T H	\$HAFMAT, SYSTEM STEADY-STATE FLOW DISTRIBUTION	KAPL	R616
6600	F4	RS	P	T H	\$HOT2, 2-D TRANSIENT HEAT CONDUCTION PROGRAM	BAPL	R286
6600	F4	RS	P	T H	\$MANTA, STEADY-STATE THERMAL-HYDRAULIC ANALYSIS	WARD	256
6600	F4	RS	P	T H	\$STOPS, TRANSIENT THERMODYNAMICS OF PRESSURIZERS	BAPL	R348
6600	F4	RS	P	T I	\$BEAMCRP, FINITE-ELEMENT BEAM CREEP ANALYSIS	HEDL	R701
6600	F4	RS	P	T I	\$BUSHL, CYL SHELL BUCKLING COLLAPSE ANALYSIS	BAPL	R481
6600	F4	RS	P	T I	\$COVE1, CREEP COLLAPSE FOR OVAL FUEL PIN TUBE	BNW	817
6600	F4	RS	P	T I	\$CYGR03, OXIDE FUEL ROD STRESS & DEFORMATION	BAPL	R449
6600	F4	RS	P	T I	\$GAPCON-THERMAL2, FUEL PIN GAP CONDUCTANCE CALC	BNW	618
6600	F4	RS	P	T I	\$M0457, PIPE, ELASTIC STRESS OF PIPING SYSTEM	BAPL	R329

6600

6600

6600	F4	RS	P	T	I	\$PELEN, FUEL PELLETT TEMPERATURE & DEFORMATION
6600	F4	RS	P	T	I	\$SAFE-PLANE, PLANE STRESS ANALYSIS, 2-D BODIES
6600	F4	RS	P	T	I	\$SEALSHL2, SHELL STRESS ANALYSIS AXISYM LOAD
6600	F4	RS	P	T	I	\$SHOCK, DYNAMIC RESPONSE OF LUMPED-MASS SYSTEMS
6600	F4	RS	P	T	I	\$SLADE-D, DYNAMIC ANALYSIS OF THIN SHELLS
6600	F4	RS	P	T	J	\$M0756,LETO, 1-D SLAB GAMMA-RAY TRANSPORT
6600	F4	RS	P	T	K	\$PARK1, NUCLEAR REACTOR POWER PLANT ANALYSIS
6600	F4	RS	P	T	L	\$QMESH,RENUM, SELF-ORGANIZING MESH GENERATION
6600	F4	RS	P	T	M	\$SHLOG, DATA MANAGEMENT, EDITING, & ANALYSIS
6600	F4	RS	P	T	P	\$BESSEL FUNCTIONS, AIRY & LOG GAMMA SUBROUTINES
6600	F4	RS	P	T	P	\$DPOLE, HELMHOLTZ EQUATION ON GENERAL 3D REGION
6600	F4	RS	P	T	P	\$M0661,M0657,M0626, POLYNOMIAL CURVE FITTING
6600	F4	RS	P	T	P	\$SUPPORT, SOLUTION OF BOUNDARY-VALUE PROBLEMS
6600	F4	RS	P	T	Q	\$COREL,RASE4,DAMG2, ION IMPLANTATION DEPOSITION
6600	F4	RS	P	T	Q	\$GROUP2, GROUP THEORY OF LATTICE DYNAMICS
6600	F4	RS	P	CT	F	\$MELT3, FAST REACTOR TRANSIENT OVERPOWER STUDY
6600	F4	RS	P	CT	I	\$AXICRP, FINITE ELEMENT CODE FOR CREEP ANALYSIS
6600	F4	RS	P	X	I	\$FINEL, FINITE-ELEMENT STUDY 2,3-D STRUCTURES
6600	F4	RS	P	X	T	\$HFN, 1-D MULTI-GP DIFFUSION SLAB CYL SPHERE
6600	F4	RS	P	X	T	\$GAPCON-THERMAL3, FUEL SS & TRANSIENT BEHAVIOR
6600	F4	RS	P	X	T	\$RICE-LASL, CHEMICALLY REACTIVE MIXTURE FLOW
6600	F4	RS	PL	T	B	\$ETOG1, ENDF/B TO MUFT, GAM, ANISN X-SEC FORMAT
6600	F4	RS	PL	T	M	\$EDITOR, ENDF/B TAPE PROCESSING AND EDITING
6600A	F+ASC	RS		T	P	\$BETTIS ENVIRONMENTAL ROUTINES, SUBROUTINE LIB.
6600B	BIN	R	L	T	Z	\$SOLDBAQ62, ALBUQUERQUE 1962 SOLAR DATA
6600B	F	S	P	X	T	\$FUNPACK2, SPECIAL FUNCTION ROUTINES
6600B	F+ASC	RS	P	T	H	\$LION4, 3-D TEMPERATURE DISTRIBUTION PROGRAM
6600B	F+ASC	RS	P	T	J	\$SPAN4, A POINT-KERNEL SHIELD EVALUATION CODE
6600B	F+ASC	RSB	X	T	M	\$TIGIR2, MODULAR DOCUMENT INFORMATION SYSTEM
6600B	F+C	RS	P	T	L	\$DATATRAN2, RAD1 GEOMETRY MODULES 2-D INPUT GEN
6600B	F+COM	RS	P	T	P	\$DATATRAN2, UTILITY PLOT MODULES F(X) & F(X,Y)
6600B	F+COM	RS	P	X	T	\$DATATRAN2, MODULAR PROGRAMMING AND DATA SYSTEM
6600B	F+COM	RS	PL	X	T	\$KENO2, MONTE CARLO MULTIGROUP CRITICALITY CODE
6600B	FTN	RS	P	T	P	\$SETS, SET EQUATION TRANSFORMATION SYSTEM
6600B	F4	RS		T	M	\$CHECKER,CRECT,DAMMET,PLOTFB,... ENDF/B V1 PROC
6600B	F4	RS		T	M	\$CRECT,CHECKER,RIGEL,PLOTFB,... ENDF/B V2 PROC
6600B	F4	RS		T	M	\$RIGEL4,CHECK4,... ENDF/B V4 PROCESSING CODES
6600B	F4	RS	P		A	\$THRES2, STATISTICAL MODEL REACTION X-SECTIONS
6600B	F4	RS	P		I	\$MANE1, RECTANGULAR MAGNETIC NETWORK SOLUTION
6600B	F4	RS	P	T	A	\$RESEND,ADLER, ENDF/B RESONANCE XSECTION CODES
6600B	F4	RS	P	T	I	\$HONDO, A DYNAMIC RESPONSE FINITE-ELEMENT CODE
6600B	F4	RS	P	T	T	\$FFEARS, LAPLACE EQUATION ISOTROPIC DIELECTRICS
6600B	F4	RS	P	CT	P	\$FORSIM, SOLN OF PARTIAL OR ORDINARY DIFF EQNS
6600B	F4	RS	P	X	T	\$EISPACK2, MATRIX EIGENVALUE/VECTOR PACKAGE
6600B	F4	RS	PL	T	R	\$SOLSYS, SOLAR ENERGY SYSTEM SIMULATION PROGRAM
6600C	F+COM	RS		T	P	\$LASLIB, LOS ALAMOS SUBROUTINE LIBRARY ROUTINES
6600C	F+COM	RS	P	X	T	\$MATHLIB, SANDIA MATHEMATICAL SUBROUTINES
6600C	F4	RS	P		I	\$BUCKLE, CREEP BUCKLING OF INITIALLY OVAL TUBE
6600C	F4	RS	P	T	I	\$SOR3, STRESS ANALYSIS SHELLS OF REVOLUTION
6600C	F4	RS	P	X	P	\$GEAR, ORDINARY DIFFERENTIAL EQN SYSTEM SOLVER
6600C	F4	RS	P	X	T	\$GEARB, SOLVE ODE SYSTEM WITH BANDED JACOBIAN
6600D	F+ASC	R	B	T	D	\$PDQ7, 1,2 OR 3-D FEW-GP DIFFUSION DEPLETION
6600D	F+COM	RS		T	P	\$MODEL, MODIFIED BETTIS ENVIRNMNTL LIB SCOPE3.3
6600D	F4	RS	P	T	C	\$TWOTRAN2, 2-D MULTI-GP TRANSPORT XY RZ RTHETA
6600D	F4	RS	P	X	T	\$DE/STEP,INTRP, SOLN OF ORDINARY DIFF EQUATIONS
6700B	F4	RS	P	X	T	\$EISPACK2, MATRIX EIGENVALUE/VECTOR PACKAGE
7600	F	RS	P	T	N	\$ZONE, 2-D FINITE ELEMENT MESH GENERATOR
7600	F+BAL	RS	P	X	T	\$MARLOWE, BINARY COLLISION CASCADE SIMULATION
7600	F+COM	RS		T	Q	\$BETTIS PROGRAMMING ENVIRONMENT LIBRARY
7600	F+COM	RS	P	T	C	\$RECAP-12, MONTE CARLO CRITICALITY CALCULATIONS
7600	F+COM	RS	P	T	D	\$TPT01, 2-D FEW-GROUP TRANSPORT WITH DEPLETION
7600	F+COM	RS	P	T	G	\$NALAP, LMFBR TRANSIENT RESPONSE TO ACCIDENT
7600	F+COM	RS	P	T	P	\$DUMP, USER-ORIENTED MEMORY DUMP UTILITY
7600	F+COM	RS	P	CT	G	\$BEACON/MOD2A, CONTAINMENT SYSTEM FLUID FLOW
7600	F+COM	RS	P	XCT	C	\$SYN3D, SINGLE-CHANNEL FLUX SYNTHESIS DIFFUSION
7600	F+COM	RS	P	XCT	H	\$VARR2, CRBRP 2-D TRANSIENT FLUID FLOW ANALYSIS
7600	F+COM	RS	PLXCT	T	B	\$MC+2-2, FAST NEUTRON SPECTRA & MULTIGP X-SECS
7600	F+COM	RS	PLXCT	T	B	\$DOE2.0, BUILDING ENERGY CONSUMPTION ANALYSIS
7600	F+COM	RSBPLXCT	G			\$CONTEMP4/MOD2, MULTICOMPARTMENT CONTAINMENT
7600	FTN	RS	LXCT	D		\$PDQ7, 1,2 OR 3-D FEW-GP DIFFUSION DEPLETION
7600	F4	RS	P		G	\$CEBUG, STEAM GENERATOR SODIUM-WATER REACTION
7600	F4	RS	P		G	\$NAHAMMER, FLUID HAMMER ANALYSIS PIPING SYSTEM

7600

BAPL	R598
BNL	252
BAPL	R282
SLL	795
SLA	581
BAPL	R343
BAPL	R743
SLA	612
BAPL	R557
SLA	656
NYU	816
BAPL	R411
SLA	731
SLA	758
LASL	620
HEDL	700
HEDL	785
KAPL	R404
BNW	241
BNW	770
LASL	720
WAPD	437
ORNL	502
BAPL	478
SLA	693
ANL	610
KAPL	R299
BAPL	R462
KAPL	R403
KAPL	406
KAPL	407
KAPL	386
RFD	450
SLA	623
BNL	384
BNL	475
BNL	638
BNL	504
BAPL	R412
BNL	465
SLA	672
SLA	577
CRNL	514
ANL	534
SLA	692
LASL	633
SLA	654
BNW	667
KAPL	R 80
LLL	592
LLL	661
BCSS	R275
CDC	478
LASL	358
SLA	640
ANL	534
LLL	765
ORNL	680
BAPL	R665
BAPL	R670
BAPL	R669
BNL	780
BKY	698
EG&G	767
ANL	713
WARD	755
ANL	355
BKY	782
EG&G	818
EG&G	R275
CEND	548
ANL	717

7600				99-GP		
7600	F4	RS P	H	\$SOLA-ICE, TRANSIENT COMPRESSIBLE FLUID FL	LASL	723
7600	F4	RS P	I	\$IMPAC2, B SHIPPING CONTAINER IMPACT ANALYSIS	LASL	715
7600	F4	RS P	P	\$EXPALS, LEAST SQUARES EXPONENTIAL DECAY CURVES	LLL	321
7600	F4	RS P	P	\$PDEONE, SOLUTIONS OF PARTIAL DIFFERENTIAL EQNS	LLL	777
7600	F4	RS P	P	\$SOERP, SECOND-ORDER ERROR PROPAGATION CODE	EG&G	764
7600	F4	RS P	T B	\$ETOG3, ENDF/B TO MUFT, GAM, ANISN X-SEC FORMAT	WAPD	538
7600	F4	RS P	T B	\$ETOT2, THERMAL LIBRARIES FROM ENDF/B DATA	WAPD	509
7600	F4	RS P	T B	\$ETOT3, ENDF/B V3 DATA TO THERMAL LIBRARY FORM	WAPD	628
7600	F4	RS P	T B	\$LINEAR,SIGMA1, LINEARIZE & BROADEN ENDF/B DATA	LLL	747
7600	F4	RS P	T C	\$FLARE, 3-D REACTIVITY AND POWER DISTRIBUTION	AINS	167
7600	F4	RS P	T C	\$TRIDENT, 2D MULTIGP TRANSPORT TRIANGULAR MESH	LASL	741
7600	F4	RS P	T C	\$TRIPLT, 2-D TRIANGULAR MESH TRANSPORT PROGRAM	LASL	608
7600	F4	RS P	T C	\$TWOTRAN-PNVW, 2-D PARTICLE TRANSPORT XY RZ RTH	LASL	573
7600	F4	RS P	T F	\$HEMP, HYDRODYNAMIC ELASTICMAGNETO PLASTIC	LLL	775
7600	F4	RS P	T F	\$TIMEX, 1-D TIME-DEP MULTIGP DISCRETE ORDINATES	LASL	756
7600	F4	RS P	T G	\$FLASH6, FULLY-IMPLICIT TRANSIENT SIMULATION	BAPL	R448
7600	F4	RS P	T G	\$RELAP3B/MOD110, REACTOR SYSTEM TRANSIENT CODE	BNL	733
7600	F4	RS P	T H	\$BEHAVE-SST, OVERPOWER TRANSIENT FUEL MECHANICS	FBRD	768
7600	F4	RS P	T H	\$COMPARE-MOD1, TRANSIENT FLOW W/SINKS & DOORS	LASL	776
7600	F4	RS P	T H	\$COMPARE, TRANSIENT FLOW IN VENTED FLUID SYSTEM	LASL	702
7600	F4	RS P	T H	\$FRAP-S3, STEADY STATE ANALYSIS OXIDE FUEL RODS	EG&G	694
7600	F4	RS P	T H	\$PACT2, COOLANT & CLADDING TEMPERATURE ANALYSIS	FBRD	S796
7600	F4	RS P	T H	\$SCHAFF, HEAT & WATER TRANSFER IN POROUS MEDIA	BKY	802
7600	F4	RS P	T H	\$TVENT, VENTILATION SYSTEM TRANSIENT ANALYSIS	LASL	809
7600	F4	RS P	T H	\$WASP2, WATER PROPERTIES FOR SAFETY ANALYSIS	BAPL	R396
7600	F4	RS P	T I	\$LIFE3, MIXED-OXIDE FUEL ELEMENT PERFORMANCE	ANL	R460
7600	F4	RS P	T I	\$SEALSHL2, SHELL STRESS ANALYSIS AXISYM LOAD	WTSC	R282
7600	F4	RS P	T K	\$DEMO4, CRBR REACTOR & PLANT TRANSIENT ANALYSIS	WARD	R676
7600	F4	RS P	T K	\$SPARK1, NUCLEAR REACTOR POWER PLANT ANALYSIS	BAPL	R743
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