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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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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
AEG-ALO FAU, RADIO FREQUENCY MANAGEMENT SYSTEM	ALOO 360 COBOL RS P M 587
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AIN6, 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
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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
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ANDLIBF, ARGONNE SUBROUTINE LIBRARY CAT. F	ANL 360B F+BAL RS T P 563
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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
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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 RSBP CT L 594
ARSTEC, NONLINEAR MIXED INTEGER OPTIMIZATION	EG&G 360 F4 RS P P 738
ASPI5, 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
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BEHAVE2, OXIDE FUEL PERFORMANCE FINITE-ELEMENT	FBRD	635	F4	RS	P	CT I	R568
BESFIT, DIFFRACTION MODEL ELASTIC SCAT X-SEC	BNL	6600	F4	RS	P	A	524
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BETTIS PROGRAMMING ENVIRONMENT LIBRARY	BAPL	6600	F+COM	RS		T P	R665
BETTY, ENTRAINMENT 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
BH99, EXTREME VALUE DISTRIBUTION DATA ANALYSIS	BAPL	6600	F4	RS	P	P	R621
BIOSSIN, BIOCHEMICAL KINETIC SIMULATION SYSTEM	CUPI	370	F+BAL	RS	P	CT U	736
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BISYN, 2-D MULTI-GP DIFFUSION SYNTHESIS CALC	NED	1108	F4	RS	P	T C	287
BLAST, REACTOR KINETICS TEMPERATURE DIST STUDY	AEB	360	F4	RS	P	E	363
BLOOSTS, COMBINED KINETICS 2-D HEAT TRANSFER	GGA	1108	F+BAL	RS	P	T E	303
BL47, DRAFTING TOOL TO PLOT PLANE STRUCTURES	BAPL	6600	F4	RS	P	L	R373
BOIL1, BOILOFF-ACCIDENT CORE HEATUP & MELTDOWN	BCL	6400	F4	RS	P	G	734
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
BUOTRI, 2D MULTIGP DIFFUSION & BURNUP TRI-MESH	GGA	1108	F+BAL	RS	P	T D	439
BUG2, 2-D MULTIGROUP DIFFUSION & BURNUP XY, R2	GGA	1108	F+BAL	RS	P	T D	438
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CINDER, M0102, POINT DEPLETION FISSION PRODUCT	BAPL	6600	F4	RS	P	D	313
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COMCAN, SYSTEM SAFETY COMMON CAUSE ANALYSIS	EG&G	360	F+BAL	RS	P	T G	704
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MOST, A MULTIDIMENSIONAL OPTIMIZATION SCHEME	KAPL	6600	F4	RS	P P	R446
MOXY/MOD032, BWR CORE HEAT TRANSFER CODE	EG&G	360B	F4	RSBP	XCT H	551
MSCAT, SLOW NEUTRON MULTIPLE SCATTERING CALC	ANL	360	F4	RS	P CT W	575
MSF21,VTE21, DESALINATION PLANT OPTIMIZATION	ORNL	360	F+BAL	RS	P T D	798
MTRC0001, SI METRIC TO U.S. CUSTOMARY UNITS	NLMO	360	F4	RS	P XC P	812
MUCHA1,MUCHA2, MULTIPLE CHANNEL ANALYSIS ECC	BCL	6400	F4	RS	P X T G	508
MULT1, MULTI-LEVEL RESONANCE THEORY XSEC CALC	KAPL	6600	F4	RS	P A	R535
MUSCAT, VIEW FACTOR SHIELDING CODE CAVITY GEOM	GGA	1108	F4	RS	P T J	259
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	R288
M0555,ACT1, LOSS-OF-COOLANT ACCIDENT ANALYSIS	BAPL	6600	F4	RS	P T G	R284
M0648, 1-D SLAB TRANSPORT WITH SLOWING DOWN	BAPL	6600	F4	RS	C	R342
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
M0807, 2-D DIFFUSION ABSORPTION-REMOVAL X-SECS	BAPL	6600	F4	RS	B	R280
M0899,NOH, STEAM TABLES 14.5-2538 PSIA	BAPL	6600	F4	RS	P H	R294
NAHAMMER, FLUID HAMMER ANALYSIS PIPING SYSTEM	ANL	360	F4	RS	P G	717
NAHAMMER, FLUID HAMMER ANALYSIS PIPING SYSTEM	ANL	7600	F4	RS	P G	717
NA1A0, COMPRESSIBLE 2-PHASE COOLANT BEHAVIOR	AAEC	360	F+BAL	RSBP	LXCT G	726
NALAP, LMFBR TRANSIENT RESPONSE TO ACCIDENT	BNL	7600	F+COM	RS	P T G	780
NATRANSIENT, FLUID HAMMER ANALYSIS 1-D PIPING	ANL	360	F4	RS	P G	718
NATRA2, FLUID HAMMER ANALYSIS 1D & 2D SYSTEMS	ANL	360	F4	RS	P T G	719
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
NOWIG, 1-D 2-GP KINETICS TEMPERATURE FEEDBACK	BAPL	6600	F4	RS	P F	R371
NPRFCOP, FUEL CYCLE COSTS PERFORMANCE DATA	UEC	6600	F4	RS	P D	146
NPRFCOP, FUEL CYCLE COSTS PERFORMANCE DATA	ANL	360	F4	RS	P D	146
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
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
OCOPTH, DRYOCR, UNCONSTRAINED OPTIMIZATION	ANL	360	F4	RS	P T P	753
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
OPTRN, 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
ORRIBLE, ROD BUNDLE FLOW & TEMPERATURE DIST.	ORNL	360	F4	RS	P T H	629
ORSIM, OPTIMIZING UTILITY GENERATION PLANNING	ORNL	360	F+BAL	RS	P X T D	699
ORTHIS,ORHEAT, 2-DIMENSIONAL HEAT CONDUCTION	ORNL	360	F4	RS	P X T H	525
PACTOLUS,CLOTHO, NUCLEAR POWER PLANT COST CODE	WEDL	1108	F5	RS	P X T D	540
PACT2, COOLANT & CLADDING TEMPERATURE ANALYSIS	FBRD	7600	F4	RS	P T H	\$796
PARET, WATER-COOLED CORE TRANSIENT ANALYSIS	EG&G	360	F+BAL	RSBP	LXCT G	555
PARK1, NUCLEAR REACTOR POWER PLANT ANALYSIS	BAPL	6600	F4	RS	P T K	R743
PARK1, NUCLEAR REACTOR POWER PLANT ANALYSIS	BAPL	7600	F4	RS	P T K	R743
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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
PDQ7, 1,2 OR 3-D FEW-GP DIFFUSION DEPLETION	EG&G	7600	FTN	RS	LXCT D	R275
PDQ7, 1,2 OR 3-D FEW-GP DIFFUSION DEPLETION	EG&G	360G	F+BAL	RSBP	XCT D	R275

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REXCO-H2, 2-D HYDRODYNAM RESPONSE TO EXCURSION	ANL	360	F4	RS P CT F		R615
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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
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R102, SPACE-INDEPENDENT INVERSE KINETICS CALC	ANL	360	F4	RS P E		168
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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
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SAFE-3D, 3-D COMPOSITE STRUCTURE STRESS STUDY	ORNL	360	F+BAL	RS P T I		332
SAFE-3D, 3-D COMPOSITE STRUCTURE STRESS STUDY	GGA	1108	F4	RS P T I		332
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SAFTAC, MONTE CARLO FAULT TREE SIMULATION CODE	UNI	1108	F+SLE	RS P G		674
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SASIA, FAST REACTOR POWER AND FLOW TRANSIENTS	ANL	6600	F4	RS P T F		400
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SEALSHL2, SHELL STRESS ANALYSIS AXISYM LOAD	SR	360	F4	RS P T I		R282
SEALSHL2, SHELL STRESS ANALYSIS AXISYM LOAD	BAPL	6600	F4	RS P T I		R282
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SITE2, ENERGY FACILITY SITING ASSESSMENT	ANL	360	F4	RS P T R		687
SIZZLE, 1-D MULTIGROUP DIFFUSION DEPLETION	AI	360	F4	RSBP X T D		58
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SNEQ, NONLINEAR ALGEBRAIC EQN SOLN CURVE PLOT	KAPL	6600	F+ASC	RS P T P		R364
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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
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SYN, 2D SYNTHESIS MULTIGP DIFF & IGP DEPLETION	NED	635	F+GMP	RS	P	T	D			495
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TRIPLET, 2-D TRIANGULAR MESH TRANSPORT PROGRAM	LASL	360	F4	RSBP	CT C	608
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TROUT, MUG MULTIGROUP XSEC LIBRARY MAINTENANCE	NED	1108	F5	RS P	T H	493
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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
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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
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WHAM6, LIQUID-FILLED PIPING SYSTEM ANALYSIS	ANL	7600B	F4	RS P	T Q	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-MPT 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
IDX, 1-D DIFFUSION FAST X-SECTION GENERATION	ANL	360	F+BAL	RSBP	XCT B	374
IDX, 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,DEPS, 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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NATIONAL ENERGY SOFTWARE CENTER: COMPILATION OF PROGRAM ABSTRACTS

by

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PREFACE

As originally published ANL-7411 was the second complete revision of program abstracts undertaken by the Center. This edition is the third. As programs for machines of the 704 era and earlier were deleted with the initial edition, programs of the IBM 7040, 7090, and CDC 3600 vintage have been removed with this revision. In addition, other changes will be evident including use of current computer technology to provide a more legible abstract, modifications required by the change in the Center's name, and the introduction of another information item, the sponsor, to the abstract format.

The table of contents of the report lists the current software collection in accession order, giving for each the KWIC-title of the package, the Center identification of the contributing installation, the computer and programming language used, symbols representative of the package contents, and the subject category of the program. The package contents symbols are defined as follows:

- R = traditional hard-copy documentation or reference material,
- S = compiler and assembly language source decks or tape records,
- B = object decks or load modules,
- P = sample problem input and output data,
- L = library information or external data files, e.g., cross-section libraries, steam table or material properties data,
- X = auxiliary routines or machine-readable information,
- C = operating system control language records,

with the presence of the character T indicating that magnetic tape(s) are necessary for transmittal of the computer-medium portion of the program package.

This collection includes programs in which the program number is preceded by the letter *R*, *G*, or *S*. The letter *R* denotes *restricted*, and U. S. citizens are required to file a release form with the Center for use of the program on either official U. S. government or commercial (nonmilitary) applications at a U. S. installation. The letter *G* designates programs which are limited to use on U. S. *government* contracts only. In addition to the release form requirement, the contract identification and the signature of the contracting officer must be furnished when requesting such programs. The Software Center is not authorized to distribute these programs outside the

United States. The letter *S* is used to identify packages which are distributed to a *special* list of designated recipients only.

Abstracts for the OECD Nuclear Energy Agency Data Bank programs in the National Energy Software Center collection are not included in this compilation.

I. HISTORY AND ACKNOWLEDGMENTS

In 1956, at the Second Annual Meeting of the American Nuclear Society, the initial meeting of an informal group called the Nuclear Codes Group was held. This group was composed of "persons interested in the development and use of computer programs for reactor design." The group held regular meetings in conjunction with the semiannual ANS meetings and published and distributed a Newsletter containing code abstracts submitted by members. These abstracts followed the format of the Atomic Energy Commission document AECU-3078, *A Bibliography of Available Digital Computer Codes for Nuclear Reactor Problems*.¹

From September 1956 to December 1959, ten Newsletters were published and distributed through the auspices of the AEC Computing Facility at New York University.² In 1959, Ward Sangren and personnel at General Atomics edited and published 300 abstracts collected from Group members.³ A supplementary list of 100 abstracts was published the following year.⁴

In 1959 also, the Nuclear Codes Group became the nucleus of the American Nuclear Society's Mathematics and Computation Division. With stature came a desire for a central facility for the computer program library and the dissemination of information concerning programs written in the areas of nuclear physics, reactor design, and engineering. In 1960, a proposal was made whereby, with the cooperation of Division members and Installation Representatives, and the Atomic Energy Commission's approval, Argonne National Laboratory undertook to serve as this central agency and the Argonne Code Center was established.

Procedures were drafted defining the material to be collected--the abstract and the "package"--and the responsibilities of the Center and of the Installation Representatives. The submission of the material was made the responsibility of the authors, the developing organization, or the sponsor, either directly or through their designated Installation Representative. The Center was made responsible for editing and publishing the abstracts, and collecting, testing, maintaining, and distributing the packages. The representatives of registered installations--AEC laboratories, contractors, and universities--were to serve as a source of information to personnel at their organization concerning the Center operation and collection, and made responsible for library programs at their installation. In addition, they were asked to provide information to the Center concerning software or requests originating at their installation and, in collaboration with Center staff, to supply the answers to the questions and inquiries received concerning the software developed at their installation.

In 1965 the Argonne Center became a separately-budgeted operation of the Reactor Physics Branch of the USAEC Division of Reactor Development and Tech-

nology. In September of 1972 the Argonne Code Center was designated as the AEC-wide computer program exchange and information center responsible for the dissemination of unclassified computer programs developed with AEC funds. The scope of the agency program was broadened later with the transfer from AEC to ERDA and then to the Department of Energy. The name was changed to National Energy Software Center in July of 1978 to more adequately reflect the present program and current computing terminology.

From 1961 until issuance of the first edition of ANL-7411 in January 1968, the Argonne Code Center published 12 distributions containing abstracts of approximately 265 programs.* The ANL-7411 collection represented a complete revision of those previously published abstracts. This compilation represents the current NESC collection.

In August 1976 in accordance with the recommendations of an ERDA Headquarters Task Force on Information Center pricing, the Center implemented a pricing policy. Under this policy the Center's information and distribution services are offered to registered installations. Organizations qualify as registered installations in either of two ways, as waiver-list installations or as subscription-fee installations.

Installations sponsored by agencies funding the Center program, those designated by other government agencies or computer software information centers with whom exchange arrangements exist, or others recognized as contributors to the Center program, are waiver-list establishments and receive Center services without charge.

Establishments not eligible for inclusion on the waiver list may subscribe to the Center program to obtain information and distribution services; such organizations are subscription-fee installations and pay the cost of services requested.

II. ABSTRACT FORMAT

The program abstract has been modified considerably over the years. Its evolution from the original AECU-3078 format is due primarily to our experience at the Center and cooperative efforts undertaken with the NEA library personnel and the American Nuclear Society's ANS-10 subcommittee membership.* At the present time an ANSI X3 Technical Committee, X3K7, is working on the development of an American National Standard for a Computer Program Abstract.

1. Name or Designation of Program

This is the name or designation given the program(s) by the author.

2. Computer for Which Program is Designed and Other Machine Version Packages Available

The computer hardware system for which the program or system was prepared is identified, and names of other computers for which versions are available are listed.

3. Description of Problem or Function

A brief description of the problem being solved or a definition of the data processing activity being carried out is given.

4. Method of Solution

A short summary of the mathematical methods employed, numerical algorithms adopted, or procedures incorporated in the program should appear under this entry.

5. Restrictions on the Complexity of the Problem

This item includes restrictions implied by storage allocation, such as maximum number of energy groups and mesh points, as well as those due to approximations used, such as implied argument-range limitations, etc.

6. Typical Running Time

Information intended to enable the user to estimate machine time requirements is listed.

7. Unusual Features of the Program

Distinguishing features and special capabilities of the program are enumerated. Information given under this item should allow the user to select, from a number of similar programs, the one most suitable for his particular problem.

8. Related and Auxiliary Programs

If this program supersedes or is an extension of an earlier program, this is noted here. Programs used in conjunction with this program, e.g., for preparing input data, plotting results, or coupled through use of external data files, are identified.

9. Status

The Center lists here the initial date of publication of the abstract. Machine versions in the library are identified and the date they were submitted is given. If this accession number has been used for a number of editions of the program, a chronology of the various editions is included. The most recent testing completed at the Center is noted.

10. References

Available publications pertinent to the program are cited. All hardcopy documentation included in the program package is listed.

11. Machine Requirements

This item lists the hardware components essential for full utilization of the program, including the amount of memory required to execute the program.

12. Programming Language(s) Used

The programming language or languages in which the program was written are identified with an indication of the percentage of each used.

13. Operating System under Which Program Is Executed

This item identifies the operating system, associated subroutine or function library, and installation support software used by the program. The version used is identified and deviations or exceptions noted.

14. Other Programming or Operating Information or Restrictions

Additional information needed by the reader to implement the program or determine the extent of the necessary implementation effort is summarized. If certain routines are in assembly rather than compiler language, these are noted.

15. Name and Establishment of Author

The names and addresses of the authors of the program and of other machine versions or editions are listed. If the author is no longer responsible for the program, the person to be contacted should be listed, as well.

16. Material Available

This lists the material being distributed, i.e., the contents of the program package.

17. Category

The subject classification assigned from the Center program or system classification guide.

Keywords

This is a listing of the keywords associated with the program, supplied by the program author and/or Center based on the Center thesaurus.

18. Sponsor

This is the name of the program office or division and the agency responsible for funding the software development effort.

III. RECOMMENDED PROGRAM PACKAGE CONTENTS

The "program package" is defined as the aggregate of all elements required for use of the software by another organization, or its implementation in a different computer environment. It is intended to include all material, associated with a computer program, necessary for its modification and effective use by individuals other than the author, on a computer system different from the one on which it was developed.

The material consists basically of two components--the computer-media material, and the traditional printed material or hard-copy documentation. The material required may include all of the following:

1. Source Decks (S)

Compiler and assembly language program decks or card-image tape records.

2. Run Decks (B)

Object decks or load modules prepared by the language processors preliminary to execution of the software. If source decks cannot be distributed for proprietary or other reasons, run decks may be substituted for interchange between users of like systems. This element provides redundancy when included in conjunction with the equivalent source material.

3. Sample Problems (P)

Test case input data decks or tape records together with output generated during problem execution, for use in checking out program implementation.

4. Data Libraries (L)

External data files required for program operation, e.g., cross-section libraries, steam table or material properties data. It is preferable for exchange purposes to use decimal form for numerical data files.

5. Control Information (C)

Operating system control language records required for compilation or assembly of the program and execution of the sample problems. This information includes device assignments, format information, storage allocation, overlay structure definitions, etc.

6. Auxiliary Information (X)

Program package items for subsidiary programs used in preparing input information, processing results, maintaining data libraries, etc., for the program. Machine-readable documentation, when available.

7. Documentation (R)

The traditional documentation associated with the computer program and its application. This material may be compiled in a single comprehensive report or it may exist as several independent documents--published paper reprints, program reports, user's manuals, program maintenance manuals, installation memoranda, computer output listings, etc. It may, regardless of form, include all of the following:

a. Problem definition or function description

Information providing the *raison d'être* for the computer program or system, a description of the problem solved or of the processing performed. A description of the mathematical model used and the computational algorithms and techniques employed should be included.

b. *Application information*

Documentation directed to the program user, i.e., a User's Manual, if a separate publication. Operating instructions, program options, and a description of the input and output formats should be covered in sufficient detail to enable the user to specify his own problem and interpret the results correctly. An example is helpful; if the identical sample problem of item 3 is used, the selected output for it can be shown in this document; otherwise, it is essential to include a copy of the computer output obtained from execution of the sample problem in the program package.

c. *Programming information*

A detailed description of the program addressed to the programmer responsible for maintenance or transfer of the program; i.e., a Program Maintenance Manual, if a separate publication. Material covered should include the overall program structure and logic, identification of subprograms and detailed information on their use, glossaries showing the relationship between problem variables and program symbols, definitions of external data files, system hardware and software requirements, shared storage assignments, overlay or segment structures, and system-dependent programming considerations.

d. *Installation environment information*

A description of the environment in which the program was developed and installation support facilities utilized such as installation-dependent library routines for mathematical functions, plotting, microfilm recording and the like. It is recommended that general Installation Environment Reports issued by individuals responsible for the computer environment at the program-originating installation be utilized for this part of the program documentation. Such documents can greatly simplify the preparation of portable program packages and facilitate effective program exchange.

Program package items 1 through 6 are most effectively maintained and transmitted in punched card or magnetic tape form; item 7 as printed material. If a large quantity of sample problem output (item 3) is generated, selected hard-copy portions plus the complete output listing on microfiche or magnetic tape may be appropriate. Data libraries (item 4) are often computer-generated and exist only on tape. Control information (item 5) may, alternatively, be supplied as a computer output listing since this information is rarely identical at different installations.

IV. SUBJECT CLASSIFICATION GUIDE

The classification scheme is intended to serve as a guide to those library programs dealing with the solution of a specific physical problem or area of related problems. The category listed in Abstract Item 17 is selected from the Subject Classification Guide by the author of the program and/or abstract or assigned by the Center staff.

A. Cross Section and Resonance Integral Calculations

Computation of reaction cross sections from nuclear theory such as the optical or Hauser-Feshbach models, resonance cross sections by Breit-Wigner or multilevel theory, determination of differential, scattering cross sections, cross-section evaluation, and compilation programs.

B. Spectrum Calculations, Generation of Group Constants, Lattice and Cell Problems

Determination of the slowing-down density or thermal spectrum, weighting and averaging of cross sections and related quantities for the production of group constants, and evaluation of design parameters by lattice and cell calculation.

C. Static Design Studies

Calculation of the reactivity and flux distribution of the reactor system, and adjustment of design parameters to prescribed specifications, i.e., criticality and power distribution search procedures.

D. Depletion, Fuel Management, Cost Analysis, and Power Plant Economics

Includes burnup programs, isotope and fission-product buildup and decay computations, and optimization studies.

E. Space-Independent Kinetics

Studies of the time-behavior of reactors, including delayed-neutron effects and feedback mechanisms, and transfer-function evaluation.

F. Space-Time Kinetics, Coupled Neutronics-Hydrodynamics-Thermodynamics and Excursion Simulations

Programs that consider spatial design characteristics and accompanying effects in studying the time behavior of the reactor.

G. Radiological Safety, Hazard and Accident Analysis

Calculation of internal and external dose rates, determination of reactor thermodynamic and hydrodynamic properties following an accident, e.g., release of radioactive materials, coolant system blowdown, steam generator rupture.

H. Heat Transfer and Fluid Flow

Steady-state and transient heat transfer computations, fluid-flow studies and calculations of thermodynamic properties.

I. Deformation and Stress Distribution Computations, Structural Analysis, and Engineering Design Studies

Includes fuel-element design evaluations, core-configuration studies, and composite structure analysis.

J. Gamma Heating and Shield Design

Gamma and photon transport calculations, computation of heat-generation rates, and penetration analysis and leakage calculations for shielding.

K. Reactor Systems Analysis

Combinations of programs, designed as systems, for solving correlated problems from several of the categories A through I.

L. Data Preparation

Generation of program parameters--checking, editing, and formatting of problem input information.

M. Data Management

Construction, maintenance, and retrieval of data files, e.g., cross section libraries, management systems such as payroll, personnel, and financial systems, property and equipment systems, network-oriented project management and indexing and retrieval systems, etc.

N. Subsidiary Calculations

Plotting, editing, and display routines that process output data from other programs.

O. Experimental Data Processing

Programs designed to process data directly acquired from an experimental situation or to assist the experimenter in the design of the experiment.

P. General Mathematical and Computing System Routines

Calculation of mathematical functions, statistical analysis, special-language routines with general data-processing capabilities, and software systems.

Q. Materials

Measurements and computation of the physical and mechanical properties of materials, simulation of radiation damage processes, corrosion studies, and determination of crystallographic functions.

R. Environmental and Earth Sciences

Environmental impact studies, geology, seismology, geophysics calculations, hydrology and ground water studies, bioenvironmental systems analyses, meteorological calculations relating to the atmosphere and its phenomena, studies of airborne particulate matter, climatology, etc.

S. Space Sciences

Analysis of orbits and trajectories, astronomy and astrophysics computations, wave propagation studies, and the calculation of reentry parameters.

T. Electronics, Engineering Equipment, and Energy Systems Studies

Automated design of electronic equipment, computer-aided design (CAD) and manufacturing (CAM), process control programs, systems analysis, and engineering computations for numerically controlled machine tools and energy consumption analysis in buildings, industry, and transportation.

U. Chemistry

Chemical analysis, mass spectroscopy, radiation chemistry, radiolysis studies, etc.

V. Particle Accelerators and High Voltage Machines

Programs relating to the design, development and operation of high-voltage machines and particle accelerators such as Van de Graaff generators, linear accelerators, cyclotrons, synchrotrons, etc.

W. Physics

Calculations relating to theory of atomic or molecular structure or properties, charged particle collision studies that involve phenomena such as charge exchange, excitation, ionization, dissociation, etc., elementary particle theories and models, scattering theory, quantum field theory and quantum electrodynamics studies, general relativity and gravitation theory computations.

X. Magnetic Fusion Research

Electric discharge phenomena and plasma physics computations, electrodynamics and magnetic hydrodynamics studies.

Y. Biology and Medicine

Biological, medical and radiological studies of the structure, functions, chemistry, biophysics, reproduction, and heredity of bacteria, plants, laboratory animals, and humans.

Z. Data

Data prepared in specified program formats for program testing and evaluation, benchmark studies, or library use.

V. THESAURUS

A thesaurus has been prepared as a basis for the assignment of keywords to the library programs. The keywords are taken from the Energy Data Base Subject Thesaurus' insofar as practicable. Accepted keywords not listed in the thesaurus include the names or acronyms identifying computer programs and reactors; these are always followed by the word "codes" or "reactors", e.g., AITP3 codes, HTGR reactors. Also accepted but not included in the thesaurus are element names and combinations of an element name and a mass number, e.g., hydrogen, uranium-235.

absorption	burnup	creep
abstracts	calorimetry	critical heat flux
accelerators	capital	criticality
accidents	capture	criticality searches
activated carbon	cavities	cross sections
activation analysis	CCCC	crystal lattices
Adams method	cell calculation	crystals
adaptive random search method	centrifugal contactors	cutting
adsorption	charged-particle transport	cylinders
advection	charges	damping
aerosols	chemical effluents	Dancoff correction
agglomeration	chemical lasers	data
air cleaning	chemical reactions	data acquisition
air conditioning	cladding	data analysis
air pollution	coal-fired MHD generators	data base systems
Airy functions	Cohen equation	data processing
algorithms	collisions	data transmission
angular distribution	collocation method	daughter products
ammonia	combustion kinetics	decay
ammonium sulfates	combustion products	decontamination
anisotropic scattering	combustors	deformation
anisotropy	comparative evaluations	delayed neutron precursors
annular space	compound nuclei	delayed neutrons
antennas	compressible flow	depletion
aspect ratio	computer aided design	deposition
assembler	computer graphics	desalination
atmospheric precipitations	computer networks	design
availability	computer output devices	design basis accidents
averages	computers	devolatilization
background radiation	concretes	diagnostic techniques
banded matrix	configuration	diagrams
bandwidth minimization	construction	dielectric materials
BASIC	containers	difference equations
beam dynamics	containment	differential equations
beam transport	containment systems	diffraction models
beams	control	diffusers
bending	control elements	diffusion
Bessel functions	control rod worths	diffusion equations
binary-fluid systems	control systems	Dirichlet problem
biochemistry	convection	disadvantage factor
BL method	coolant boiloff	discrete ordinate method
blowdown	coolant loops	dispersions
boilers	coolants	distance
Boltzmann statistics	cooling load	distribution
boundary conditions	coordinates	distribution functions
boundary-value problems	copper	Doppler broadening
Boussinesq approximation	core flooding systems	Doppler coefficient
breeding	correlation functions	dose rates
Breit-Wigner formula	correlations	doses
bubble growth	cost	dosimeters
buckling	counter current	drift tubes
buildings	coupled channel theory	droplets
buildup	cracking	ducts

dynamic loads	flexibility	incoherent scattering
earth atmosphere	flow blockage	incompressible flow
economic analysis	flow models	indexes
economics	flow rate	inelastic scattering
eigenvalues	fluctuations	information retrieval
eigenvectors	fluid flow	information systems
elastic scattering	fluid mechanics	initial-value problems
elasticity	flux synthesis	inspection
electric power	foliar uptake	integrals
electric utilities	forecasting	interactive computing
electricity	forests	interfaces
electrodes	FORTRAN	interpolation
electromagnetic radiation	fossil-fuel power plants	inventories
electron beams	Fourier transformation	investment
electron multipliers	fracture properties	ion beams
electron spectra	fuel assemblies	ion exchange
electronic circuits	fuel cans	ion implantation
electrons	fuel cycle	isothermal processes
elementary functions	fuel element clusters	isotope production
elements	fuel elements	isotopes
emergency plan	fuel management	iterative methods
emission spectra	fuel pellets	kernels
ENDF/B	fuel rods	kinetics
energy	fuel-cladding interaction	klystrons
energy analysis	fuel-coolant interactions	Lagrange equations
energy consumption	fuels	land pollution
energy demand	fusion reactions	Laplace equation
energy transfer	gamma function	lattice vibrations
engineered safety systems	gamma radiation	lead
engineering	gamma spectra	leaks
enrichment	gaseous wastes	least square fit
enthalpy	gases	Legendre polynomials
environment	Gauss function	lenses
environmental effects	gears	Li-drifted Ge detectors
environmental impacts	geometry	libraries
environmental transport	geothermal energy	life-cycle cost
epithermal neutrons	geothermal power plants	lifetime
equations	geothermal systems	lighting systems
equations of motion	gloveboxes	liquid metals
equations of state	gloves	liquids
equipment	ground water	LOCA
erosion	group constants	log gamma function
error function	group theory	LWR reactors
errors	Kauser-Feshbach theory	magnetic disks
evaporators	KODA	magnetic fields
excursions	health hazards	magnetic flux
expansion	heat	magnets
experiment planning	heat distribution systems	maintenance
fabrication	heat exchangers	management
failures	heat flow	manufacturing
fast fission factor	heat transfer	Markov process
fast neutrons	heating	mass balance
fatigue	heating load	mass spectrometers
fault tree analysis	heavy water	mass transfer
feedback	hexagonal configuration	materials testing
few-group	hexagonal lattices	mathematical logic
films	hot pressing	matrices
filters	hot springs	maximum-likelihood fit
finite difference method	hydraulics	mechanical properties
finite element method	hydrodynamics	mechanical structures
fires	hydroelectric power plants	mechanical vibrations
fission	hydrology	mechanics
fission products	hydrothermal systems	melt-down
fission spectra	ice condensers	melting
flanges	ICE method	mesh generation
flash heating	impact shock	meteorology

metric system	phase transformations	reactor cooling systems
NHD channels	phonons	reactor core restraints
microhardness	photographic films	reactor cores
microprocessors	photomultipliers	reactor kinetics
mixer-settlers	pipe fittings	reactor lattices
mobile homes	pipe joints	reactor noise
moderators	pipes	reactor operation
moisture	PL method	reactor period
molecules	planning	reactor safety
molten metal-water reactions	plants	reactor stability
moment of inertia	plasma	regional analysis
monitoring	plasma seeding	Reich-Moore formula
Monte Carlo method	plasticity	reliability
motors	plates	reprocessing
multi-channel analysers	plotters	resolution
multigroup	plumes	resonance
multigroup theory	point kernels	resonance absorption
multilevel analysis	point sources	resonance escape probability
multiplication factors	poisoning	resonance integrals
multivariate analysis	Poisson equation	resonance scattering
natural convection	polarization	rod bundles
Navier-Stokes equation	pollution	rod drop method
network analysis	polynomials	roofs
neutron age	porosity	root absorption
neutron diffusion equation	porous materials	ruptures
neutron flux	Porter-Thomas distribution	s matrix
neutron reactions	potential flow	safety
neutron spectra	potential scattering	sampling
neutron transport theory	power distribution	scattering
neutrons	power generation	scattering law
nitric acid	power plants	SCISRS
nonlinear problems	power-cooling-mismatch accidents	seawater
nonlinear programming	present worth method	secondary emission
nuclear cascades	pressure	sediments
nuclear engineering	pressure dependence	self-shielding
nuclear facilities	pressure gradients	sensitivity
nuclear fuels	pressure vessels	series expansion
nuclear materials management	probability	shear
nuclear models	processing	shells
nuclear power plants	procurement	shielding
nuclear properties	production	shields
nuclear reaction yield	programming	SI units
numerical solution	programming languages	simulation
one-dimensional	prompt neutrons	site selection
one-group theory	pulsed neutron techniques	slabs
open-cycle NHD generators	pumps	slags
operating systems	Purex process	slowing-down
operation	quadratures	soils
optical models	quality control	solar air conditioning
optimization	r matrix	solar energy
ordinary differential equations	r-theta	solar power plants
orthogonal transformation	r-theta-z	solar radiation
oxidation	r-z	solar space heating
partial differential equations	radiation effects	solid state physics
particle interactions	radio equipment	solids
particle size	radioactive aerosols	solutions
particles	radioactive clouds	solvent extraction
pattern recognition	radioactivity	Sommerfeld integrals
PDP computers	radioactivity transport	sorting
performance	radioisotopes	space dependence
performance testing	randomness	space heating
personnel	rankine cycle power systems	space-time
PERT method	reaction kinetics	special functions
perturbation theory	reactivity	specifications
ph value	reactivity insertions	spectra
phase space	reactor channels	spectral density

spectrometers
 spheres
 spherical harmonics
 sprays
 standardization
 standards
 static loads
 statistical models
 statistics
 steady flow
 steady-state conditions
 steam
 steam generators
 stochastic processes
 storage
 strains
 streams
 stress analysis
 stress relaxation
 stresses
 structured programming
 subsonic flow
 sulfates
 sulfites
 sulfur dioxide
 surface air
 surface waters
 swelling
 synthesis
 system failure analysis
 systems analysis
 temperature
 temperature coefficient

temperature dependence
 temperature distribution
 temperature feedback
 temperature gradients
 testing
 thermal analysis
 thermal conduction
 thermal conductivity
 thermal expansion
 thermal neutrons
 thermal radiation
 thermal stresses
 thermal utilization
 thermalization
 thermodynamic properties
 thermodynamics
 thermonuclear reactions
 Thorex process
 three-dimensional
 time dependence
 tornadoes
 toroidal configuration
 total energy systems
 trace amounts
 transfer functions
 transients
 translators
 transport theory
 trapping
 triangular configuration
 triangular-2
 tritium
 tubes

turbines
 turbulence
 turbulent flow
 two-dimensional
 two-group
 two-phase flow
 urban areas
 utility routines
 vapors
 variations
 velocity
 ventilation
 ventilation systems
 viscosity
 viscous flow
 vortex flow
 walls
 water
 water pollution
 water quality
 watersheds
 wave propagation
 weather
 Wigner-Wilkins model
 Wilkins equation
 wires
 working fluids
 x-ray diffraction
 x-y
 x-y-z
 xenon oscillations
 zircaloy

VI. ABSTRACT COLLECTION

When programs are initially entered into the Center collection, they are assigned accession numbers that are used to identify the program and its abstract. When the abstract is prepared and thereafter whenever it is modified, the month and year are inserted in the abstract heading in the format MM/YY.

1. NAME OR DESIGNATION OF PROGRAM - FIRE5
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Multigroup equations are solved by iterating on the fission source. Finite difference equations are used in multi-region problems, while a core radius may be specified for equivalent bare reactor problems with only the energy variable. Detailed thermal flux spectra may be computed using upscattering and downscattering cross sections. In computing the i th iterate of the flux, the $(i-1)$ st iterate is used to compute fission source and upscattering, and the i th iterate is used to compute downscattering. FIRE5 computes flux-weighted average values of the macroscopic cross sections which can be used as input for few-group codes. The flux distribution obtained from FIRE5 and the corresponding multigroup macroscopic cross sections are used to obtain the average values. The following few-group constants are computed for each region r and group l : macroscopic absorption cross section, modified macroscopic fission cross section, diffusion constant, macroscopic removal cross section, and flux.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
15 regions
4 collapsed groups
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - FIRE5 is an extension of the FIRE2 program.
9. STATUS - Abstract first distributed 1961
IBM704 version submitted October 1961 by LASL, deleted October 1967
IBM360 version (FIRE2) submitted December 1966, replaced by FIRE5 September 1968
10. REFERENCES - F. W. Brinkley and C. B. Mills, A One-dimensional Intermediate Reactor Computing Program, LA-2161, March 1957
F. W. Brinkley, A One-dimensional Intermediate Reactor Computing Program, LA-2161 Supplement, May 1959
W. Malan and R. Van Der Walt, FIRE-2 A One-dimensional Reactor Computing Program in FORTRAN IV for Multi-region, Multi-group Reactors, PEL 131, December 1966
FIRE-5, Preliminary PEL Report, 1968
11. MACHINE REQUIREMENTS - IBM360 Model 40G
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
O. G. P. Grosskopf
South African Atomic Energy Board

Private Bag 256
Pelindaba, Pretoria, South Africa

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (896 cards)
Library (456 cards)
Reference reports
17. CATEGORY - C
KEYWORDS - diffusion, one-dimensional, slabs, cylinders, neutron age, spheres, multigroup,
group constants, neutron flux, FIRE codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FOG
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
GE625
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
Input data must be macroscopic
Scattering is limited to the next lower group
1 to 4 energy groups are permitted
Maximum number of mesh points = 239
Maximum number of regions = 40
6. TYPICAL RUNNING TIME - A typical problem requires less than a minute
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - AIMS (NESC Abstract 29) The original IBM7090 version of FOG was prepared by H. P. Flatt of the Atomic International Mathematics and Computer Sciences Division, Canoga Park, California.
9. STATUS - Abstract first distributed February 1962
IBM7090 version submitted by AI January 1962, deleted July 1976
CDC1604 version submitted by CDC March 1964, deleted July 1976
GE625 version submitted July 1968
10. REFERENCES - H. P. Flatt, The FOG One-dimensional Diffusion Equation Codes. NAA-SR-6104, 1961
R. L. Brunnenmeyer and R. A. Mickle, FOG GE-625 Version (NE571) Users Notes, Bechtel Note, July 1968
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
R. L. Brunnenmeyer and R. A. Mickle
Bechtel Corporation
50 Beale Street
San Francisco, California 94119
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (2861 cards)
Reference report and Notes
17. CATEGORY - C
KEYWORDS - diffusion equations, one-dimensional, few-group, slabs, cylinders, spheres, criticality searches, neutron flux, AIMS codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - AIM6
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM370
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
10 space points
18 energy groups
Only downscatter is permitted, and in the current version neutrons from a given group are permitted to scatter only to a maximum of 5 successive lower groups.
6. TYPICAL RUNNING TIME - For 18 groups, 3 minutes would be a typical time for a single problem, although times may be as low as 30 seconds. The sample problem requires 2 minutes on the IBM370.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - FOG (NESC Abstract 28). The original version of AIM6 was prepared by H. P. Flatt and D. C. Baller of the Atomic International Mathematics and Computer Sciences Division, Canoga Park, California.
9. STATUS - Abstract first distributed February 1962.
IBM7090 version submitted by AI January 1962, replaced by IBM370 version submitted July 1972, sample problem executed by NESC.
CDC1604 version submitted by CDC August 1969, deleted July 1978.
10. REFERENCES - H. P. Flatt and D. C. Baller, The AIM-6 Code, NAA Program Description, January 1961, Errata and Addenda.
11. MACHINE REQUIREMENTS - 300K bytes and 1 scratch unit.
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 -
S. Nakamura and W. Benedict
Nuclear Engineering Department
The Ohio State University
206 West 18th Avenue
Columbus, Ohio 43210
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (3503 cards)
Sample problem (30 cards)
Library (337 cards)
Control information (JCL 9 cards)
Sample problem output (17 pages)
Reference report, Errata, and Addenda.
17. CATEGORY - C

KEYWORDS - diffusion equations, one-dimensional, multigroup, slabs, cylinders, spheres, criticality searches, neutron flux, FOG codes

18. **SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - PERT
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - PERT is a perturbation program designed for use with the AIMS 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.
4. METHOD OF SOLUTION - A linear perturbation theory is used for the calculations of the relative change in k_{eff} .
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - About 30 seconds are required for a typical problem.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - AIMS (NESC Abstract 29) and FOG (NESC Abstract 26). The original IBM7090 version of PERT was prepared by H. P. Flatt of the Atomic International Mathematics and Computer Sciences Division, Canoga Park, California.
9. STATUS - Abstract first distributed February 1962.
IBM7090 version submitted by AI January 1962, replaced by IBM360 version submitted June 1967.
CDC1604 version submitted by CDC March 1964, deleted July 1978.
10. REFERENCES - H. P. Flatt, PERT, NAA Program Description, February 1961.
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
G. Gowins
Boeing Huntsville Simulation Center
The Boeing Company
P. O. Box 1680
Huntsville, Alabama 35807
16. MATERIAL AVAILABLE -
Source deck (457 cards)
Sample problem (114 cards)
Reference report and Notes
17. CATEGORY - C
KEYWORDS - perturbation theory, one-dimensional, reactivity, lifetime, slabs, cylinders, spheres, AIMS codes, FOG codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - CURFIT
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 $y = a(i) + b(i) \cdot x + c(i) \cdot (x^{**}2) + d(i) \cdot (x^{**}3)$
 - (5) Fourier series
4. METHOD OF SOLUTION - The solution varies with the fit. CURFIT produces polynomial coefficients by using orthogonal polynomials. The single exponential and the cosine fits employ the least squares method. In the series of cubic fits the curve is a composite of cubic parabolas having continuous first and second derivatives throughout with the second derivatives at the end points set to zero. The Fourier series method used was one developed by J. P. Jewett.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - Less than 15 seconds per case are required.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - A previous version existed for the Philco 2000 computer.
9. STATUS - Abstract first distributed June 1968
CDC6600 version submitted June 1968
10. REFERENCES - J. A. Warrington, CURFIT, Curve Fitting Program, KAPL-M-6483, July 15, 1965
R. J. Cullen, 6600 CalComp Plotter Routines, KAPL Note, July 25, 1966
J. A. Warrington, CONVIX, A FORTRAN 4 Format Free, Symbolically Addressed Input Routine, KAPL/DAC/CT Informal Program Description, June 17, 1968
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and ASCENT
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 2.0
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Input preparation is easy, due to use of a comma loader.
15. NAME AND ESTABLISHMENT OF AUTHOR -
J. A. Warrington
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (3621 cards)
Sample problem (88 cards)
Reference report, Note, Program Description
17. CATEGORY - P
KEYWORDS - least square fit, decay, buckling, data processing, CONVIX codes

1. NAME OR DESIGNATION OF PROGRAM - CLOUD
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - Meteorological parameters such as wind velocity, lateral and vertical diffusion parameters, stability parameters, and the presence of physical boundaries such as a ground surface and a temperature inversion layer, are considered. Decay of the source material is described either by the use of a simple parent-daughter decay scheme or by a Way-Wigner type relationship
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - 2 minutes are required
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The original IBM7090 version of CLOUD was prepared by D S Duncan of the Atomic International Mathematics and Computer Sciences Division, Canoga Park, California
9. STATUS - Abstract first distributed April 1962
IBM7090 version submitted by AI March 1962, replaced by IBM360 version submitted March 1967
CDC1804 version submitted by CDC March 1964, deleted July 1978
10. REFERENCES - D S Duncan, CLOUD, An IBM 709 Program for Computing Gamma-ray Dose Rate from a Radioactive Cloud, NAA-SR-MEMO-4822, 1959
R E Cooper, Savannah River Laboratory Changes to AI CLOUD Program - IBM 360 Version
11. MACHINE REQUIREMENTS - 32K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
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 Co., Inc
Aiken, South Carolina 29801
16. MATERIAL AVAILABLE -
Source deck (822 cards)
Sample problem (23 cards)
Reference report and Note
17. CATEGORY - G
KEYWORDS - dose rates, gamma radiation, radioactive clouds, decay, earth atmosphere, meteorology
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - TEMPEST2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - 1 to 2 minutes are required
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - SOFOCATE, KATE. The original IBM7090 version of TEMPEST2 was prepared by R. H. Shudde and J. Dyer of Atomic International, Canoga Park, California.
9. STATUS - Abstract first distributed April 1962.
IBM7090 version submitted by Al March 1962, replaced by IBM360 version submitted June 1967, replaced by Edition B February 1974.
CDC1604 version submitted by CDC March 1964, deleted July 1978.
10. REFERENCES - R. H. Shudde, TEMPEST-II, NAA Program Description, 1960, and Supplements 1-3, 1960-1961.
R. H. Shudde and J. Dyer, TEMPEST II - A Neutron Thermalization Code, AMTD-111, June 1962.
R. H. Shudde, TEMPEST - Conversion of a Decimal Cross Section Library to a Binary Cross Section Library, AMTD-112, November 1961.
R. H. Shudde, TEMPEST - A Binary Cross-section Library Reader, AMTD-113, November 1961.
R. H. Shudde, SOFOCATE Library to TEMPEST Library Converter, AMTD-114, November 1961.
R. H. Shudde, Preparation of Cross-sections for the TEMPEST Decimal Library, AMTD-115, November 1961.
11. MACHINE REQUIREMENTS -
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 -
G. Gowins
Boeing Huntsville Simulation Center
The Boeing Company
P. O. Box 1680
Huntsville, Alabama 35807
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (1280 cards)
Sample problem (21 cards)
Library (784 cards)
Sample problem output (14 selected pages)
Reference reports

17. CATEGORY - B

KEYWORDS - thermalization, Wigner-Wilkins model, moderators, Wilkins equation, Boltzmann statistics, SOFOGATE codes, KATE codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FORM
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM370
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - About 5 to 6 seconds are required.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - MUFT library editing routines are included as auxiliary codes. AITP1 prepares the binary library tape. The original IBM7090 version of FORM was prepared by D. J. McGoff of Atomics International, Canoga Park, California.
9. STATUS - Abstract first distributed April 1962.
IBM7090 version submitted by Al March 1962, replaced by IBM370 version submitted July 1972, sample problem executed by NESC.
CDC1604 version submitted by CDC March 1964, deleted July 1978.
10. REFERENCES - D. J. McGoff, FORM, A Fourier Transform Fast Spectrum Code for the IBM709, NAA-SR-MEMO-5766, 1960.
Atomics International FORM Cross-section Library, AI Note, November 1962.
P. Kazemsky and S. Nakamura, The FORM Code, Ohio State Modifications to NAA-SR-MEMO-5766, 1972.
11. MACHINE REQUIREMENTS - 200K bytes 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 -
15. NAME AND ESTABLISHMENT OF AUTHORS -
S. Nakamura and P. Kazemsky
Nuclear Engineering Department
The Ohio State University
206 West 18th Avenue
Columbus, Ohio 43210
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (FORM 1141 cards, AITP1 227 cards)
Sample problem (34 cards)
Library (8319 cards)
Control information (FORM JCL 9 cards, AITP1 JCL 8 cards)
Reference report, Note, and Modifications
17. CATEGORY - 8
KEYWORDS - Fourier transformation, slowing-down, neutron spectra, fast neutrons, few-group, AITP1 codes, MUFT codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SIZZLE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - There must be no more than 101 space points, 18 energy groups, or 20 elements. Only downscatter is permitted, and in the current version neutrons from a given group are permitted to scatter only to a maximum of five successive lower groups.
6. TYPICAL RUNNING TIME - 3 to 10 minutes on an IBM360 Model 50
7. UNUSUAL FEATURES OF THE PROGRAM - Concentration search and CRT (cathode ray tube) output are special features of SIZZLE.
8. RELATED AND AUXILIARY PROGRAMS - AIMS (NESC Abstract 28) and the auxiliary IBM360 microscopic library program SIZLIB. The original IBM7090 version was prepared by D. P. Salkus and H. P. Flatt of Atomic International, Canoga Park, California.
9. STATUS - Abstract first distributed July 1962.
IBM7090 version submitted by AI April 1962, replaced by IBM360 version submitted May 1967.
CDC1804 version submitted by CDC March 1964, deleted July 1978.
10. REFERENCES - D. P. Salkus and H. P. Flatt, SIZZLE - A Fast or Intermediate Reactor Burn-up Code, NAA Program Description, February 1963, AI-64-MEMO-183, August 1964.
R. A. Blaine, SIZLIB - Conversion to IBM System/360, Volumes I and II, AI-66-MEMO-164, December 1966.
R. A. Blaine and E. Brambilla, SIZZLE - Conversion to IBM System/360, Volume I, AI-66-MEMO-165, December 1966.
R. A. Blaine, Atomic International Environment Report, May 1967.
11. MACHINE REQUIREMENTS -
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 SIZLIB program punches a microscopic cross section library in hexadecimal form for use in conjunction with SIZZLE and produces a listing of its contents. Flow charts for the 360 version of SIZZLE and SIZLIB are available from NESC on a loan basis.
15. NAME AND ESTABLISHMENT OF AUTHOR -
R. A. Blaine
Mathematics and Computer Sciences
Atomic International
P. O. Box 309
Canoga Park, California 91304
*Present address-IBM Palo Alto Scientific Center
Palo Alto, California 95014

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (SIZZLE 4415 cards, SIZLIB 256 cards)
Object deck (SIZZLE 2874 cards)
Sample problems (SIZZLE 36 cards, SIZLIB 568 cards)
Reference reports
17. CATEGORY - D
KEYWORDS - depletion, diffusion equations, one-dimensional, multigroup, criticality searches, thorium 232, uranium 238, fission products, SIZLIB codes, ALM5 codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SOR3
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 radius of curvature. These features make the program applicable to shell structures with moderately large thickness to radius ratios.
4. METHOD OF SOLUTION - The numerical integration of the governing differential equations is performed by a variable interval size Adams-Moulton method. The problem is first converted from a two-point boundary value problem to an initial-value problem. Five separate integrations with different sets of initial conditions are required. Each integration proceeds with automatic adjustment of interval size for maximum speed within the limitation of preset bounds on the associated truncation error.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
30 shells into which the structure is divided
30 input points for the shell
10 points at which detailed stress printout is to be provided
for brittle fracture purposes
6. TYPICAL RUNNING TIME - An average time of 10 seconds per case is required.
7. UNUSUAL FEATURES OF THE PROGRAM - SOR3 has a branched-shell option which automatically performs the cut and fill operations associated with the analysis of such structures as a pressure vessel connected to a support skirt. Special output options tailored to the needs of stress, fatigue and brittle fracture design evaluations are available.
8. RELATED AND AUXILIARY PROGRAMS - SOR3 is an extension of the earlier SOR2 program. One of the SOR3 options provides for punched card output which can be fed directly to SORSDB (NESC Abstract 391), a KAPL program written to facilitate the checking of a given design against structural design basis criteria.
9. STATUS - Abstract first distributed June 1968
CDC6600 version of SOR2 submitted June 1968, replaced by revised edition July 1969, replaced by SOR3 February 1973, corrected July 1974.
10. REFERENCES - J. R. Fitch and R. L. Fagan, SOR-3, A Program for the Stress Analysis of Shells of Revolution, KAPL-M-7100(L), August 30, 1971.
J. A. Mirabal and D. G. Dight, SOR-II - A Program to Perform Stress Analysis of Shells of Revolution, KAPL-2292, September 15, 1963.
F. C. Carlson and R. E. Dobson, SORSDB, A Computer Program for the Stress and Fatigue Evaluation of Shells of Revolution, KAPL-M-6728, April 1969.
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3 0
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
J. R. Fitch and R. L. Fagan
Knolls Atomic Power Laboratory
General Electric Company
Schenectady, New York 12301

16. MATERIAL AVAILABLE - Restricted Distribution

Magnetic Tape Transmittal
Source deck (3285 cards)
Sample problem (351 cards)
Sample problem output (72 selected pages)
Reference report, KAPL-M-7100(L)

17. CATEGORY - I

KEYWORDS - stresses, shells, spheres, cylinders, temperature distribution, SOR2 codes, SORSD8 codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FAIMOS
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - A finite difference approximation to the neutron diffusion equations is used
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
 - Maximum number of energy groups = 18
 - Maximum number of space points = 101
 - Maximum number of regions = 20
 - Maximum number of downscattering groups = 8
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - AIM6 (NESC Abstract 29) The original IBM7090 version of FAIM was prepared by D. C. Baller and H. P. Flail of the Atomic International Mathematics and Computer Sciences Division, Canoga Park, California
9. STATUS - Abstract first distributed August 1963
IBM7090 version submitted by AI May 1963, replaced by IBM360 version submitted June 1967
CDC1604 version submitted by CDC June 1966, deleted July 1978
10. REFERENCES - D. C. Baller, The FAIM Code, A Multigroup, One-dimensional Diffusion Equation Code, AMTD-118, January 1962, NAA-SR-7137, April 15, 1962
R. G. Cockrell, A Description of FAIMOS, A Multigroup One-dimensional, Neutron Diffusion Equation Code, May 1967
H. P. Flail, Finite Difference Approximations to the Neutron Diffusion Equation, AI-TDR-5889, 1960
R. G. Cockrell, The Use of TEMPEST II, GAM-1, FAIM, and PERT Codes for Neutronics Studies of Nuclear Propulsion Reactors, Boeing Document No. D5-13332, 1967
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV (H)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Since the FAIMOS code does not have the microscopic cross section library as used in the FAIM code, the user must supply the cross-section values as input data
15. NAME AND ESTABLISHMENT OF AUTHOR -
 - R. G. Cockrell
 - Boeing Huntsville Simulation Center

The Boeing Company
P. O. Box 1680
Huntsville, Alabama 35807

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (3283 cards)
Sample problem (30 cards)
Reference reports, NAA-SR-7137 and A Description of FAIMOS
17. CATEGORY - C
KEYWORDS - diffusion equations, one-dimensional, multigroup, slabs, cylinders, spheres,
FAIM codes, AIM6 codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - AIREK3
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
Maximum number of precursor groups = 15
Maximum number of feedbacks = 50
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The original IBM7090 version of AIREK3 was prepared by L. R. Blue and M. Hoffman of the Atomic International Mathematics and Computer Sciences Division, Canoga Park, California.
9. STATUS - Abstract first distributed August 1963
IBM7090 version submitted by AI May 1963, replaced by IBM360 version submitted April 1967
CDC1604 version submitted by CDC June 1966, deleted July 1978
10. REFERENCE - L. R. Blue and M. Hoffman, Generalized Program For the Numerical Solution of Space Independent Reactor Kinetics Equations, AMTD-131, January 1963
11. MACHINE REQUIREMENTS -
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 -
O. G. P. Grosskopf
South African Atomic Energy Board
Private Bag 256
Pretoria, Pretoria, South Africa
16. MATERIAL AVAILABLE -
Source deck (388 cards)
Sample problem (35 cards)
Reference report
17. CATEGORY - E
KEYWORDS - Cohen equation, feedback, computer graphics, reactor kinetics, delayed neutron precursors
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - HERESY3
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 eta 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 eta, and axial leakage buckling.
4. METHOD OF SOLUTION - Direct power iteration on matrix form of the heterogeneous critical equation is used.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 50 flux/geometry symmetry positions
 - 20 physically different assemblies
 - 9 resonance levels
 - 5000 rod coordinate positions
6. TYPICAL RUNNING TIME - Finite reactor lattice of 50 rods requires about 3 minutes, an infinite supercell of 15 rods about 2 minutes, and an axial buckling criticality search about 5 minutes.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - HERESY3 is interfaced to accept cell data from a HAMMER system (NESC Abstract 277) lattice library tape and calculate heterogeneous rod parameters and moderator constants directly.
9. STATUS - Abstract first distributed March 1964
 - IBM7080 version of HERESY1/KERNEL submitted December 1963, deleted April 1972
 - IBM360 version of HERESY3 submitted April 1972, sample problem executed by NESC
10. REFERENCES - D. R. Finch, HERESY3 Computer Code, DP-1284, February 1972
 - C. N. Klahr, L. B. Mendelsohn, and J. Heitner, Heterogeneous Reactor Calculation Methods, Final Report, NYO-2660, June 30, 1961
 - C. N. Klahr, L. B. Mendelsohn, and J. Heitner, Heterogeneous Reactor Calculation Methods, Quarterly Progress Report No. 6, NYO-2678, September 30, 1960
11. MACHINE REQUIREMENTS - 45K single-precision words of high speed core plus 50K single-precision words of disk (or drum) storage.
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and BAL
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
 - D. R. Finch
 - Savannah River Laboratory
 - E. I. duPont de Nemours and Company, Inc
 - Aiken, South Carolina 29801

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (5264 cards)
 Sample problem (60 cards)
 Control information (JCL-16 cards)
 Reference report, DP-1284

17. CATEGORY - C

KEYWORDS - reactivity, thermal utilization, resonance escape probability, two-dimensional, power distribution, reactor lattices, buckling, heterogeneous reactors, criticality searches, HERESY1 codes, HAMMER codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - NPRFCCP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600, IBM360,370/195
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
Maximum number of regions or zones = 10
6. TYPICAL RUNNING TIME - 1 to 2 minutes are required
7. UNUSUAL FEATURES OF THE PROGRAM - Certain of the operating and economic parameters will generally remain constant for a wide range of reactor core designs. Therefore, the program includes a set of standard values for these parameters so that the amount of basic input data required is minimal. The use of these so-called standard values is optional with the program user, and any combination of or all of these standard values may be modified as desired. Fuel processing costs may be computed for spent-fuel management programs which provide for the reprocessing, separately or in any combination, of single or multiple spent-fuel batches from one or more regions having the same or different final enrichments. Thus, the lowest cost spent-fuel management program can be readily determined.
8. RELATED AND AUXILIARY PROGRAMS - The original IBM7090 version of NPRFCCP was prepared by J T Jackman of Kaiser Engineers, Oakland, California.
9. STATUS - Abstract first distributed November 1964
IBM7090 version submitted June 1964, replaced by IBM360 version July 1974
CDC6600 version submitted April 1973
IBM360 version submitted July 1974, sample problem executed by NESC
10. REFERENCE - J T Jackman, Guide to Nuclear Power Cost Evaluation, TID-7025, April 30, 1963
11. MACHINE REQUIREMENTS -
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 -
15. NAME AND ESTABLISHMENT OF AUTHORS -
6600 F O Tyson
Technical Computer Services
United Engineers and Constructors, Inc
1401 Arch Street

Philadelphia, Pennsylvania 19105

360

Richard L. Price
National Energy Software Center
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

16. MATERIAL AVAILABLE -

Source decks (6600-1446 cards, 360-1353 cards)
Sample problems (6600-136 cards, 360-137 cards)
Reference report, Appendix A

17. CATEGORY - D

KEYWORDS - fuel cycle, economics, performance

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - AILMOE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - A fine group structure of up to 750 groups is superimposed over the coarse, multigroup structure and a fundamental mode calculation is performed in either the P1, B1, consistent P1, or consistent B1 option. Coarse group cross sections are provided by the user. A library of Legendre polynomial expansion coefficients of the scattering cross section is available for several elements for 1500 energy groups.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
Maximum number of coarse groups = 24
Maximum number of elements = 20
Maximum number of fine groups = 750
6. TYPICAL RUNNING TIME - 7 minutes are required for the first problem and 3 minutes for additional problems on the IBM360/50 (on-line mode).
7. UNUSUAL FEATURES OF THE PROGRAM - The basic modifications to ELMOE consist of -
 - (a) modifying the tape manipulation to permit updating or creating a library tape in the same job as an ELMOE calculation,
 - (b) modifying the coarse-group library routines,
 - (c) providing for input of multigroup bucklings and suppression of the buckling-iteration calculation,
 - (d) providing restart capability to bypass recalculation of the light element scattering matrix,
 - (e) providing for input of changes to the coarse-group cross sections without remaking the library.
8. RELATED AND AUXILIARY PROGRAMS - The original IBM704 version of ELMOE was prepared by A. L. Rago and H. H. Hummel of Argonne National Laboratory, Argonne, Illinois.
9. STATUS - Abstract first distributed November 1964
IBM704 version (ELMOE) submitted by ANL June 1964, deleted October 1967
IBM360 version submitted September 1967
IBM7094 version submitted AI September 1967, deleted July 1978
10. REFERENCES - R. A. Blaine, AILMOE, Atomic International's Version of the ELMOE Code, NAA-SR-MEMO-11892, April 1966
R. A. Blaine, AILMOE - Conversion to System/360, AI Computing Notice 18 W00009, December 1966
A. L. Rago and H. H. Hummel, ELMOE An IBM 704 Program Treating Elastic Scattering Resonances in Fast Reactors, ANL-6805, January 1964
R. A. Blaine, Atomic International Environment Report, May 1967
11. MACHINE REQUIREMENTS - Minimum of 256K bytes
12. PROGRAMMING LANGUAGE USED - FORTRAN IV (H)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Non-IBM users must provide their own means for reading past a tape mark. This function is provided by the file function at NAA. IBM System/360 users will need to modify the data definition (DD) cards to conform with the standards of their installations. The distributed procedure assumes that AILMOE resides in the link library with program name W00009. The data set name for

the coarse group library is W00009 ANLXEC and for the Legendre coefficient library is W00009 ANLLEG. The remainder of the data sets are explained in the AI installation environment report. This procedure must reside in the PROCLIB with member name W00009 to function as described in the System/360 conversion notice. FORTRAN data set reference number 14 is used for the punched output.

15. NAME AND ESTABLISHMENT OF AUTHOR -

R. A. Blaine
Mathematics and Computer Sciences
Atomics International
P. O. Box 309
Canoga Park, California 91304

*Present address-IBM Palo Alto Scientific Center
Palo Alto, California 95014

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

Source decks (AILMOE 2001 cards, library program 91 cards)
Sample problem (AILMOE 21 cards)
Library (file 1, tape 2 435 cards)
Legendre coefficients (file 2, tape 2 12,224 cards)
Reference reports

17. CATEGORY - B

KEYWORDS - moderators, elastic scattering, Fourier transformation, fast neutrons, group constants, neutron flux, PL method, BL method, ELMOE codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - EXTERMINATOR2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360, GE625, CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - The multigroup, two-dimensional neutron diffusion equations are solved in x-y, r-z, or r-theta geometry
4. METHOD OF SOLUTION - The EQUIPOISE method (reference 2) is employed to solve the finite-difference analogs of the multigroup neutron diffusion equations
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Since FORTRAN IV variable-dimensioning techniques were used in EXTERMINATOR2, the only restriction on problem size is the available core storage. The code examines the problem size and stores fluxes and equation coefficients (except for scattering matrix coefficients which are recalculated at each iteration) according to the machine core size in one of four ways -
 - (1) All fluxes and equation coefficients are contained in core and no I/O devices are used during the iterative part of the calculation
 - (2) All equation coefficients are contained in core and I/O devices are used to store the fluxes
 - (3) The fluxes are contained in core and I/O devices are used to store the equation coefficients
 - (4) Both coefficients and fluxes are used from I/O devices

For a problem with an I-J mesh, K energy groups, M different materials, N nuclides, and L sets of specifications of composition locations, the core storage required for variables, when all fluxes and coefficients are used from I/O devices, is

$$4 \cdot I + 24 \cdot J + 16 \cdot K + 2 \cdot M + 8 \cdot N + (2 \cdot M + N + 1) \cdot K \cdot 2 + 8 \cdot I \cdot J + 14 \cdot J \cdot K + 15 \cdot M \cdot K + M \cdot N + 4 \cdot N \cdot K + 5 \cdot L + 6$$

words. The core storage required to be able to contain the fluxes and coefficients in core is

$$4 \cdot I + 24 \cdot J + 16 \cdot K + 2 \cdot M + 8 \cdot N + (2 \cdot M + N + 1) \cdot K \cdot 2 + 8 \cdot I \cdot J + 4 \cdot J \cdot K + 15 \cdot M \cdot K + M \cdot N + 4 \cdot N \cdot K + 5 \cdot L + 10$$

If all cross sections are macroscopic, N is 1 above
6. TYPICAL RUNNING TIME - The running time of a problem will depend upon the size of the problem, the computer, the compiler and operating system being used, and the amount of I/O required during the iterative part of the calculation. The following table gives the running times and rates of some typical problems run on the IBM360/75 computer using the IBM FORTRAN IV compiler with Level 2 optimization and operating system/360. The machine has a 512K byte core memory plus 1024K bytes of large capacity storage

Mesh size	Groups	2311 disk	No iter	Time(min)	Rate
31 x 31	3	no	83	3	0.0007
42 x 25	9	no	151	17	0.0007
31 x 81	9	no	92	28	0.0008
51 x 51	25	yes	149	255	0.0016

7. UNUSUAL FEATURES OF THE PROGRAM - EXTERMINATOR2 -
 - (a) Three outer-boundary conditions may be imposed - zero flux, zero normal derivative, or periodic. The logarithmic boundary condition may also be specified, either along boundaries or internal to the mesh
 - (b) Neutron scattering is allowed from any group to any other
 - (c) Eigenvalue problems, constant source problems, poison search problems, and nuclide density search problems may be solved by direct iteration with the unknown treated as the eigenvalue of the problem. Indirect search by solution of succeeding eigenvalue problems is also included

Special neutron problems can be solved in which some of the fluxes are negative

- (d) The effect on the multiplication factor and the fluxes due to pointwise equilibrium xenon concentrations may be taken into account
- (e) The code will calculate adjoint fluxes and do perturbation calculations
- (f) Flux-weighted broad-group microscopic cross sections may be calculated
- (g) Succeeding cases require only those input data which are different from the input from the preceding case
- (h) Optional output includes point-group fluxes as neutrons per cm^{-2} -second, point neutron density as neutrons per cm^{-3} , point source density as fissions per cm^{-3} -second or neutron productions per cm^{-3} -second, nuclide reaction rates, total and composition neutron balances, and cumulative heating along defined coolant channels

8. **RELATED AND AUXILIARY PROGRAMS** - The original IBM7090 version of EXTERMINATOR was prepared by T. B. Fowler, M. L. Tobias, and D. R. Vondy of Oak Ridge National Laboratory, Oak Ridge, Tennessee. EXTERMINATOR2 is a FORTRAN IV version of the code EXTERMINATOR with major improvements. EXTERMINATOR was developed from the slower few-group diffusion code, 20GRAND.

9. **STATUS** - Abstract first distributed April 1965
 IBM7090 version of EXTERMINATOR submitted by ORNL March 1965, replaced by IBM360 version of EXTERMINATOR2 submitted May 1967
 GE625 version of EXTERMINATOR2 submitted July 1968
 CDC6600 version of EXTERMINATOR2 submitted November 1970

10. **REFERENCES** - T. B. Fowler, M. L. Tobias and D. R. Vondy, EXTERMINATOR-2 A FORTRAN IV Code for Solving Multigroup Neutron Diffusion Equations in Two Dimensions, ORNL-4078, April 1967

M. L. Tobias and T. B. Fowler, The EQUIPOISE Method - A Simple Procedure for Group-diffusion Calculations in Two and Three Dimensions, Nuclear Science and Engineering, Vol. 12, pp. 513-518, 1962

T. B. Fowler, M. L. Tobias, and D. R. Vondy, EXTERMINATOR - A Multigroup Code for Solving Neutron Diffusion Equations in One and Two Dimensions, ORNL-TM-842, July 1966

R. L. Brunnenmeyer and R. A. Mickle, EXTERMINATOR-2 GE-625 Version (NE573) Users Note, Bechtel Note, July 1968

11. **MACHINE REQUIREMENTS** - A machine with a minimum of about 64K words of core storage and 5 I/O devices for temporary storage in addition to those for input data and printed output. Some problems may require 4 additional I/O devices.

12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV

13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360 (IBM360), GECOS (GE625), and SCOPE (CDC6600)

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - EXTERMINATOR2 can be made to conform to machines of different core sizes simply by adjusting the fixed dimension of only one variable in a short master program. The code as compiled under the IBM FORTRAN IV compiler on the IBM360 computer is about 35,000 words long but can be shortened by as much as one-half this length by removing some of the subroutines which do optional calculations. Using the overlay feature of the IBM360 operating system, the storage requirements can be reduced to about 15,000 words. Because of storage limitations the GE625 version was shortened and the following five subroutines were deleted -

- (1) group rebalancing subroutine,
- (2) neutron balance and reaction rate print subroutine,
- (3) neutron absorption and density calculation subroutine,
- (4) adjoint flux calculation subroutine, and
- (5) channel heating calculations subroutine

16 NAME AND ESTABLISHMENT OF AUTHORS -

360 T B Fowler, M L Tobias, and D R Vondy
Oak Ridge National Laboratory
P O Box X
Oak Ridge, Tennessee 37830

625 R L Brunnenmeyer and R A Mickle
Bechtel Corporation
50 Beale Street
San Francisco, California 94119

6600 Sam Pacino
Combustion Engineering, Inc
P O Box 500
Windsor, Connecticut 06095

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (360-6643 cards, 625-4882 cards, 6600-6984 cards)
Sample problems (360-67 cards, 6600-67 cards)
Reference report, ORNL-4078, and Note as appropriate

17. CATEGORY - C

KEYWORDS - diffusion equations, two-dimensional, multigroup, x-y, r-z, r-theta, reactivity, neutron flux, group constants, cross sections, libraries, 20-GRAND codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FLARE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - GE635, IBM360, CDC7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The calculations include a representation of the coupled effects of flow, power, voids, and each control rod independently.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Because of the independent representation of the control rods, a three-dimensional calculational scheme was employed. This three-dimensional geometry combined with computer size limitations restricted the calculations to a relatively coarse mesh. The present version of the code will handle a maximum array of 14 x 14 x 12 nodes with either mirror or diagonal symmetry.
6. TYPICAL RUNNING TIME - 5 minutes are required to run the sample problem on the IBM360. 6 seconds are required to run the sample problem on a CDC7600.
7. UNUSUAL FEATURES OF THE PROGRAM - A 3-dimensional coarse-mesh flux calculation is incorporated.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed April 1965
Philco-2000 version submitted February 1965, deleted October 1967
GE635 version submitted November 1966
CDC3600 version submitted by CDC December 1966, sample problem executed by NESC, deleted July 1976
IBM360 version submitted January 1971, sample problem executed by NESC
CDC6600 version submitted September 1976, replaced by CDC7600 version submitted November 1978, sample problem executed by NESC December 1978 on a CDC7600 and a CDC6600
10. REFERENCES - D. L. Delp, D. L. Fisher, J. M. Harriman, and M. J. Stedwell, FLARE - A Three-dimensional Boiling Water Reactor Simulator, GEAP-4588, July 16, 1964
Nels J. Anderson, Jr., IDFTAP, A FORTRAN IV Function Subprogram, S6T001, January 15, 1965
BITA, A FORTRAN-compatible Subroutine, L5T001, December 3, 1964
Modification of Input and Output for CDC7600 Version, FLARE NESC No. 167 7600, NESC Note 79-15, December 11, 1978
11. MACHINE REQUIREMENTS - 39K and 3 tapes in addition to the system units are used on the GE635, 400K and 5 tapes or disks are required on the IBM360. 60,000 (octal) words of small core memory and 12,000 (octal) words of large core memory are needed for the CDC7600 version.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GECOS (GE635), OS/360 (IBM360), and SCOPE (CDC7600)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The program uses two intermediate tapes and produces a tape for off-line punched cards. To execute the CDC7600 version on a CDC6600, the parameter EC20 should be entered on the JOB card.

15. NAME AND ESTABLISHMENT OF AUTHORS -

635	D L Delp and D L Fisher, Physics J M Harriman and M J Stedwell, Programming General Electric Company 175 Curtner Avenue San Jose, California 95125
360	George W Perry Middle South Services, Inc Box 81000 New Orleans, Louisiana 70160
360	Dr Frederick W Buckman Consumers Power Company 1945 Parnall Avenue Jackson, Michigan 49201
7600	T Kettler Nuclear Energy Services, Inc Shelter Rock Road Danbury, Connecticut 06810

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (635-3272 cards, 360-3442 cards, 7600-2987 cards)
 Sample problems (635-51 cards, 360-42 cards, 7600-50 cards)
 Control information (JCL 360-16 cards)
 Sample problem output (360-13 pages)
 Reference report, GEAP-4598, and Subroutine Descriptions and Note as appropriate to machine version

17. CATEGORY - C

KEYWORDS - reactivity, power distribution, three-dimensional

18. SPONSOR - AEC

1. NAME OR DESIGNATION OF PROGRAM - INVERSE KINETICS(R102)
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - Time derivatives of neutron density are obtained by application of (a) five-point quartic, (b) three-point parabolic, (c) five-point least-mean-square cubic, (d) five-point least-mean-square parabolic, or (e) five-point least-mean-square linear formulae to the neutron density or to the natural logarithm of the neutron density. Between each data point the neutron density is assumed to be (a) exponential-(third-order polynomial), (b) exponential, or (c) linear. Changes in reactivity between data points are obtained algebraically from the kinetics equations, neutron density derivatives, and the algebraic representation of neutron density. First and second time derivatives of the reactivity are obtained by use of any of the formulae applicable to the neutron density
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
50 delay groups
1000 data points
99 data blocks
(A data block is a sequence of input points characterized by a fixed time-interval between points, a smoothing option, and a number of repetitions of the smoothing option)
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM - This program has been used for the determination of feedback parameters, control rod design, and evaluation of control rod worth. Various modes of solution allow high precision with analytic data or the analysis of digitalized data from recording equipment. Smoothing of input data may be obtained by single or repeated application of five-point cubic, five-point parabolic, three-point linear, or five-point linear least-mean-square smoothing formulae. Tabular output includes excess reactivity, its first and second derivatives, input and smoothed input data, integral of neutron density, and instantaneous period. Precursor data may be input or obtained from the program library. Steady-state initial conditions may be specified by input of a constant reactivity or period. Non-steady-state conditions require precursor density information. Discontinuous changes in reactivity may be given as input or calculated by the program. Any number of reruns with varying solution modes and smoothing options may be scheduled
8. RELATED AND AUXILIARY PROGRAMS - This program supercedes RE138 and RE171, ANL IBM704 programs
9. STATUS - Abstract first distributed February 1966
CDC3600 version submitted by ANL December 1965, sample problem executed by NESC,
replaced by IBM360 version submitted February 1973, sample problem executed by NESC
IBM7094 version submitted by WAPD December 1965, deleted July 1978
10. REFERENCES - Precursor library in program is from ANL-5800, Second Edition, Reactor Physics Constants, July 1963
J. J. Kaganove, ANL-AMD Program Library Report R102, June 1965
11. MACHINE REQUIREMENTS -
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 -

J J Kaganove
Applied Mathematics Division
Argonne National Laboratory
8700 South Cass Avenue
Argonne, Illinois 60439

16. MATERIAL AVAILABLE -

Source deck (825 cards)
Sample problem (525 cards)
Sample problem output (27 selected pages)
Reference report

17. CATEGORY - E

KEYWORDS - reactor kinetics, reactivity, feedback, delayed neutron precursors, control rod worths, B101 codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - AISITE2/R153
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 48 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.
4. METHOD OF SOLUTION - Analytic solutions to the differential equations are evaluated.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 100 isotopes
 - 20 distances
 - 10 values of variable parameter
 - 8 organs
 - 4 levels of containment
6. TYPICAL RUNNING TIME - One case with 10 distances and 10 values of the variable parameter requires about 20 seconds for both printed and graphical output.
7. UNUSUAL FEATURES OF THE PROGRAM - AISITE2 has been optimized to reduce running time by keeping track of those portions of the calculation which need not be re-evaluated, i.e., are not affected by the variable parameter. This optimization resulted in a savings of up to a factor of 10 over the earlier version of the code.
8. RELATED AND AUXILIARY PROGRAMS - This program is a later version of the program, AISITE (NAA-SR-MEMO-9235).
9. STATUS - Abstract first distributed February 1966
 - IBM7094 version submitted by AI April 1965, deleted July 1978
 - CDC3600 version submitted by ANL October 1965, sample problem executed by NESC, deleted July 1978
 - IBM360 version submitted March 1968
10. REFERENCES - R. A. Blaine and E. L. Bramblett, AISITE II, A Digital Computer Program for Investigation of Reactor Siting, NAA-SR-9962, September 1964.
 - M. Hoffman and W. A. Rhoades, AICRT3, A General Code for Display of Digital Data, NAA-SR-MEMO 9069, October 1963
 - R. A. Blaine, Atomic International Environment Report, May 1967
 - D. H. Lovegrove, ANL-AMD Program Library Report R153, October 1965, and Modifications
11. MACHINE REQUIREMENTS - 256K bytes 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 - Dummy routines can be used for SC-4020 subroutines GRAPH and AICRT3, or these routines can be rewritten.
15. NAME AND ESTABLISHMENT OF AUTHORS -
 - R. A. Blaine
 - Mathematics and Computer Sciences
 - Atomic International
 - P. O. Box 309

Canoga Park, California 91304
•Present address-IBM Palo Alto Scientific Center
Palo Alto, California 95014

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (2833 cards)
Sample problem (99 cards)
Reference reports
17. CATEGORY - G
KEYWORDS - dose rates, distance, containment, fission products, AISITE codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - 2DF
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Storage restrictions are specified by a complicated equation involving SN order, number of materials, mesh intervals, and energy groups, and specified boundary conditions.
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The original CDC1604A version of 2DF was prepared by Martin Shapiro of the United Nuclear Corporation, White Plains, New York. A General Atomic version of 2DF is used to prepare flux and current data tapes for use by GAPER2D (NESC Abstract 471).
9. STATUS - Abstract first distributed February 1966
CDC1604A version submitted by UNC January 1966, deleted July 1978
UNIVAC1108 version submitted February 1972
10. REFERENCES - United Nuclear Corporation Notes on 2DF Input Data Deck Arrangement, 2DF Problem Deck Arrangement, Operating Instructions, 2DF Input Forms
2DF Cross Section Input, Phys/Math Memo 3818, October 23, 1964
Maximum Size 2DF Problem, Phys/Math Memo 3703, September 9, 1964
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN V
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC8
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
R. J. Archibald
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (3711 cards)
Sample problem (882 cards)
Reference Notes and Inter-office Memoranda
17. CATEGORY - C
KEYWORDS - two-dimensional, multigroup, x-y, r-z, r-theta, discrete ordinate method, criticality searches, anisotropic scattering, DTF codes, GAPER2D codes

1. NAME OR DESIGNATION OF PROGRAM - FORE2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - GE635, IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - FORE2 input consists of property data, geometry, power and flow distribution factors, external time varying functions, experimental coefficients, and termination data. The differential equations for fluid flow, heat transfer, and point neutronics are solved by explicit finite-difference procedures.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Reactor excursions which can be calculated are restricted to those transients in which the reactor is not substantially destroyed. As a general rule, changes in reactor geometry and composition during an excursion are limited to those cases in which the reactivity effects of the changes may be considered as small perturbations of the initial system. Thus, accidents involving large-scale disassembly and bulk meltdown of a core are not covered by FORE2. FORE2 is valid only while the core retains its initial geometry.
6. TYPICAL RUNNING TIME - On a 10 microsecond computer FORE2 running time is on the order of 3.5 seconds per step, for a 1 microsecond computer 0.5 second per step.
7. UNUSUAL FEATURES OF THE PROGRAM - Unusual features of FORE2 include
 - (a) variable clad-fuel gap coefficient model,
 - (b) simulation of liquid metal voiding,
 - (c) unlimited wrapup and restart capability with changes in input permitted before restart,
 - (d) determination of maximum stable time-step by code,
 - (e) separation of power into prompt and total (includes decay heat),
 - (f) capability to use any single phase coolant,
 - (g) inclusion of fuel bowing and core deformation due to axial pressure difference,
 - (h) ability to handle correctly the variation of coolant flow rate in channels with orificing during a coastdown accident.
8. RELATED AND AUXILIARY PROGRAMS - The original Philco-2000 version of FORE was prepared by P. Greebler, D. B. Sherer and N. H. Walton of the General Electric Atomic Power Equipment Department, San Jose, California.

FORE2 consists of three independent codes -

 - (a) EEEE performs all calculations and gives a condensed or short edit of the results.
 - (b) FEDIT gives a detailed or long edit of the results.
 - (c) FRCURV performs curve plotting of the output.
9. STATUS - Abstract first distributed February 1968.

Philco-2000 version of FORE submitted by NED November 1965, deleted July 1978.
GE635 version of FORE2 submitted July 1967.
IBM360 version of FORE2 submitted February 1968.

10. REFERENCES - P Greebler, D B Sherer, N H Walton, FORE, A Computational Program for the Analysis of Fast Reactor Excursions, GEAP-4090, October 16, 1962, plus Errata and Addenda, EA2, February 10, 1965, EA3, June 22, 1965, and EA4, December 22, 1965
 T J Heames, Adaptation of the General Electric Fast Oxide Reactor Excursion Code Number Two, FORE-II, to Operating System 360 Model 50/75, ANL Reactor Physics Division Memorandum, February 1968
 J N Fox, B E Lawler, and H R Butz, Fore II, A Computational Program for the Analysis of Steady-state and Transient Reactor Performance, GEAP-5273, September 1966
 FORE2 Subroutine Descriptions including -
 Nels J Anderson, Jr, IDFTAP, A FORTRAN IV Function Subprogram, S6T001, January 15, 1965
 BITA, L5T001, December 3, 1964
 Nels J Anderson, Jr, FORTRAN IV Subroutine ERRSYS, S4T001, January 15, 1965
 FLEXO, J3T001, January 21, 1965
 FLTBCD, L2T006
 LISTFORM, S6T002, February 12, 1964
 MFXBCD, L2T004, November 16, 1965
 C T Ehlers, NSORT, P5T001, October 29, 1964
 John W Weil, PLOTIC, K5T003
 Walter A Duncan, VAMPIR, K5F009, April 25, 1966
 A E Scadden, ZERO, Division Overflow Modifier, Q4T001
 LIMRTN, GESJ Note, September 19, 1967
11. MACHINE REQUIREMENTS - 3 files and 40K memory (GE635)
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GECOS (GE635), OS/360 (IBM360)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - FORE2 calls several systems subroutines which are not included with the program. However, writeups of these subroutines are included with the code package
15. NAME AND ESTABLISHMENT OF AUTHORS -
 635 J N Fox, B E Lawler, and H R Butz
 Advanced Products Operation
 General Electric Company
 Sunnyvale, California 94086
 360 T J Heames
 Reactor Analysis and Safety Division
 Argonne National Laboratory
 9700 South Cass Avenue
 Argonne, Illinois 60439
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
 Source decks (FORE2 635-8763 cards, 360-8461 cards, FEDIT 635-1148 cards, 360-1465 cards, 360-917 cards, FACURV 635-2305 cards)
 Sample problems (635-139 cards, 360-128 cards)
 Reference reports, Errata and Addenda, Memo, FORE2 Subroutine Descriptions
17. CATEGORY - F
 KEYWORDS - excursions, power distribution, temperature, feedback, kinetics, fuels, coolants, fluid flow, heat transfer, EEEE codes, FEDIT codes, FACURV codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ISOTOPES
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1100
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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,gamma), (n,p), (n,2n), etc., or it may be produced by decay of a parent isotope.
4. METHOD OF SOLUTION - The program uses solutions to the Bateman equation for reaction and decay including the analytical solution for optimum time to produce maximum yield. The input data required includes the half-lives and cross sections of the target and product isotopes, the relative abundance of the target isotope in the original material, neutron flux values, and irradiation time values if optimum time is not desired.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The number of flux values used may range from 2 to a maximum of 100 for each individual reaction and decay problem.
6. TYPICAL RUNNING TIME - Approximately 2 seconds of processor time are required for compilation and execution of the sample problem on an UNIVAC1100/44.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The original ISOTOPES program was developed by Charles W. Friend and Alton R. Jenkins of Oak Ridge National Laboratory in the FORTRAN 63 language for the CDC1604A computer.
9. STATUS - Abstract first distributed February 1966
CDC1604 version submitted June 1965, deleted July 1978
UNIVAC1100 version submitted July 1978, sample problem executed by NESC March 1979 on an UNIVAC1100/44.
10. REFERENCES - Charles W. Friend and Alton R. Jenkins, ISOTOPES - A Program for Neutron Product Yields and Decay Calculations Using a Control Data 1604A Computer, ORNL-3673, January 1965.
11. MACHINE REQUIREMENTS - Less than 3600 words of memory were used in executing the sample problem.
12. PROGRAMMING LANGUAGE USED - FORTRAN V
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC8
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The input is unchanged from that described in ORNL-3673, except for the use of one blank card to separate cases and two blank cards to terminate a run.
15. NAME AND ESTABLISHMENT OF AUTHOR -
A. Furman
Lockheed Missiles and Space Company
Department 19-43, Building 102
P. O. Box 504
Sunnyvale, California 94086
16. MATERIAL AVAILABLE -
Source deck (312 cards)
Sample problems (23 cards)
Reference report

17. CATEGORY - D

KEYWORDS - isotope production, decay, differential equations, nuclear reaction yield, irradiation reactors

18. SPONSOR - AEC

1. NAME OR DESIGNATION OF PROGRAM - BRT1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 sigma a, sigma f, nu sigma f, sigma s, and d for the cell composition and the values of sigma a, sigma f, nu sigma f, sigma s, and sigma tr for the isotopic constituents.
4. METHOD OF SOLUTION - The method used in solving the transport integral equation is the power iteration method. To accelerate convergence the code uses a combination of Gauss iteration, renormalization, over-relaxation, and extrapolation procedures.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 30 speed groups
 - 30 space points
 - 30 isotopes in mixture
 - 30 isotopes in the edit
 - 8 mixtures
6. TYPICAL RUNNING TIME - The sample problem is a 2-region slab and is solved using 10 space points and 30 speed groups. There are two mixtures used. Five materials are used in the cell and one in the edit. The time in general is a function of the number of space points and energy groups used by the problem.

Typical running time for BRT1 with the random access library is one minute with a reflecting boundary condition and 30 seconds with a white boundary condition. Succeeding cases require approximately 15 seconds each.
7. UNUSUAL FEATURES OF THE PROGRAM - In BRT1 options include the white boundary condition, current calculation, transverse buckling, linear anisotropic scattering correction, and smeared cell punched output for use as region input to a succeeding case. Random access library data can be stored on drum or disk.
8. RELATED AND AUXILIARY PROGRAMS - RLITHE updates and/or prints the BRT data tape or random access data.
9. STATUS - Abstract first distributed February 1966.

CDC3600 version (ANL THERMOS) submitted by ANL August 1965, sample problem executed by NESC, deleted July 1978.

UNIVAC1108 version of BRT1 submitted November 1970.
10. REFERENCES - H. C. Honeck, A Thermalization Transport Theory Code for Reactor Lattice Calculations, BNL-5828, September 1961.

H. C. Honeck, The Distribution of Thermal Neutrons in Space and Energy in Reactor Lattices Part I - Theory, Nuclear Science and Engineering, p. 193, 1960.

C. L. Bennett and W. L. Purcell, BRT-1 Battelle Revised THERMOS, BNWL-1434, June 1970.

D. R. Skea and L. J. Page, THERMOS/Battelle The Battelle Version of the THERMOS Code, BNWL-516, June 1967.
11. MACHINE REQUIREMENTS - 64K memory, input, output, program, library, and punch units plus 3 scratch units or equivalent drum storage.
12. PROGRAMMING LANGUAGE USED - FORTRAN V
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - CSCX
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHORS -

C. L. Bennett and W. L. Purcell
 Reactor Physics Department
 Pacific Northwest Laboratories
 Battelle
 P. O. Box 999
 Richland, Washington 99352

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (BRT1 2540 cards, RLITHE 483 cards)
 Sample problem (23 cards)
 Library (BRT1 7448 cards)
 Reference reports, BNL-5826 and BNWL-1434

17. CATEGORY - B

KEYWORDS - transport theory, reactor lattices, slabs, thermal neutrons, neutron spectra, cylinders, one-dimensional, scattering, cross sections, LIBP codes, GAKER codes, RLITHE codes, THERMOS codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GAMTEC2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1107, GE625, CDC6400
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 MFN (diffusion code) and DTF (SN transport code) formats.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The maximum number of concentric regions in the unit lattice cell is 16. Each region may contain up to 10 isotopes. Group constants may be computed for one thermal group and from 1 to 34 epithermal groups.
6. TYPICAL RUNNING TIME - 20 to 25 seconds on the CDC6400
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - GAMTEC2 combines the Atomic International TEMPEST (NESC Abstract 50) and the General Atomic GAM1 codes to compute multigroup constants for both thermal and epithermal neutrons in one operation. The original IBM7090 version was prepared by L. L. Carter and C. R. Richey of Battelle Pacific Northwest Laboratories, Richland, Washington and C. E. Hughey of General Electric Company, Richland, Washington.
9. STATUS - Abstract first distributed February 1966
IBM7090 version submitted September 1965, deleted July 1978
UNIVAC1107 version submitted February 1967
GE625 version submitted July 1968
CDC6400 version submitted January 1973
10. REFERENCES - L. L. Carter, C. R. Richey and C. E. Hughey, GAMTEC-II - A Code for Generating Consistent Multigroup Constants Utilized in Diffusion and Transport Theory Calculations, BNWL-35, May 1965, and Errata
R. L. Brunnenmeyer and R. A. Mickle, GAMTEC-II GE-625 Version (NE572) User's Notes, Bechtel Note, July 1968
11. MACHINE REQUIREMENTS - The code requires the use of 2 tape units in addition to the usual input and output units - one for the single data library tape and one for temporary storage. Also, an on-line card punch or tape for punch output is required. The CDC6400 version uses disk as scratch storage.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2 (UNIVAC1107) and SCOPE 3.4 (CDC6400)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The GE625 version has been modified to incorporate a simple routine for calculating Dancoff correction factors and to provide punched output for FOG (NESC Abstract 28). The CDC6400 version requires the RUN compiler.

15. NAME AND ESTABLISHMENT OF AUTHORS -

1107	L. L. Carter and C. R. Richey Pacific Northwest Laboratories Battelle P. O. Box 999 Richland, Washington 99352
1107	C. E. Hughey General Electric Company Richland, Washington 99352
625	R. L. Brunnenmeyer and R. A. Mickie Bechtel Corporation 50 Beale Street San Francisco, California 94119
6400	R. A. Rydin Nuclear Engineering Department University of Virginia Charlottesville, Virginia 22901

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (1107-9925 cards, 625-6140 cards, 6400-6347 cards)
 Sample problems (1107-18 cards, 625-16 cards, 6400-19 cards)
 Auxiliary routines (625-757 cards, 6400-1062 cards)
 BCD library (12,398 cards)
 Reference report, Errata, and Note

17. CATEGORY - 8

KEYWORDS - multigroup theory, group constants, spectra, Boltzmann statistics, reactor lattices, cylinders, Wigner-Wilkins model, Wilkins equation, moderators, thermal neutrons, PL method, BL method, Dancoff correction, MFN codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - CURIE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM370
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Differential equations relating the number of atoms of a fission product produced to the reactor power and operating time are solved. The same equations are solved repeatedly after reactor shutdown with the power set equal to zero and the operating time replaced by the decay time, or time since reactor shutdown.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
20 decay times
10 elements for which fission product histories are printed
6. TYPICAL RUNNING TIME - A typical problem requires 4 to 8 seconds of IBM370/195 CPU time.
7. UNUSUAL FEATURES OF THE PROGRAM - Variable power histories may be approximated by replacing the actual history with a series of step-functions and considering the shutdown fission product inventory of one step to be the initial inventory of the next one.
8. RELATED AND AUXILIARY PROGRAMS - The original IBM7094 version, consisting of three programs CURIE, DOSE, and THUNDERHEAD, was prepared by G. P. Kenfield of the Atomic International Kinetics and Safety Unit, Canoga Park, California. DOSE and THUNDERHEAD have been succeeded by COMRADEX3 (NESC Abstract 533).
9. STATUS - Abstract first distributed February 1966.
IBM7094 version of CURIE/DOSE/THUNDERHEAD submitted August 1965, replaced by IBM370 version of CURIE August 1978, sample problem executed by NESC August 1978 on an IBM370/195.
10. REFERENCES - G. P. Kenfield, W. R. Lahe, W. B. Sayer, R. H. MacAdams, W. A. Harris, CURIE-DOSE-THUNDERHEAD - A Digital Computer Program for External and Internal Radiation Dose Calculations, NAA-SR-8884, June 1965, and Errata
CURIE, ANL-RAS Note, August 1978
CURIE, NESC No. 198-370, Library Description, National Energy Software Center Note 78-31, August 18, 1978.
11. MACHINE REQUIREMENTS - 250K bytes of storage are required.
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 AUTHOR -
A. E. Klickman and P. H. Froehle
Reactor Analysis and Safety Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. MATERIAL AVAILABLE -
Source deck (422 cards)
Sample problem (4 cards)
Library data (382 cards)
Control information (JCL 43 cards)

Sample problem output (16 pages)
Reference report, Errata and Notes

17. **CATEGORY - G**
KEYWORDS - fission products, radioactivity, earth atmosphere, decay, inventories, buildup, reactor operation, DOSE codes, THUNDERHEAD codes, RIBD codes
18. **SPONSOR -** DOE Division of Reactor Research and Technology

1. NAME OR DESIGNATION OF PROGRAM - HEATING2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM370
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The numerical techniques used are the techniques developed by T. B. Fowler and E. R. Volk which were used in the Oak Ridge National Laboratory GHT code. The geometry section was added at ASTRA by R. R. Liguori and J. W. Stephenson and appeared as the original HEATING code.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
750 nodes
100 material regions
40 materials
6. TYPICAL RUNNING TIME - Less than 10 seconds is required for execution of the sample problem.
7. UNUSUAL FEATURES OF THE PROGRAM -
(a) Geometry described by lattice lines which results in a simplified input.
(b) Extensive printing under user control.
8. RELATED AND AUXILIARY PROGRAMS - GHT, a generalized heat conduction code for the IBM704 computer (ORNL-2174), and Atomic Power Development Associates HEATING code (ASTRA 417-5 0).
9. STATUS - Abstract first distributed February 1966.
IBM7094 version submitted by AI September 1965, replaced by IBM370 version submitted February 1976, sample problem executed by NESC May 1976 on an IBM370/195.
10. REFERENCES - R. D. Brunell, HEATING and HEATING 2, AI-64-MEMO-177, 1964.
Southern Services, Inc., User's Manual for Program EN8705SS (adapted from AI-64-MEMO-177), May 1975.
11. MACHINE REQUIREMENTS - 255K bytes memory 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 -
15. NAME AND ESTABLISHMENT OF AUTHOR -
Bobby D. Bell
Southern Services, Inc.
Perimeter Center East
P. O. Box 720071
Atlanta, Georgia 30346

16. MATERIAL AVAILABLE -

Source deck (1408 cards)
Sample problem (40 cards)
Reference user's manual

17. CATEGORY - H

KEYWORDS - heat transfer, one-dimensional, temperature, time dependence, transients, GHT codes, HEATING codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - DTF4
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360, CDC6600, GE625
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Energy dependence is treated by the multigroup approximation and angular dependence by a general discrete ordinates approximation. Anisotropic scattering is approximated by a truncated spherical harmonics expansion of the scattering kernel. Within-group scattering and up-scattering (if any) iteration processes are accelerated by system-wide renormalization procedures. Approximations and iterative cycles are described in detail in the DTF4 report.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The variable dimensioning capability of FORTRAN IV has been utilized so that any combination of number of groups, number of spatial intervals, size of angular quadrature, etc., can be used that will fit within the total core storage available to a user. The code itself requires about 8000 words, but it can be shortened by deleting certain subroutines which perform optional calculations.
6. TYPICAL RUNNING TIME - The IBM360 version took 3 minutes to compile and execute the sample problem.
7. UNUSUAL FEATURES OF THE PROGRAM - General anisotropic scattering capability is provided in each of the three geometries, up-scattering convergence acceleration is used, an optional group- and point-wise convergence test is available, and a neutron conserving negative flux correction routine is used.
8. RELATED AND AUXILIARY PROGRAMS - The code is a major revision of the DTF code. The report GAMLEG (reference 3) provides cross sections for photon transport problems in a form suitable for input to DTF4.
9. STATUS - Abstract first distributed February 1966
IBM7030 version submitted by LASL December 1965, deleted July 1978
IBM7094 version submitted by LER July 1966, deleted July 1978
GE625 version submitted October 1966
CDC6600 version submitted November 1966
IBM360 version submitted April 1967, revised July 1969, sample problem executed by NESC
10. REFERENCES - K. D. Lathrop, DTF-IV, A FORTRAN-IV Program for Solving the Multigroup Transport Equation with Anisotropic Scattering, LA-3373, July 15, 1965
B. G. Carlson, W. J. Worlton, W. Guber, and M. Shapiro, DTF Users Manual, UNC Phys/Math 3321, Volumes I and II, 1963
K. D. Lathrop, GAMLEG, CCA-115, Nuclear Science and Engineering, Vol. 24, February 1966
R. L. Brunnenmeyer and R. A. Mickle, DTF-IV GE-625 Version (NE101) Users Notes, Bechtel Note, July 1968
11. MACHINE REQUIREMENTS - No disks or tapes are used. A clock is used but, by removing a few program statements, this requirement can be eliminated.
12. PROGRAMMING LANGUAGES USED - FORTRAN IV (CDC6600), FORTRAN IV and MAP (GE625), FORTRAN IV and BAL (IBM360)

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 (IBM360), and SCOPE (CDC6600)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
 - 6600 K D Lathrop
Los Alamos Scientific Laboratory
P O Box 1663
Los Alamos, New Mexico 87545
 - 625 R L Brunnenmeyer and R A Mickle
Bechtel Corporation
50 Beale Street
San Francisco, California 94119
 - 360 G J Duffy
Applied Mathematics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
 - Source decks (6600-2071 cards, 625-2198 cards, 360-1863 cards)
 - Sample problems (6600-322 cards, 625-25 cards, 360-92 cards)
 - Reference report, LA-3373, and Notes
17. CATEGORY - C
KEYWORDS - transport theory, one-dimensional, multigroup, slabs, cylinders, spheres, criticality searches, anisotropic scattering, DTF codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - VARI-QUIR
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600, IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - The time-dependent, multigroup, two-dimensional neutron diffusion equations are solved in x-y or r-z geometry
4. METHOD OF SOLUTION - Modified-Euler with a single iteration The ICE subroutine is used (AAICE3 - integration with controlled error)
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 4 groups
 6 precursor groups
 36 regions
 20 different materials
6. TYPICAL RUNNING TIME - The running time is a function of the type of problem, the precision one wants, and the real problem time The sample problem that accompanies the 360 version takes a few minutes An actual reactor has been programmed using 5 by 7 regions, and the program took 1 hour 5 minutes to calculate the steady-state fluxes from scratch
7. UNUSUAL FEATURES OF THE PROGRAM - Feedback is introduced into the code through three subroutines to initialize the feedback, to carry it through, and to print out any desired feedback variables at various times These subroutines are written by the user, so that any desired feedback may be introduced
8. RELATED AND AUXILIARY PROGRAMS - VARI-QUIR requires the ICE subroutine
9. STATUS - Abstract first distributed February 1966
 IBM7090 version submitted December 1965, deleted May 1969
 CDC6600 version submitted May 1969
 IBM360 version submitted July 1969, sample problem executed by NESC
10. REFERENCES - J W Biese, G Collier, and C E Brack, VARI-QUIR, A Two-dimensional Time-dependent Multi-group Diffusion Code, WNL-TNR-133 Revised, December 1965
 E L Cox, 360 Version of VARI-QUIR, University of Missouri Note, July 16, 1969
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE (CDC6600) and OS/360 (IBM360)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
 6600 George Collier
 Industry and Defense Products
 Astronuclear Laboratory
 Westinghouse Electric Corporation
 Box 10864
 Pittsburgh, Pennsylvania 15236

 360 Edwin L Cox
 Research Reactor Facility
 University of Missouri
 Research Park
 Columbia, Missouri 65201

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (6600-2012 cards, 360-1896 cards)
Sample problems (6600-74 cards, 360-88 cards)
Reference report and Note
17. CATEGORY - C
KEYWORDS - space-time, two-dimensional, diffusion equations, x-y, r-z, neutron flux, feedback, ICE codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FSDP3
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - FSDP3 computes pointwise cross sections from single-level Breit-Wigner resonance parameters
4. METHOD OF SOLUTION - The cross section at each energy is computed from a summation of contributions from a specified number of neighboring resonances. The contribution from each resonance is expressed in terms of conventional symmetric and asymmetric Doppler line-shape functions which are calculated from convergent or asymptotic series approximations
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The maximum number of neutron energies is 5000 when the ENDF/B format input option is used and limited only by computing time considerations otherwise. A maximum of 3000 resonances per I-J state may be used with the ENDF/B format input option and 3000 s-wave resonances with the old input format. The number of resonances to be considered on each side of each neutron energy may be the same as the total number of resonances per I-J state except when the multilevel Breit-Wigner scattering option is used in which case a maximum of 100 resonances per I-J state on each side is allowed. Relative orbital angular momentum values l greater than 3 are not allowed ($l=0$ is an s-wave interaction). The mathematical assumptions needed to express the results in terms of the conventional Doppler line shape functions may be invalid at very low neutron energies. The basic formulation is incomplete for the very high temperatures attainable in stars or in nuclear explosions
6. TYPICAL RUNNING TIME - Approximately 0.1 second per neutron energy is required
7. UNUSUAL FEATURES OF THE PROGRAM - The true neutron energy dependence of the total resonance width is used. The multilevel Breit-Wigner scattering option is programmed so that no additional Doppler line-shape function evaluations are required when this option is used
8. RELATED AND AUXILIARY PROGRAMS - The FSDP2 (undocumented) and the FASDOP codes are earlier versions of the FSDP3 code
9. STATUS - Abstract first distributed July 1968
IBM7044 version of FASDOP submitted February 1966, deleted August 1972
UNIVAC1108 version of FSDP3 submitted August 1972
10. REFERENCES - D. R. Mathews, FSDP3, A Computer Program for Computing Cross Sections from Resonance Parameters, GULF-GA-A12052, April 5, 1972
C. A. Stevens, FASDOP, A FORTRAN IV Computer Program for Computing Cross Sections from Resonance Parameters, GAMO-6562, August 9, 1965
11. MACHINE REQUIREMENTS - 50,511 (decimal) words for data storage plus 7995 words for instructions, an optional cross section output tape, and 2 scratch files (tape or drum) are required
12. PROGRAMMING LANGUAGE USED - FORTRAN V
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC8
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - No unusual programming tricks are used. The program structure consists of a main program (FSDP3) and five subroutines (FSDP, UPON, REVERS, QPUN, and DELTM). Array equivalencing is used only for the punched output subroutine QPUN. Subroutine DELTM calls a system routine named TICKER which returns the time of day in units of 1/60 of a second. For a given orbital angular momentum l , only resonances with the same compound nucleus spin J (and hence the same statistical factor g) are allowed to interfere. This means that, in cases in which an average value of the spin J has been used for certain resonance levels because of insufficient experimental data, all such levels will interfere among themselves when the multilevel Breit-Wigner scattering option is used.

15. NAME AND ESTABLISHMENT OF AUTHOR -

D. R. Mathews
General Atomic Company
P. O. Box 81608
San Diego, California 92138

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (1063 cards)
Sample problem (94 cards)
Control information (25 cards)
Reference report, GULF-GA-A12052

17. CATEGORY - A

KEYWORDS - resonance, cross sections, Breit-Wigner formula, multilevel analysis,
scattering, FSDP2 codes, FASDOP codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GAMBLES
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The multigroup diffusion theory equations are approximated by five-point difference equations for an arbitrary non-uniform mesh-grid. The system of difference equations is solved by an extension of the power method to find the eigenvector (neutron flux) and the eigenvalue (k-effective). Successive line overrelaxation is applied in a special form (exponential overrelaxation) which guarantees the non-negativity of the neutron flux. Coarse mesh rebalancing is used to improve the pre-asymptotic convergence behavior. A variation of Aitken's method is used to improve the asymptotic convergence behavior, in assuming only one error mode.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 10 energy groups
 - 255 different material regions
 - 20,000 space mesh points
6. TYPICAL RUNNING TIME - A seven-group problem (3 fast groups and 4 thermal groups) in r-z geometry with 2842 mesh-points took 82 iterations assuming a tight convergence criterion (maximum relative flux change less than 0.00007). The total running time (including extensive output) was 12 minutes.
7. UNUSUAL FEATURES OF THE PROGRAM -
 - (a) The coarse mesh rebalancing scheme makes the successful solution of difficult problems possible for which certain group-mesh points are both strongly and weakly coupled to some of their neighbors (for example, highly non-uniform mesh spacings or material properties, airgaps, cell problems with weak group coupling, etc.)
 - (b) Good convergence behavior for large power reactor problems is accomplished by a combination of coarse mesh rebalancing and an asymptotic flux extrapolation procedure which assumes a single error mode.
 - (c) Simultaneous performance of computation and data transfer with virtually no delay caused by the use of drum storage.
 - (d) Ability to do efficient restarts for longer-running problems and the ability to accept a flux guess on tape from a similar problem.
8. RELATED AND AUXILIARY PROGRAMS - The original IBM7044 version of GAMBLES4 was prepared by J. P. Dorsey and R. Froehlich of General Atomic Company, San Diego, California. The programming effort of GAMBLES5 is a major revision of most of GAMBLES4. Most of the essentials of the iterative technique used have been adopted from EXTERMINATOR (NESC Abstract 156). It should also be noted that -
 - (a) the program uses a special Assembly language program called CTTS for drum and tape use,
 - (b) the program CTTS uses a special version of NTRAN which permits overwrites of selected records in a drum data file, and
 - (c) the program depends strongly on special features of the General Atomic 1108 EXEC2 operating system.

9. STATUS - Abstract first distributed July 1966
IBM7044 version (GAMBLE4) submitted by GGA February 1965, deleted July 1978
UNIVAC1108 version (GAMBLE5) submitted January 1968
10. REFERENCES - J. P. Dorsey, GAMBLE-4, A Program for the Solution of the Multigroup Neutron Diffusion Equations in Two Dimensions, with Arbitrary Group Scattering, for the IBM7044 FORTRAN IV System, GA-6540, July 1, 1965
J. P. Dorsey and R. Froehlich, GAMBLE-5, A Program for the Solution of the Multigroup Neutron-diffusion Equations in Two Dimensions, with Arbitrary Group Scattering, for the UNIVAC-1108 Computer, GA-8188, December 4, 1967
R. Froehlich, A Theoretical Foundation for Coarse Mesh Variational Techniques, Proceedings of the International Conference on Research Reactor Utilization and Reactor Mathematics, Volume 1, pp 219-237, May 2-4, 1967
T. B. Fowler, M. Tobias, and D. Vondy, EXTERMINATOR, A Multigroup Code for Solving Neutron Diffusion Equations in One and Two Dimensions, ORNL-TM-842, July 1966
11. MACHINE REQUIREMENTS - 65,536 words of core storage and 3 tape units on one data channel, 1,572,864 words of FH-880 drum storage from one data channel, and a peripheral printer
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and Assembly language
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - VERSION IX and EXEC2, GAX23
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
J. P. Dorsey and R. Froehlich*
General Atomic Company
P. O. Box 81608
San Diego, California 92138
*Present address-Kernforschungszentrum Karlsruhe
75 Karlsruhe, West Germany
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (18,043 cards)
Sample problem (48 cards)
Reference reports, GA-6540 and GA-8188
17. CATEGORY - C
KEYWORDS - diffusion equations, two-dimensional, multigroup, x-y, r-z, reactivity, neutron flux, GAMBLE4 codes, EXTERMINATOR codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - WAMPUM
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - WAMPUM follows a procedure similar to that outlined in Guide to Nuclear Power Cost Evaluation, TID-7025, Volume 4, with some modification to provide more generality in application.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - Less than 1 minute is required.
7. UNUSUAL FEATURES OF THE PROGRAM -
 - (a) Both government and private fuel ownership are considered.
 - (b) Capital costs of fuel cycle operations are evaluated directly, by applying an interest rate to the fabrication cost and inventory value, and implicitly, by holding constant the present value of each cost item over the irradiation period.
 - (c) Provision is made for distinguishing between fed and bred fuel.
 - (d) Two fuel particle types having different enrichments can be accommodated which permits calculations involving segregated fuel.
8. RELATED AND AUXILIARY PROGRAMS - The original IBM7044 version was prepared by F. W. Todt and J. R. Triplett of General Atomic Company, San Diego, California.
9. STATUS - Abstract first distributed July 1966.
IBM7044 version submitted by GGA February 1968, deleted July 1978.
CDC6600 version submitted April 1973.
10. REFERENCE - F. W. Todt and J. R. Triplett, A General Fuel Cycle Economics Code, GA-5316, October 27, 1965.
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 -
15. NAME AND ESTABLISHMENT OF AUTHOR -
Frank D. Tyson
Technical Computer Services
United Engineers and Constructors, Inc.
1401 Arch Street
Philadelphia, Pennsylvania 19105
16. MATERIAL AVAILABLE -
Source deck (1019 cards)
Sample problem (62 cards)
Reference report

17. CATEGORY - D

KEYWORDS - fuel cycle, economics, depletion, performance, fuel elements, REVISED GAD codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - OPUS
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - The program sets up a sparse matrix representing the flow of mass and energy in the system and solves the corresponding set of linear equations repeatedly, thus accounting for nonlinear effects
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Power levels from 100 to 1000 megawatts are acceptable. A maximum of 100 turbogenerator arrangements can be included. Systems up to 100 nodes leading to no more than 749 equations can be studied
6. TYPICAL RUNNING TIME - A 900 MW system is generated and analyzed in about 1.8 minutes
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed July 1966
IBM7044 version submitted February 1966, deleted February 1975
UNIVAC1108 version submitted February 1975
10. REFERENCES - F. S. Freudiger and J. E. Gratteau, OPUS, A Power Plant Performance Analysis Program, GAMD-6674, August 27, 1965
T. L. Emrick, TICKER Subroutine, March 16, 1966
11. MACHINE REQUIREMENTS - 32K machine with 5 tapes besides input and output tapes
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
J. E. Gratteau
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (10,722 cards)
Sample problem (37 cards)
Control information (309 cards)
Reference report and Subroutine Description
17. CATEGORY - D
KEYWORDS - coolants, performance, economics, gases, nuclear power plants
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - HFN
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1107, CDC6600, CYBER74
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Energy-space separability of the flux is assumed and a finite-difference approximation employed. The resulting flux equations are solved by a Gaussian forward-elimination, backward-substitution method. For more details, see reference 1.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -

Number of	Greater than or equal to	Less than or equal to
energy groups	2	20
regions	1	50
materials	1	100
group parameters		3500
groups-mesh points		2100
6. TYPICAL RUNNING TIME - Because of flexibility, the time required varies greatly. In a specific case of 10 groups, 100 mesh-points, 3 regions, direct flux only, no upscattering, approximately 10-20 seconds were used on the UNIVAC1107. CDC6600 times should be about one-fourth of the UNIVAC1107 times. NESC executed the sample problem for the CDC version in less than 25 seconds on a CDC6600.
7. UNUSUAL FEATURES OF THE PROGRAM - Many optional calculations are included such as criticality search on one variable, fission densities, power densities, and flux gradients, regionwise average fluxes, power, and fission densities, leakage cross sections, perturbation integrals, pointwise and groupwise direct-adjoint flux-gradient and flux products, and detector activation traverses. HFN does its own library tape updating, and includes surface, pointwise, or regionwise source specification options.
8. RELATED AND AUXILIARY PROGRAMS - HFN is an extensive modification of GE-ANPD program FN, and uses the LISTIV, generalized input routine.
9. STATUS - Abstract first distributed July 1966
 UNIVAC1107 version submitted March 1966
 CDC6600 version submitted April 1974, sample problem executed by NESC February 1979 on a CDC6600.
10. REFERENCES - P. G. Fischer, Multigroup, Multiregion, One Space Dimension Neutron Diffusion Theory Calculation - Program FN, XDC-60-3-68
 J. R. Lilley, Computer Code HFN - Multigroup, Multiregion, Neutron Diffusion Theory in One Space Dimension, HW-71545, November 17, 1981
 D. D. Matsumoto, LISTIV - A FORTRAN IV Generalized Input Routine, BNWL-41, March 1965.
11. MACHINE REQUIREMENTS - 64K UNIVAC1107 with 786,432 word drum (exclusive of system requirements), a tape unit, on-line printer, card reader and clock. The CDC version requires 122K (octal) words of memory.
12. PROGRAMMING LANGUAGES USED - FORTRAN IV (99.9%) and SLEUTH-11 (0.1%) (UNIVAC1107), FORTRAN IV (CDC6600).
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - CSC EXEC2 Package B (UNIVAC1107), SCOPE 3.4 (CDC6600).

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHORS -

1107 J. R. Lilley
Hanford Engineering Development Laboratory
P. O. Box 1970
Richland, Washington 99352

6600 A. J. Bell
Hanford Engineering Development Laboratory
P. O. Box 1970
Richland, Washington 99352

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (1107-3880 cards, 6600-3836 cards)

Sample problems (122 cards)

CYBER74 LISTIV routine (source-151 cards, test case-193 cards)

Reference reports, BNWL-41 and HW-71545

17. CATEGORY - C

KEYWORDS - diffusion equations, one-dimensional, multigroup, criticality searches, slabs, cylinders, spheres, LISTIV codes, FN codes

18. SPONSOR - AEC Division of Reactor Development and Technology

1. NAME OR DESIGNATION OF PROGRAM - FLOW-MODEL
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - The discontinuous nodal flow model approximation leads to a system of simultaneous nonlinear equations which are solved by iteration
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
20 channels
100 axial nodes
100 axial q points
6. TYPICAL RUNNING TIME - The sample problem requires 1 minute
7. UNUSUAL FEATURES OF THE PROGRAM - The program can use an SC-4020 graphical display device for plotting results
8. RELATED AND AUXILIARY PROGRAMS - The original IBM7094 version was prepared by R. F. Berland of the Mathematical and Computing Sciences Group, Atomic International, Canoga Park, California
9. STATUS - Abstract first distributed July 1966
IBM7094 version submitted by AI May 1966, deleted July 1978
IBM360 version submitted January 1971, sample problem executed by NESC
10. REFERENCES - D. E. Schramm and R. F. Berland, A Multi-channel Two-dimensional, Two-phase Flow Model and IBM7090 Code, NAA-SR-MEMO-9444, December 31, 1963
11. MACHINE REQUIREMENTS -
240K bytes 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 -
George W. Perry
Middle South Services, Inc
Box 81000
New Orleans, Louisiana 70160
16. MATERIAL AVAILABLE -
Source deck (370 cards)
Sample problem (35 cards)
Reference report
17. CATEGORY - H
KEYWORDS - two-dimensional, fluid flow, coolants, computer graphics, BWR reactors
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FLANGE1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - 3 minutes are required on the UNIVAC1108.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - GASKET (NESC Abstract 263)
9. STATUS - Abstract first distributed April 1967.
IBM7044 version submitted June 1966, deleted September 1969.
UNIVAC1108 version submitted September 1969.
10. REFERENCES - H. C. Honeck and Y. D. Naliboff, Appendix E Integral Neutron Thermalization Annual Summary Report October 1964 through September 1965, GA-6824, March 1966.
G. M. Borgonovi, Neutron Scattering Kernels Calculations at Epithermal Energies, GA-9950, March 17, 1970.
11. MACHINE REQUIREMENTS - 32K memory, 2 magnetic tapes, one scratch unit
12. PROGRAMMING LANGUAGE USED - FORTRAN V
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
G. M. Borgonovi
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE -
Source deck (869 cards)
Sample problem (5 cards)
Reference reports
17. CATEGORY - A
KEYWORDS - scattering law, cross sections, angular distribution, GASKET codes
18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - LASER
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - 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 nonlinearities 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.
4. **METHOD OF SOLUTION** - The methods used in solving the neutron transport equation are essentially those utilized by the MUFT and THERMOS programs. The nonlinear effects in the burnup equations are accounted for by computing the rate of change of the neutron flux with time and by using the Runge-Kutta numerical procedure to recover the flux as a function of time. The depletion equations are solved by assuming a polynomial expansion for exponential functions. The production and loss of chain members during irradiation are evaluated by simple matrix algebra. The procedure allows for a time-dependent flux in the form of a power series.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - This version of LASER is restricted to one-dimensional, cylindrical geometry. The maximum number of space points is 14, with a maximum of 5 space points in the fuel region. The code is restricted to 4 mixtures (moderator, non-absorbing heavy scatter, cladding, fuel). The moderator can be either light water (Neikm or free gas scattering kernel), or heavy water (Neikm scattering kernel). The cladding material can be stainless steel, aluminum or zircaloy-2. The fuel can be a metal oxide or cermet. The epithermal and fast energy ranges include 50 energy groups. The thermal range includes 35 energy groups. Only the U235 chain (through U236) and the U238 chain (through Pu242) are available in the code. The fission products are separated into Xe135, the directly-produced Sm149, and all other fission products lumped into one pseudo fission product. The cross sections for the lumped fission products are represented by polynomials in the burnup. The spatial distribution of U238 resonance captures within the fuel rods is given as input.
6. **TYPICAL RUNNING TIME** - The greater part of the LASER execution time is consumed by the THERMOS calculation. Execution times for no-burnup cases are approximately 1 to 2 minutes when the maximum number of space points is specified. For a burnup problem, execution time is 1 to 2 minutes when the linear approximation is chosen, and 4 to 6 minutes when nonlinear effects are included.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The program provides a complete edit for the lattice in the energy range 0 to 10 MeV, including integral quantities and homogenized few-group cross sections. The user has a choice of thermal neutron scattering kernels, resonance self-shielding treatments, and cell criticality searches. Linear and nonlinear treatments of the burnup equations are provided. The detailed spatial burnup distribution within the fuel rods is taken into account. A burnup problem can be continued after any time-step, by using the special input deck punched after each time-step.
8. **RELATED AND AUXILIARY PROGRAMS** - The original IBM7094 version of LASER was prepared by C. G. Poncelat of the Westinghouse PWR Plants Division, Pittsburgh, Pennsylvania. LIBP generates the thermal library tape. SIGI converts, by interpolation, the cross section data corresponding to a given energy mesh to cross section data suitable for input to the LIBP program.
9. **STATUS** - Abstract first distributed April 1967
IBM7094 version submitted by WAPD August 1966, deleted February 1977

IBM360 version submitted February 1973, replaced September 1973, replaced by Edition B February 1977, sample problem executed by NESC February 1977 on an IBM370/195

10. REFERENCES - C G Poncelet, Burnup Physics of Heterogeneous Reactor Lattices, WCAP-6069, June 1965
C G Poncelet, LASER - A Depletion Program for Lattice Calculations Based on MUFT and THERMOS, WCAP-6073, April 1966
LASER, ACC No 249 360, ACC Programming Note 74-7, October 1973
11. MACHINE REQUIREMENTS - 150K with library tape and 2 scratch 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 -
C E Carson
Nuclear Engineering Branch
Tennessee Valley Authority
303 Power Building
Chattanooga, Tennessee 37401
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (LASER 7778 cards, LIBP 385 cards, SIGI 165 cards)
2314 load module (LASER2 LOAD 383 blocks)
Sample problems (LASER 15 cards, LIBP 1496 cards)
Libraries (LASER 140 binary records)
Control information (JCL 20 cards)
Reference reports and ACC Note
17. CATEGORY - B
KEYWORDS - slowing-down, thermalization, spectra, reactor lattices, depletion, one-dimensional, cylinders, criticality searches, LIBP codes, SIGI codes, MUFT codes, THERMOS codes
18. SPONSOR - Tennessee Valley Authority Office of Power

1. NAME OR DESIGNATION OF PROGRAM - SAFE-PLANE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
UNIVAC1108, CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The finite-element method is used to construct a mathematical model by assembling discrete elements. The total potential energy of the structure is determined and subsequently minimized by iteration on components of the displacement field until static equilibrium of the structure is attained. Strains and stresses are computed from the resulting displacements.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
Multi-material structures with varying rigidities converge very slowly.
Not valid for incompressible materials.
Maximum number of nodal points = 675
Maximum number of elements = 1350
6. TYPICAL RUNNING TIME - Less than 3 minutes are required for a full capacity problem on the 1108.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - Other programs useful for stress analysis of prestressed concrete reactor vessels are SAFE-AXISYM and SAFE-PCRS for axisymmetric composite structures and SAFE-SHELL (NESC Abstract 253) for thin shells of revolution. On the 1108, ICON2 (a contour plotting program) plots the pointwise stress/strain output as a series of equal intensity contours. SAFE-PLANE replaces PIZZA.
9. STATUS - Abstract first distributed April 1967
IBM7044 version submitted August 1966, dated October 1967
UNIVAC1108 version submitted October 1967
CDC6600 version submitted July 1970
10. REFERENCES - Input Instructions for SAFE-PLANE Computer Program
Yusef R. Rashid, Analysis of Axisymmetric Composite Structures by the Finite Element Method, GA-8769, October 15, 1966
Prestress Concrete Reactor Vessels Analytical Methods Development, GACD-7256, June 1968
D. C. Cornell, SAFE-PLANE, A Computer Program for the Stress Analysis and Design of Two-dimensional Composite Bodies, A User's Manual, GA-7851, June 30, 1967
11. MACHINE REQUIREMENTS - Approximately 47000 words storage (decimal) plus the operating system (1108). Requirements can be easily reduced by simple adjustment of DIMENSION statements.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
1108 D. C. Cornell
General Atomic Company
P. O. Box 81608
San Diego, California 92138

6600 Morris Reich
 Brookhaven National Laboratory
 Upton, Long Island, New York 11973

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal (6600 version)
 Source decks (1108-1029 cards, 6600-1072 cards)
 Sample problems (1108-142 cards, 6600-735 cards)
 Reference reports and input instructions
17. CATEGORY - I
 KEYWORDS - stresses, two-dimensional, strains, static loads, finite element method, ICON2 codes, PIZZA codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SAFE-SHELL
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The finite-element method is used to construct a mathematical model by assembling discrete elements. The total potential energy of the structure is determined and subsequently minimized by differentiating the energy function with respect to each displacement component. The equilibrium equations are then solved by tri-diagonalization. Strains and stresses are computed from the resulting displacement field.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
Maximum number of nodal points = 181
Maximum number of elements = 180
Capacity can be easily increased at cost of storage requirements.
6. TYPICAL RUNNING TIME - Less than 3 minutes are required for a full capacity problem on the 1108.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - Other programs useful for stress analysis of prestressed concrete reactor vessels are SAFE-AXISYM and SAFE-PCRS for axisymmetric composite structures and SAFE-PLANE (NESC Abstract 252) for plane structures involving in-plane stress distributions.
9. STATUS - Abstract first distributed April 1967
IBM7044 version submitted August 1968, dated October 1967
UNIVAC1108 version submitted October 1967
10. REFERENCES - Input Instructions for SAFE-SHELL Computer Program
Finite Element Analysis of Axisymmetric Composite Structures, GA-6303, June 4, 1965
Yusef R. Rashid, Analysis of Axisymmetric Composite Structures by the Finite Element Method, GA-6763, October 15, 1965
Prestress Concrete Reactor Vessels Analytical Methods Development, GACD-7258, June 1966
D. C. Cornell, SAFE-SHELL, A Computer Program for the Stress Analysis of Thin-shell Bodies of Revolution, A User's Manual, GA-7852, June 30, 1967
11. MACHINE REQUIREMENTS - 32K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
D. C. Cornell
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE -
Source deck (1195 cards)
Sample problem (41 cards)
Reference reports, GA-6763, GACD-7258, GA-7852, and Input Instructions

17. CATEGORY - I

KEYWORDS - shells, stresses, mechanical structures, strains, finite element method

10. SPONSOR

1. NAME OR DESIGNATION OF PROGRAM - R101
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The method of solution was originally described in ANL-5577
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
Maximum number of delay groups = 20
6. TYPICAL RUNNING TIME - Less than 30 seconds was required to compile and execute the sample problem
7. UNUSUAL FEATURES OF THE PROGRAM - An interrupt facility is incorporated which permits parameter changes and edit or termination when a specified value of a parameter is attained
8. RELATED AND AUXILIARY PROGRAMS - R102 (NESC Abstract 168) is the inverse program
9. STATUS - Abstract first distributed April 1967
CDC3600 version submitted by ANL October 1966, sample problem executed by NESC, deleted July 1978
IBM7094 version submitted by WAPD November 1966, deleted July 1978
IBM360 version submitted February 1973, sample problem executed by NESC
10. REFERENCES - J. J. Kaganove, Reactor Kinetics, R101 AMD Program Library Report, October 7, 1964
R. O. Brillan, Some Problems in the Safety of Fast Reactors, ANL-5577, May 1956
11. MACHINE REQUIREMENTS - 240K bytes of 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 -
J. J. Kaganove
Applied Mathematics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. MATERIAL AVAILABLE -
Source deck (450 cards)
Sample problem (36 cards)
Reference report, AMD Program Library Report
17. CATEGORY - E
KEYWORDS - reactor kinetics, delayed neutrons, reactor period, reactivity, R102 codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - MANTA
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
GE635, CDC6600,7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The program embodies two independent analytical solutions. The solution proceeds by solving for the node temperatures of the first segment, evaluating the change in coolant temperature, and proceeding to calculate the temperatures of the second segment. This process continues until all segment temperatures have been evaluated. A pressure drop check on each coolant channel is then made which requires that all channel pressure drops be within specified input values. If these values are not converged, a new flow rate for each channel is derived and the solution repeated until convergence is achieved.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
200 nodes
1 to 100 internal nodes
101 to 150 surface nodes
48 coolant nodes
24 coolant channels
20 segments
6 connections per node except for the coolant nodes which have 5
6. TYPICAL RUNNING TIME - About 3 seconds per node are required on the GE635
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - MANTA uses the TIGERS method for thermal-hydraulics calculations
9. STATUS - Abstract first distributed April 1967
GE635 version submitted November 1966
CDC6600 version submitted January 1970
10. REFERENCES - S. F. Armour and D. L. Smith, MANTA-Mixing Analyzed Nodal Thermal-hydraulic Analysis, GEAP-4805, February 1965
Description-Steam Property Functions, 11 F001-F029
Nels J. Anderson, Jr., IOFTAP, A FORTRAN IV Function Subprogram, S6T001, January 15, 1965
System Routine ENSERT, CDC Note
BITA, GESJ Note
11. MACHINE REQUIREMENTS - 35K GE635, with 3 scratch tapes
12. PROGRAMMING LANGUAGE USED - FORTRAN IV

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GECOS (GE635) and SCOPE (CDC6600).
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - MANTA requires the use of steam properties which are not supplied, but a subroutine writeup is included. A tape definition subroutine writeup is also included. A CDC6600 system routine ENSERT was used to make the GE635 subroutine BITA operational. Also, on the CDC6600 it is necessary to use a MODE(0) control card, which prevents the error exit from the computer due to the generation of an infinite or indefinite (i. e. $X/0$). On the GE635, division by zero returns a 0.
15. NAME AND ESTABLISHMENT OF AUTHORS -

635	M. J. Stedwell, M/C 311 Nuclear Energy Division General Electric Company 175 Curtner Avenue San Jose, California 95125
635	B. G. Atraz Advanced Products Operation General Electric Company 210 De Guigne Drive Sunnyvale, California 94086
6600	E. H. Novendstern Advanced Reactors Division Westinghouse Electric Corporation Waltz Mill Site Box 158 Madison, Pennsylvania 15663
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (635-4774 cards, 6600-4940 cards)
Sample problems (635-206 cards, 6600-149 cards)
Sample problem output (6600-49 pages)
Reference reports and Notes
17. CATEGORY - H
KEYWORDS - fuel elements, temperature distribution, heat transfer, fluid flow
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - REAX
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - GE635
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - REAX calculates psi and chi functions and resonance cross sections as a function of energy for each resonance of each material. For hyperfine group structure, REAX calculates sources and fluxes at a specified radius using accumulated cross sections from all neighboring resonances. REAX integrates fluxes and cross sections over input energy ranges to obtain average values
6. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 5 fuel temperatures
 - 5 moderating materials
 - 3 fuel isotopes
 - 30 first fertile isotope resonances
 - 10 second fertile isotope resonances
 - 80 fissile isotope resonances
8. TYPICAL RUNNING TIME - A problem consisting of 27 resonances and 2500 hyperfine groups takes about two minutes per specified radius
7. UNUSUAL FEATURES OF THE PROGRAM - REAX includes provisions for background cross section approximations and for interference scattering in the first fertile isotope
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed April 1967
GE635 version submitted November 1966
10. REFERENCES - R. Protsik, Epithermal Capture and Fission Distribution in a Fuel Rod - The Computer Code REAX, GEAP-4973, April 1966
Nels J. Anderson, Jr., IOFTAP, A FORTRAN IV Function Subprogram, S6T001, January 15, 1965
11. MACHINE REQUIREMENTS - 35K GE635 with input and output media
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GE635 GEOS
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
 - R. Protsik
 - Advanced Products Operation
 - General Electric Company
 - 310 De Guigne Drive
 - Sunnyvale, California 94086
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
 - Source deck (1845 cards)
 - Sample problem (47 cards)
 - Reference reports
17. CATEGORY - B

KEYWORDS - cell calculation, resonance, fuel rods, epithermal neutrons, cross sections, capture, fission, DOPIE codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - EXPN
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - GE635
3. DESCRIPTION OF PROBLEM OR FUNCTION - EXPN analyzes pulsed neutron data using the Garelis-Russell 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.
4. METHOD OF SOLUTION - Using a weighted least squares technique the decay constant alpha is determined assuming an exponential decay, $\exp(\alpha t)$. An iterative type calculation is used to determine the parameter $(k\text{-beta}/l)$. The pulsed source induced delayed neutron background is computed and corrected for any extraneous source contribution. These contributions appear as a separate input and are normalized by the code to the number of sweeps of the problem. The sweeps refer to the repetition rate of the time analyzer. That is, the time analyzer repetition rate can be different from the repetition rate of the pulsed neutron source.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - A maximum of - 256 channels
6. TYPICAL RUNNING TIME - 6 seconds per sample are required
7. UNUSUAL FEATURES OF THE PROGRAM - EXPN will accept paper tape input provided the paper tape is converted to card images prior to input to the program.
8. RELATED AND AUXILIARY PROGRAMS - This program has been previously called EOSPUNS, or EXPLICIT.
9. STATUS - Abstract first distributed April 1967
GE635 version submitted November 1966
10. REFERENCES - E. Garelis and J. L. Russell, Jr., Theory of Pulsed Neutron Source Measurements, Nuclear Science and Engineering, Vol. 16, pp. 263-270, 1963.
E. Garelis and P. Meyer, Development of Pulsed Neutron Application to Power Reactor Start-up Procedures - Seventh and Eighth Quarterly Progress Reports, GEAP-4606, October 1, 1963 - March 31, 1964.
P. Meyer and C. L. Peterson, EXPN, January 14, 1964.
Nels J. Anderson, Jr., IOFTAP, A FORTRAN IV Function Subprogram, S6T001, January 15, 1965.
11. MACHINE REQUIREMENTS - 35K machine with input and output media
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GE635 GECOS
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
C. L. Peterson, M/C 311
Nuclear Energy Division
General Electric Company
175 Curtner Avenue
San Jose, California 95125

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (1308 cards)
Sample problem (360 cards)
Reference reports, EXPN and IDFTAP
17. CATEGORY - O
KEYWORDS - decay, data processing, least square fit, EXPLICIT codes, *EDSPUNS codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - MUSCAT
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - The concept of view factors has been utilized. The view factor is defined as the fraction of neutrons, leaving one surface in all directions, which is intercepted by a second surface. If there are n different surface areas, a system of n algebraic equations in n unknowns is used to yield the values of the total incident neutron currents. Double integrals are reduced to single integrals for computation.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The geometry of the cavity is limited to the three cases enumerated in item 3.
6. TYPICAL RUNNING TIME - An execution time of 1 to 2 minutes is required.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed April 1967
UNIVAC1108 version submitted December 1966
10. REFERENCE - M. J. Gerber and B. W. Roos, MUSCAT, A FORTRAN IV View Factor Shielding Code, GAMM-6776, December 8, 1965.
11. MACHINE REQUIREMENTS - 32K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
M. J. Gerber and B. W. Roos
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (3455 cards)
Sample problem (81 cards)
Reference report
17. CATEGORY - J
KEYWORDS - scattering, leaks, numerical solution, cylinders, neutron flux, cavities
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GADOSE/DOSET
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The array of first-order linear differential equations describing the physical system (a 6-isotope universal decay chain with 5 physical locations) was solved and the resulting algebraic expressions programmed to shorten running time. The computations are a series of exact solutions at the specified times.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The problem is restricted to 5 time solutions and 5 dose-distance solutions. There is no limit on the number of decay chains but each chain is limited to 6 isotopes. DOSET accepts up to 6 discrete fission-product activity additions as a function of time.
6. TYPICAL RUNNING TIME - On the UNIVAC1108 GADOSE summation printout requires 30 seconds, while GADOSE long print of all isotopes takes 1 minute. DOSET summation printout requires 1 minute, while DOSET long print of all isotopes takes 2 minutes.
7. UNUSUAL FEATURES OF THE PROGRAM - The algebraic solutions of the differential equations are programmed rather than solving the problem by a numerical integration scheme.
8. RELATED AND AUXILIARY PROGRAMS - There are two versions of GADOSE, the difference being the output provided. GADOSE1 prints all of the activities and doses for each isotope. GADOSE2 has a condensed edit of only the activities and dose summations by isotope classification.
9. STATUS - Abstract first distributed April 1967
UNIVAC1108 version submitted December 1966
10. REFERENCE - E. Lee, R. J. Mack, and D. B. Sedgley, GADOSE and DOSET - Programs to Calculate Environmental Consequences of Radioactivity Release, GA-6511, April 25, 1966.
11. MACHINE REQUIREMENTS - 32K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Input requires fission product decay chain library including isotope curves, decay constants, branching ratios, beta or gamma energy, and biological dose effectiveness (rem/curie inhaled), in addition to physical parameters for structural leakage, recirculation, filter efficiency, and meteorological data.
15. NAME AND ESTABLISHMENT OF AUTHOR -
D. B. Sedgley
General Atomic Company
P. O. Box 81608
San Diego, California 92138

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (5726 cards)

Reference report

17. CATEGORY - G

KEYWORDS - radioactivity, dose rates, fission products, HTGR reactors, isotopes, decay, production, earth atmosphere

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - MACH1
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC6500, IBM360,370/195
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - 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.
4. **METHOD OF SOLUTION** - The diffusion equation solution method is the same as that in AIM6 (NESC Abstract 28). Perturbation and effective beta routines have been adapted from DEL and 1188/RE. Remaining computations consist of straightforward data manipulation.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Maxima of -
 - 20 spatial regions
 - 150 mesh points
 - 20 energy groups
 - 5 modal spectra (IBM360 version)
 - 15 downscatter groups
 - 20 isotopes per problem
 - 20 homogenized materials
 - 20 isotopes per homogenized material

A special scatter treatment is used which allows full downscatter for hydrogen isotopes.
6. **TYPICAL RUNNING TIME** - Running time is strongly dependent on the type of problem and quality of initial guess. A k-calculation of a water-moderated system with 16 groups, 5 downscatter groups, 20 regions, and 130 mesh points, with a constant initial source guess converged in 11 inner iterations to within $10^{-5}(\Delta k/k)$ in 46.5 seconds. A composition search on a fast reactor core using 22 groups, 12 downscatters, 9 regions, 150 mesh points, and region-dependent initial source guess, converged with a total of 19 inner iterations and 3 trials to $10^{-6}(\Delta k/k)$, found the adjoint solution to the same accuracy and ran a single perturbation pass in 144.9 seconds. The IBM test without overlays took 8 seconds of CPU time on the Model 195.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The program was designed for use on fast reactor survey computations and as a supporting utility for more complex programs. Wielandt's method can be used in conjunction with the spectral synthesis option to greatly accelerate eigenvalue convergence. Problems can be run in sequence with only required data changes as input for problems after the first. The program contains a call to a non-existent overlay. This can provide a link to any routine written by the user for modification or manipulation of MACH1 output data. The routine has access to input data and data generated by the code, and can control later problems through option switches. Microscopic cross sections may be called from a library or input at run time. Individual cross section quantities may be modified temporarily for a problem.
8. **RELATED AND AUXILIARY PROGRAMS** - AIM6, DEL, and 1188/RE were adapted and modified to make up the major portions of the program.
The original CDC3600 version was prepared by D. A. Meneley of the Reactor Physics Division, Argonne National Laboratory, Argonne, Illinois.
9. **STATUS** - Abstract first distributed April 1967.
CDC3600 version submitted by ANL December 1966, deleted July 1978.
CDC6500 version submitted March 1969.
IBM360 version submitted January 1973, sample problem executed by NESC on an IBM370/195.
10. **REFERENCES** - D. A. Meneley, L. C. Kvilek, and D. M. O'Shea, MACH 1 A One-dimensional Diffusion Theory Package, ANL-7229, June 1966.
D. Meneley, MACH1 Guide and MACH1 Dictionary, ANL-RP Memoranda, June 1967.

1972 William G Price, MACH/360, University of Michigan Informal Documentation,
1951 H P Flatt and D C Baller, The AIM-6 Code, NAA Program Description, January
1965 L C Kvitek, DEL, A Perturbation Program Written in FORTRAN, ANL-7052, June
L C Kvitek, Multigroup Calculations of Effective Delayed-neutron Fractions,
Prompt Neutron Lifetime, and Related Kinetics Parameters, IBM-704 Program 1188/RE,
ANL-6511, March 1962

11. MACHINE REQUIREMENTS - The IBM360 version uses 5 tape drives and 1645K core storage assuming no overlay organization
12. PROGRAMMING LANGUAGES USED - FORTRAN IV (CDC6500, IBM360-98%), BAL (IBM360-2%)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 (IBM360) and SCOPE (CDC6500)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The program can be divided into six overlays with a total of eleven segments
15. NAME AND ESTABLISHMENT OF AUTHORS -
6500 K O Oll
Nuclear Engineering Department
Purdue University
West Lafayette, Indiana 47906

360 William G Price, Jr
Plasma Physics Laboratory
Princeton University
P O Box 451
Princeton, New Jersey 08540
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (MACH1 6500-7105 cards, 360-7661 cards, MACHLIB3 6500-479 cards, 360-509 cards)
Object decks (MACH1 360-4100 cards)
Sample problems (MACH1 6500-40 cards, 360-32 cards)
Libraries (MACHLIB3 6500-2145 cards, 360-2081 cards)
Control information (JCL 360-50 cards)
Reference report, ANL-7223, ANL-RP Memoranda, and for the IBM360 version, MACH 360 document
17. CATEGORY - C
KEYWORDS - diffusion equations, one-dimensional, multigroup, slabs, cylinders, spheres, criticality searches, reaction kinetics, averages, perturbation theory, DEL codes, AIM6 codes, 1188/RE codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GASKET
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - Neutron scattering kernels are obtained from the scattering law using the relation

$$\sigma(\alpha_0 \text{ to } \alpha, \theta) = (\sigma_{\text{tab}}/4\pi) \cdot \sqrt{(\alpha/\alpha_0)} \cdot \exp(-\beta/2) \cdot s(\alpha, \beta)$$
 where α_0 and α are, respectively, initial and final neutron energies, θ is the cosine of the neutron scattering angle in the laboratory, and α and β respectively, dimensionless momentum and energy transfers. GASKET calculates s at points of a 2-dimensional α, β mesh. Numerical methods are used to evaluate Fourier transforms of s . For very large values of α and β an option is included to use Wick's short collision approximation for s .
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 100 points in distributed frequency spectrum
 - 100 points in anisotropic part of the frequency spectrum
 - 2 discrete oscillators if $w_{\text{sub } 1}$ does not equal zero, otherwise 20
 - 20 phonon terms calculated for each delta line
6. TYPICAL RUNNING TIME - 10 minutes are required on the UNIVAC1108, 8 on the CDC6600
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - An auxiliary code, FLANGE (NESC Abstract 247), is used to generate cross section information from the scattering law
9. STATUS - Abstract first distributed April 1967
UNIVAC1108 version submitted December 1966, replaced by later version September 1969
10. REFERENCES - J. U. Koppel, J. R. Triplett, and Y. D. Haliboll, GASKET, A Unified Code for Thermal Neutron Scattering, GA-7417 Revised, March 10, 1967
GASKET Update Note, GGA Note
Integral Neutron Thermalization, Annual Summary Report, GA-8280, pp 146-152, September 30, 1967
11. MACHINE REQUIREMENTS - 32K machine with about 26K available for the program and one scratch unit (drum, disk, or tape)
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHORS -

Program J. U. Koppel, J. R. Triplet, and Y. D. Naliboff

Abstract D. H. Houston
General Atomic Company
P. O. Box 81608
San Diego, California 92138

16. MATERIAL AVAILABLE -

Source deck (1385 cards)
Sample problem (61 cards)
Reference report, Note, and GA-8280 Excerpt

17. CATEGORY - A

KEYWORDS - scattering law, incoherent scattering, moderators, FLANGE codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - RSAC
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The fission product inventory generated by the reactor operating conditions and the inventory remaining at various times after release are computed using the equations of W. Robinson in Journal of Chemical Physics, Vol. 17, pages 542-547, June 1949. The external gamma dose and the deposition gamma dose are calculated by determining disintegration rates as a function of space and time, then integrating using Hermite's numerical techniques for the spatial dependence. The inhalation-ingestion dose is determined by the type and quantity of activity inhaled and the biological rate of decay following inhalation. These quantities are integrated with respect to time to obtain the dosage. The ingestion dose is related to the inhalation dose by an input constant.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - About 6 minutes are required to run both sample problems.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed April 1967
IBM7040 (MAP) version submitted January 1967, deleted August 1968
IBM7040 (FORTRAN) version submitted August 1968, deleted July 1972
IBM360 version submitted July 1972, replaced by revised Edition B April 1975,
sample problem executed by NESC
10. REFERENCES - R. L. Coates and N. R. Horton, RSAC - A Radiological Safety Analysis Computer Program, IDO-17151, May 1966
L. C. Richardson, Users Manual for FORTRAN Version of RSAC, A Radiological Safety Analysis Computer Program, IDO-17281, May 1966
11. MACHINE REQUIREMENTS - 150K bytes and 1 tape drive
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 - Subroutines CVI, DATE, and TIMSET, and function SL are written in Assembly language.
15. NAME AND ESTABLISHMENT OF AUTHOR -
L. C. Richardson
EG&G Idaho, Inc
P. O. Box 1625
Idaho Falls, Idaho 83401
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (FORTRAN 2344 cards, BAL 679 cards)
2314 load module (120 blocks)
Sample problem (965 cards)
Control information (JCL 63 cards)
Reference reports

17. CATEGORY - G

KEYWORDS - radioactivity, fission products, dose rates, earth atmosphere

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - CYGRO2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The initial forces, dimensions, stresses and strains are assumed known. Fuel and clad are considered partitioned into concentric rings with stresses, strains, and material properties assumed uniform throughout. Strain rates, expressed in terms of deformation rates, are related to stress rates by the Prandtl-Reuss equations modified to include thermal expansion, growth, plasticity, and creep. The internal strain energy rate in a ring is equated to the external work rate to obtain equilibrium equations relating ring boundary loads to stresses and, in turn, ring deformation rates. These flexibility equations and the boundary condition equations are then solved to give the load and deformation rates of each ring and, in turn, stress and strain rates are determined. The size of the time increment is restricted so that maximum changes in stress and strain do not exceed specified limits. All rates are multiplied by the time increment and added to the value of the corresponding variable at the start of the time-step to determine their values at the end. This procedure is repeated until the end of the problem.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 54 rings
 5 gas pore regions
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - CYGRO1. The main difference between the two programs is the treatment of fuel swelling by irradiation. In CYGRO2 thermal conductivity is a function of both temperature and porosity, and elastic-plastic creep data are given in a table of properties for four temperatures instead of three as in CYGRO1. CYGRO2 uses the Bettis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed December 1967
 CDC6600 version submitted January 1967
10. REFERENCES - C. M. Friedrich and W. H. Gullinger, CYGRO-2, A FORTRAN IV Computer Program for Stress Analysis of the Growth of Cylindrical Fuel Elements with Fission Gas Bubbles, WAPD-TM-547, November 1966
 C. M. Friedrich, CYGRO-1, Stress Analysis of the Growth of Concentric Cylinders, WAPD-TM-514, October 1965, and Addendum 1, July 1966
 C. J. Pfeiler, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967
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 - There are calls made to a timing routine TICK which is a system subroutine and is not included in the CDC-6600 FORTRAN Programming Bettis Environmental Report package.

15. NAME AND ESTABLISHMENT OF AUTHORS -

G. M. Friedrich and W. H. Guiling
 Bettis Atomic Power Laboratory
 Westinghouse Electric Corporation
 Box 79
 West Mifflin, Pennsylvania 15122.

16. MATERIAL AVAILABLE - Restricted Distribution

Magnetic Tape Transmittal
 Source deck (3355 cards)
 Reference report, WAPD-TM-547

17. CATEGORY - 1

KEYWORDS - stresses, fuel elements, deformation, strains, temperature, pressure, cylinders,
 CYGRO1 codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - WATER
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The principal source of data is the steam tables adopted by the Sixth International Conference on the Properties of Steam. Bi-linear interpolation in pressure and temperature is used for interpolating the single-phase property tables while a cubic function is used to interpolate the saturation curves as a function of a single independent variable, either pressure or temperature. The ability to associate a property and derivative with a state outside the table limits has been included. The property is formed by linearly extrapolating the tabular data at constant pressure and/or constant temperature. The pressure or temperature gradient at the closest boundary is taken as the derivative. The reciprocal of pressure was used as an auxiliary coordinate to improve the linear interpolation in the specific volume.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The largest errors for enthalpy, specific heat, specific volume, and thermal conductivity occur near the saturation curve, especially near the critical point. The largest error in viscosity occurs at low temperatures.
6. TYPICAL RUNNING TIME - 2 to 6.5 milliseconds are required for one property plus two derivatives, i.e. one table look-up.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - WATER uses the Bellis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed December 1967
CDC6600 version submitted February 1967
10. REFERENCES - W. A. Colman and L. L. Lynn, WATER, A Large Range Thermodynamic and Transport Water Property FORTRAN IV Computer Program, WAPD-TM-568, December 1966.
C. J. Pfeifer, CDC-6600 FORTRAN Programming - Bellis Environmental Report, WAPD-TM-668, January 1967.
11. MACHINE REQUIREMENTS - The storage required for the property data is 2677 locations. Total storage requirement is about 4000 locations. There are no tape requirements.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - BKS8
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The WATER subroutine package is used by the FORTRAN IV call -
CALL WATER (P, H, T, X, PROP, N)
P = pressure, psia
H = enthalpy, btu/lb
T = temperature, degree F
X = quality defined by $(h - h_f)/(h_g - h_f)$
PROP = a 1-dimensional array of dimensions (at least 21 used for properties and derivatives as subroutine output)
N = an integer set to indicate which properties are to be determined and whether H, T, or X is to be supplied in addition to P.

A separate subroutine package provides saturated data in terms of one independent variable by the FORTRAN IV call -

CALL SATVLU (R1, R2, R3, R4, X, IND)

R1 = saturation property

R2 = saturation property slope

R3 = saturation vapor property

R4 = saturation vapor property slope

X = independent property

IND = indicator set to specify what the independent property is together with what properties and derivatives are to be supplied

15. NAME AND ESTABLISHMENT OF AUTHORS -

W A Colfman and L L Lynn
Bellis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 78
West Mifflin, Pennsylvania 15122

16. MATERIAL AVAILABLE - Restricted Distribution

Source deck (756 cards)

Reference report, WAPD-TM-568

17. CATEGORY - H

KEYWORDS - thermodynamics, water, pressure, temperature, liquids, vapors

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - CAESAR4/LIBLST
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - Standard finite-difference equations are used
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 20 regions
 - 20 elements in library
 - 12 elements per material
 - 10 materials
 - 100 intervals
 - 35 groups
 - 10 downscatter groups
 - 20 groups and 15 elements in resonance cross section calculation
6. TYPICAL RUNNING TIME - 1 to 3 minutes are required
7. UNUSUAL FEATURES OF THE PROGRAM -
 - (a) Non-homogeneous boundary conditions
 - (b) Fixed source calculation
 - (c) Convergence on search quantity as well as on eigenvalue of source
 - (d) Transverse buckling calculated or input as constant, group-dependent, region-dependent or group- and region-dependent
 - (e) Option to use source from previous case to start iteration
 - (f) Numerous printing options
 - (g) Data edits include flux normalization, peak-to-average power, median fission energy, median flux energy, mass fissile elements, breeding ratio by region and by reactor, neutron balance and reaction rates, mass and reaction rates by element, by region and reactor, integrated fluxes, median fission, absorption and flux energy by mesh point, total buckling punchout for AILMOE (NESC Abstract 147)
 - (h) Group- or group- and region-dependent fission spectrum
 - (i) Adjoint flux calculation
 - (j) Perturbation calculation using the PERT4 code (NESC Abstract 304)
 - (k) Nine different criticality searches
 - (l) Transport correction to diffusion coefficient
 - (m) Microscopic cross section library
 - (n) Input of microscopic and/or macroscopic cross sections
 - (o) Preparation of homogenized materials by cell calculation
 - (p) Resonance cross section calculation by ARES2 or by table interpolation in cell and/or reactor calculation
 - (q) Material-dependent cross section taps providing a different microscopic cross section library for each material
 - (r) Multiple case feature - only changes to previous case are required. Cell calculation can be rerun as well as reactor problems
8. RELATED AND AUXILIARY PROGRAMS -
 - (a) CAESAR4 is based on the AIM, FOG (NESC Abstract 28), FAIM (NESC Abstract 120), PERT (NESC Abstract 30) and ARES2 programs

(b) The microscopic library program, LIBLST

9. STATUS - Abstract first distributed December 1967
IBM360 version submitted April 1967
10. REFERENCES - D C Baller, CAESAR, Conversion to System/360, AI-66-MEMO-167, Vol I and Flowcharts, Vol II, December 1966
D C Baller and R A Blaine, LIBLST, Conversion to System/360, AI-66-MEMO-166, Vol I and Flowcharts, Vol II, December 1966
D C Baller and R A Blaine, LIBLST, A Library Preparation Program for the CAESAR IV Code, AI-66-MEMO-123, August 1966
R A Blaine, Atomics International Environment Report, May 1967
11. MACHINE REQUIREMENTS - 256K 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 -
R A Blaine*
Supervisor, Reactor Computing Systems Unit
Mathematics and Computer Sciences
Atomics International
P O Box 309
Canoga Park, California 91304
*Present address-IBM Palo Alto Scientific Center
Palo Alto, California 95014
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (CAESAR4 9302 cards, LIBLST 290 cards)
Object decks (CAESAR4 4506 cards, LIBLST 268 cards)
Sample problem (CAESAR4 798 cards)
Library (LIBLST 407 cards)
Reference reports (flowchart volumes may be requested on a loan basis only)
17. CATEGORY - C
KEYWORDS - diffusion equations, one-dimensional, multigroup, slabs, cylinders, spheres, criticality searches, AIM codes, FOG codes, FAIM codes, PERT codes, ARES2 codes, AILMOE codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - CLIP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - CLIP is the cross section library preparation and maintenance program for FORM and THREDES
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - 1 to 2 minutes are required
7. UNUSUAL FEATURES OF THE PROGRAM - CLIP -
 - (a) creates a FORM and/or THREDES library from cards,
 - (b) updates the FORM or THREDES library,
 - (c) lists the FORM or THREDES library,
 - (d) duplicates the FORM or THREDES libraryThe TEMPEST cross sections (for THREDES) may come from a decimal or hexadecimal library or an existing THREDES library. The FORM cross sections may come from cards or an existing FORM or THREDES library. The libraries may reside on disk or tape
8. RELATED AND AUXILIARY PROGRAMS -
 - (a) FORM library programs
 - (b) TEMPEST (NESC Abstract 50) library programs
 - (c) FORM (NESC Abstract 51)
 - (d) THREDES (NESC Abstract 273)
9. STATUS - Abstract first distributed December 1967
IBM360 version submitted April 1967
10. REFERENCES - R. F. Berland and R. A. Blaine, CLIP, Conversion to IBM System/360, AI-66-MEMO-168, Vol. I and Flowcharts, Vol. II, December 1966
R. F. Berland and R. A. Blaine, CLIP, A Program to Construct, Update and List the FORM or THREDES Master Data Tape, AI-CE-MEMO-12, March 1966
R. A. Blaine, Atomics International Environment Report, May 1967
11. MACHINE REQUIREMENTS - 256K 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 -

R. A. Blaine
Supervisor, Reactor Computing Systems Unit
Mathematics and Computer Sciences
Atomics International
P. O. Box 309
Canoga Park, California 91304
*Present address-IBM Palo Alto Scientific Center
Palo Alto, California 95014
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (929 cards)
Object deck (980 cards)
TEMPEST and FORM decimal libraries (7076 cards)
Reference reports (flowchart volume may be requested on a loan basis only)

17. CATEGORY - M

KEYWORDS - cross sections, libraries, maintenance, information retrieval, data processing, FORM codes, THREDES codes, TEMPEST codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FIGRO
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Fuel swelling is computed from either the Greenwood-Speight model or the assumption of fixed bubble number and spacing. Thermal conductivity of the cladding is a function of temperature. That of the fuel is calculated from a functional relationship involving temperature, depletion, porosity, and material properties. Heat transfer at gaps and interfaces is described by user-specified heat transfer coefficients or by a model based on conduction through a physical gap whose size is determined by fuel and clad differential thermal expansion, by fuel swelling, and by clad in-pile creep shrinkage. The gap gas conductivity is a function of temperature and gas composition. The transient conduction equations are solved by a Crank-Nicholson scheme for the fuel and a lumped parameter model for the clad.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Each fuel zone may be subdivided into a maximum of 50 concentric equal-thickness annuli for the calculation of temperature and fuel growth.
6. TYPICAL RUNNING TIME - The estimated running time is 2 seconds for a specified clad-surface flux problem and 10 seconds for a specified internal fuel temperature problem.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - In fuel element design studies FIGRO is used to set basic temperature parameters and as a survey tool for comparing depletion capabilities, with CYGRO (NESC Abstract 266) used to confirm the analysis of fuel element behavior. FIGRO uses the Bellis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed December 1967
Philco 2000 version submitted March 1967, deleted June 1968
CDC6600 version submitted June 1968, replaced by updated version January 1971
10. REFERENCES - I. Goldberg, L. L. Lynn, and C. D. Sphar, FIGRO - FORTRAN IV Digital Computer Program for the Analysis of Fuel Swelling and Calculation of Temperature in Bulk-oxide Cylindrical Fuel Elements, WAPD-TM-618, December 1966
L. A. Waldman, L. L. Lynn, and I. Goldberg, FIGRO (Addendum) - A CDC-6600 Computer Program for the Analysis of Fuel Swelling and Calculation of Temperature in Bulk-oxide Cylindrical Fuel Elements (LWBR-LSBR Development Program), WAPD-TM-618 Addendum I, October 1967
I. Goldberg and L. L. Lynn, FIGRO (Addendum II) - A CDC-6600 Computer Program for the Analysis of Fuel Swelling and Calculation of Temperature in Bulk-oxide Cylindrical Fuel Elements (LWBR-LSBR Development Program), WAPD-TM-618 Addendum II, April 1970
C. J. Pfeifer, CDC-6600 FORTRAN Programming - Bellis Environmental Report, WAPD-TM-666, January 1967
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3 1
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - FIGRO uses the INPF package described in reference 4
15. NAME AND ESTABLISHMENT OF AUTHORS -
L. L. Lynn, L. A. Waldman, I. Goldberg,
and C. D. Sphar
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (3302 cards)
Sample problem (37 cards)
Sample problem output (13 pages)
Reference report, WAPD-TM-618, and Addenda
17. CATEGORY - H
KEYWORDS - temperature distribution, fuel elements, cylinders, thermal expansion, depletion, heat transfer, fuel pellets
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - THREDES
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
 - BAM - assumes separability of space and energy - iterates between TEMPEST-II to obtain Wigner-Wilkins, Wilkins or Maxwellian-averaged cross sections and the cylindrical cell code to obtain thermal disadvantage factors. Physics data is made available for use in FORM and FOG or KINDLE.
 - FORM - solves the Fourier transform of the Boltzmann equation for the fast spectrum and prepares physics data for use in FOG or KINDLE.
 - FOG - solves the 4-group diffusion theory approximation to the one-dimensional transport equation using a standard finite-difference scheme.
 - KINDLE - performs an analytic solution of isotope equations and reactivity equations.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - BAM -
 - 10 regions
 - 100 space points
 - 20 isotopes per region
 - FORM -
 - 18 different isotopes
 - FOG -
 - 4 groups
 - 238 space points
 - KINDLE -
 - 2 groups
6. TYPICAL RUNNING TIME - 5 to 10 minutes are required
7. UNUSUAL FEATURES OF THE PROGRAM -
 - (a) Emphasis on multiple cases with only changes specified to allow rapid parameter surveys.
 - (b) Ability to use modules individually.
 - (c) Use of modules as an integrated system to prepare data for one another.
 - (d) Ability to perform entire reactor design calculations in one computer run.
8. RELATED AND AUXILIARY PROGRAMS - CLIP (NESC Abstract 271) combines the library preparation programs for FORM and TEMPEST (NESC Abstract 50) and is used to generate, print and/or maintain TEMPEST, FORM, and THREDES libraries on tape or disk.
9. STATUS - Abstract first distributed December 1967
IBM360 version submitted April 1967
10. REFERENCES - R. A. Blaine, THREDES, Conversion to IBM System/360, AI-66-MEMO-169, Vol. I and Flowcharts, Vol. II, December 1966.

R A Blaine, THREDES, Atomics International Thermal Reactor Design System,
AI-CE-MEMO-11, March 1966

R A Blaine, Atomics International Environment Report, May 1967

11. MACHINE REQUIREMENTS - 256K 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 - If an SC-4020 graphical display device is available, AICRT4 and the NAA SC-4020 subroutine package are available through -

UAIDE Librarian
c/o Stromberg-Carlson
P O Box 2449
San Diego, California
15. NAME AND ESTABLISHMENT OF AUTHOR -

R A Blaine
Supervisor, Reactor Computing Systems Unit
Mathematics and Computer Sciences
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Canoga Park, California 91304
-Present address-IBM Palo Alto Scientific Center
Palo Alto, California 95014
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (7973 cards)
Object deck (6527 cards)
Sample problem (252 cards)
Reference reports (flowchart volume may be requested on a loan basis only)
17. CATEGORY - K

KEYWORDS - reactors, design, one-dimensional, cell calculation, neutron spectra, diffusion equations, depletion, BAM codes, FORM codes, FOG codes, KINDLE codes, CLIP codes
18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - WIGL2
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC6600, UNIVAC1108, IBM370
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - 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.
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.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - For the 6600 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. For the 1108 -
 let i = number of delay groups
 n = number of compositions
 ndt = number of changes in time-step size
 p = number of spatial points
 k = number of thermal-hydraulic regions
 r = number of nuclear regions
 then $(3 \cdot ndt + (3+i) \cdot r + 40 \cdot n + 6 \cdot k + (8+i) \cdot p + i)$ less than
 or equal to 12,000
 and $(26 \cdot p + r + 18 \cdot k + 12)$ less than or equal to 16,000
6. **TYPICAL RUNNING TIME** - On the 6600 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. On the 1108 a problem with 50 spatial points and one delayed neutron group requires 0.10 second per time-step, one with 75 spatial points requires 0.16 second per time-step. NESC executed the sample problem with 21 points, one delayed neutron group and 100 time-steps in 1.16 CPU seconds on an IBM370/195.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The theta-method used in the difference equations is unique in WIGL2. Also, the program performs an automatic criticality rod search and contains rather complete feedback.
8. **RELATED AND AUXILIARY PROGRAMS** - WIGL2 for the CDC6600 is a slightly modified version of the FORTRAN II program, WIGL2, as written for the Philco 2000. It represents an extension of the program WIGLE (WAPD-TM-416). The CDC6600 version of WIGL2 uses the Bellis Environmental Routines (NESC Abstract 478).
9. **STATUS** - Abstract first distributed December 1967
 CDC6600 version submitted April 1967
 UNIVAC1108 version submitted October 1967
 IBM370 version submitted October 1978, sample problem executed by NESC July 1978 on an IBM370/195

10. REFERENCES - A F Henry and A V Vola, 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, and Addendum 1, January 1967
C J Pleifer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967
Stephen Johnson, WIGL2 Modified for Use on the UNIVAC 1108, A Supplement to the Westinghouse Report Number WAPD-TM-532, GAMO-7545, June 1967
E T Dugan and R E Rogers, NOTES ON THE IBM370 VERSION OF WIGL2, University of Florida Note, September 28, 1976
11. MACHINE REQUIREMENTS - On the 6600 WIGL2 requires 130,000 (octal) central memory words and one disk is used 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. On the 1108 64K of core memory and 2 tapes (input and output) are used. The 370 version uses 350K bytes of memory and a card punch.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 2 0 (CDC6600), EXEC 2 GAX27 (UNIVAC1108), and OS/370 (IBM370)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The required CDC software environment is described in reference 2. It includes routines for program loading, input conversion, and the storage, retrieval, and processing of permanent files. The IBM370 version should be compiled with the H-extended compiler with the OPT=2 and AUTOBL(OBLPAD4) options. Input data for the 370 differ slightly from those used by the 1108 version. The sample problem writes output to the punch unit.
15. NAME AND ESTABLISHMENT OF AUTHORS -
6600 Author A V Vola
Contact L D Eisenhart
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 78
West Mifflin, Pennsylvania 15122

1108 Stephen R Johnson
General Atomic Company
P O Box 81608
San Diego, California 92138

370 E T Dugan and R E Rogers
Department of Nuclear Engineering Sciences
University of Florida
202 Nuclear Sciences Center
Gainesville, Florida 32611
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source decks (6600-4489 cards, 1108-4041 cards, 370-4144 cards)
Sample problems (6600-32 cards, 1108-50 cards, 370-48 cards)
Reference reports, WAPD-TM-532, GAMO-7545, Addendum, and Note appropriate to machine version
17. CATEGORY - F
KEYWORDS - space-time, one-dimensional, diffusion equations, two-group, slabs, cylinders, spheres, heat transfer, xenon, temperature, control, feedback, WIGLE codes
18. SPONSOR - AEC Division of Naval Reactors

1. **NAME OR DESIGNATION OF PROGRAM** - PDQ8, PDQ7
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC7600, 6600, IBM360
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - 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.
4. **METHOD OF SOLUTION** - For the explicit spatial solution, difference equations are obtained at each point by integrating the differential equations over an appropriate mesh element. The resulting equations are three-point, five-point, seven-point, and nine-point for one dimension, two-dimensional rectangular, two-dimensional hexagonal and three-dimensional rectangular, two-dimensional quadrilateral and three-dimensional hexagonal. The group equations are solved directly using Gauss elimination in one dimension, by use of the single-line cyclic Chebyshev semi-iterative method in two dimensions, and by use of the single-line successive overrelaxation method in three dimensions. The source iterations are accelerated by use of Chebyshev extrapolation applied to the group fluxes. The synthesis solution utilizes the axially discontinuous trial function formulation and solves the iterative problem by use of the Weilandt method. The feedback capabilities are implemented by utilizing a system of time-dependent cross sections and generalized depletion chains.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The total number of groups is limited to five, although six equations may be solved if the P(3) option is used. All storage is dynamic so no fixed problem size limits are imposed. However, as a general rule, the product of groups and points in an explicit solution is limited to roughly ten million due to disk capacity limitations. For synthesis calculations, the disk capacity limitation of about thirty million will limit the product of the number of gross blocks per plane and the number of trial functions or the product of the total number of gross blocks and the number of isotopes. These disk capacity limitations are for the CDC7600, the capacity of the CDC6600 is about one-tenth of the stated limitations.
6. **TYPICAL RUNNING TIME** - The PDQ8 program can solve two-dimensional problems at the rate of about one million group-points per hour and three-dimensional problems at the rate of about one-half to three-quarters of a million group-points per hour on the CDC7600. The CDC6600 PDQ8 times would be about five times the CDC7600 times. The synthesis spatial solution time is dependent on the number of trial functions used and the number of gross blocks. The actual running times may vary widely due to the convergence rate of the iterations, the use of control searches or feedbacks, or the complexity of the depletion formulation. PDQ7 running time in hours on a CDC6600 may be estimated by dividing the product of groups and points by 150,000. Sample problem running time on the IBM360/195 is about 4 minutes.
7. **UNUSUAL FEATURES OF THE PROGRAM** - Except for the group flux spatial calculation, both explicit and synthesis solutions utilize the same input, calculational, and edit portions of the program so that consistent comparisons of the two methods can be easily obtained.
8. **RELATED AND AUXILIARY PROGRAMS** - Cross sections, or tables, may be input on cards and/or may be obtained from a File Manager (reference 2) input file. Input card data may be merged with card data from one or more File Manager input files. The program will also

accept input File Manager files containing pointwise flux, block concentrations, geometry, block flux, synthesis integrals, and, in PDQ8, quadrilateral geometry figures. On request, the program will prepare File Manager output files containing pointwise flux, block concentrations, partition power, various edit integrals, geometry, gross block power, block flux, synthesis mixing coefficients, synthesis integrals, fine block power, and PDQ8 quadrilateral geometry figures.

The water properties required for thermal feedback calculations are obtained from a package of subroutines described in reference 3. PDQ8 uses the BETTIS ENVIRONMENTAL LIBRARY (NESC Abstract 665) and the M0899/HOH package (NESC Abstract 294). The EG&G CDC7800 version of PDQ7 uses a proprietary MODEL library from CDC. The EG&G IBM360 version of PDQ7 contains necessary NRTS Environmental Subroutines (NESC Abstract 613).

9 STATUS - Abstract first distributed December 1967

CDC6600 (BETTIS) version of PDQ7 submitted May 1967, replaced by revised Edition C June 1971, replaced May 1979 by CDC7600 version of PDQ8 submitted November 1978, program compiled by NESC January-February 1979 on a CDC7600
 IBM360 (IBM) version of PDQ7 submitted February 1969, deleted November 1971
 CDC6600 (B&W) version of PDQ7 submitted February 1970, deleted May 1979
 IBM360 (EG&G) version Edition B of PDQ7 submitted April 1970, revised to Edition C April 1971, replaced by Edition D August 1972, Edition E March 1973, Edition F March 1974, Edition G February 1977, sample problem executed by NESC March 1974 on an IBM370/195
 CDC6600 KRONOS (Boeing) version of PDQ7 submitted July 1973
 CDC7600 (EG&G) version of PDQ7 submitted January 1977

**10. REFERENCES - C. J. Pfeifer and C. J. Spitz, PDQ-8 Reference Manual, WAPD-TM-1266, May 1978
 W. R. Cadwell, Ed., Reference Manual - Bettis Programming Environment, WAPD-TM-1181, September 1974**

L. L. Lynn, A Digital Computer Program for Nuclear Reactor Design Water Properties, WAPD-TM-680, July 1967
 PDQ8, NESC No. R275 7600B, Tape Description and Implementation Information, National Energy Software Center Note 78-43, March 31, 1979
 W. R. Cadwell, PDQ-7 Reference Manual, WAPD-TM-678, January 1967
 R. J. Breen, O. J. Marlowe, and C. J. Pfeifer, HARMONY - System for Nuclear Reactor Depletion Computation, WAPD-TM-476, January 1965
 R. J. Wagner, ACC No. 275 360D-G, Operational Notes for PDQ7/14, ANC Note, August 25, 1972
 C. J. Pfeifer, PDQ-7 Reference Manual II, WAPD-TM-947(L), February 1971
 C. J. Pfeifer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967
 PDQ7 Transmittal Tape (ACC 275 360D-G), ANC Note, January 18, 1973
 A. W. Brown, J. A. McClure, and R. J. Wagner, Summary of PDQ-7 (IBM-360-370 Version) Input Data Requirements and Operating Procedures, ANCR-1061, March 1972
 UPD, A Program to Update Source Decks, ANC Note P01750, March 1972
 NRTS Environmental Subroutine Manual, ANC Document, December 1972
 PDQ7, ACC No. R275 6600D, Argonne Code Center Programming Note 74-16, December 3, 1973
 PDQ7, ACC No. 275 7600, Argonne Code Center Note 78-4, November 1, 1977
 R. J. Wagner, INEL Transmittal of PDQ7 Version 2, INEL Note, January 21, 1977
 R. J. Wagner, FAPFIM - Fortran Access to Permanent File Macros, INEL Note, October 11, 1976

11. MACHINE REQUIREMENTS - On CDC systems the central memory size should be at least 65K, the program will utilize up to 1000K of extended core memory, and up to four disks transferring in parallel. The IBM360 version of PDQ7 requires at least 400K bytes of memory and auxiliary disk storage (Models 2314 or 3330)

12. PROGRAMMING LANGUAGES USED - PDQ8 - FORTRAN and COMPASS (RUN and FTN compatible), PDQ7 - FORTRAN and ASCENT (CDC6600), FORTRAN FTN4 8 (CDC7600), FORTRAN IV (H) and BAL (IBM360)

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - PDQ8 - SCOPE 1 1 (CDC7600), SCOPE 3 3 (CDC6600), PDQ7 - KRONOS 2 0 (CDC6600), SCOPE 2 1 4 (CDC7600), OS/360 (IBM360)

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The required PDQ8 software environment is described in reference 2 and that for PDQ7 in reference 9. It includes routines for program loading, free-field input conversion and processing, storage and retrieval of permanent File Manager files, scratch input/output, storage allocation, and plotting. All files used to communicate with other jobs, including other PDQ8 jobs, are in File Manager form.

The EG&G CDC7600 version of PDQ7 is also operable on a CDC6600 under the SCOPE 3.4 or NOS operating systems with the modifications described in reference 16.

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

6600 PDQ7 W. R. Cadwell and C. J. Pfeifer

7600B PDQ8 C. J. Pfeifer and C. J. Spitz
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Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122

360A PDQ7 R. J. Creasy
International Business Machines Corporation
2670 Hanover Street
Palo Alto, California 94304

360B-G PDQ7 R. J. Wagner and A. W. Brown
7600 Computer Science Branch
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401

360B-G PDQ7 J. A. McClure
Energy Incorporated
P. O. Box 738
Idaho Falls, Idaho 83401

6600 B&W PDQ7 M. L. Dech and R. W. McCraney
Control Data Corporation
G. R. Poetschat and G. L. Russell
Power Generation Division
Babcock & Wilcox Company
P. O. Box 1260
Lynchburg, Virginia 24505

6600 KRONOS F. M. Knox
PDQ7 Boeing Computer Services, Inc.
P. O. Box 24346
Seattle, Washington 98124

16. **MATERIAL AVAILABLE - Restricted Distribution**

Magnetic Tape Transmittal

Source decks (PDQ8 96,804 cards, PDQ7 EG&G 360-38,268 cards)

Update files (Boeing UPDATE OLDPL of PDQ7 6600-238 records, UPDATE OLDPL of Bettis Environmental Routines 6600-130 records, MODIFY OPL of PDQ.MFN,CATLIST 6600-20 records, EG&G UPDATE OLDPL of PDQ7 7600-519 records, UPDATE OLDPL of INP subroutines 7600-29 records, UPDATE OLDPL of INEL environmental library source 7600-80 records)

Load module (2314 EG&G PDS PDQTRMT 360-1862 blocks)

Load module (3330 EG&G PDS PDQTRMT 360-1862 blocks)

Sample problems (PDQ8 518 cards, PDQ7 EG&G 360-761 cards)

Auxiliary programs (PDQ7 EG&G BUFR 360-246 cards, PDQD1 360-31 cards, PDQD 360-148 cards, PDQR 360-107 cards, PDQTL 360-53 cards, miscellaneous 360-3135 cards)

Flux files (PDQ7 EG&G 360-137 blocks)

Water property file (PDQ7 EG&G 7600-15 records)

PDQ7 loader directives (EG&G 7600-2 records)

Sample problem output (PDQ7 EG&G 360-196 pages)

Reference reports, WAPD-TM-678, WAPD-TM-668, WAPD-TM-947(L), WAPD-TM-1268, ANCR-1061, NRTS Manual, and Notes, as appropriate

17. CATEGORY - D

KEYWORDS - depletion, diffusion equations, one-dimensional, slabs, iterative methods, cylinders, spheres, two-dimensional, x-y, r-z, three-dimensional, x-y-z, synthesis, few-group, hexagonal configuration, HARMONY codes, UPD codes, BUFR codes, PDQDI codes, PDQD codes, PDQR codes, PDQTL codes

18. SPONSOR - DOE Division of Naval Reactors

1. NAME OR DESIGNATION OF PROGRAM - AVOID
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - GE625
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - Given the inner and outer radii of a void annulus, the neutron flux ratio across the annulus, and the effective escape probabilities for neutrons entering the void, the code computes the effective diffusion coefficient and loss cross section which are consistent with a P_1 flux expansion in the void
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maximum of -
100 equal intervals at which the gap flux is calculated
6. TYPICAL RUNNING TIME - The eight sample problems used 5 seconds of processor time on the GE625
7. UNUSUAL FEATURES OF THE PROGRAM - A FORTRAN IV Bessel function subroutine for J_0 , J_1 , K_0 , K_1 is included
8. RELATED AND AUXILIARY PROGRAMS - AVOID can be used as a subroutine of one-dimensional diffusion or transport codes for radial calculations, thus eliminating the need for a prior knowledge of the flux ratio across the gap
9. STATUS - Abstract first distributed December 1967
GE625 version submitted May 1967
10. REFERENCE - W. B. Henderson, Program AVOID, NMP-438, A FORTRAN IV Program for Evaluating the Equivalent Diffusion Coefficient and Loss Cross Section of an Annular Void in Cylindrical Reactors, GEMP-424, April 15, 1968
11. MACHINE REQUIREMENTS - 12K core memory exclusive of system use
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GECOS
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The main program uses 1170 (octal) locations plus 1454 (octal) locations of common storage. The Bessel subroutine uses 374 (octal) locations. The program should compile on any system having the NAMELIST feature
15. NAME AND ESTABLISHMENT OF AUTHOR -
W. B. Henderson
Nuclear Materials and Propulsion Operation
General Electric Company
Cincinnati, Ohio 45215
16. MATERIAL AVAILABLE -
Source deck (190 cards)
Sample problem (12 cards)
Reference report
17. CATEGORY - B
KEYWORDS - annular space, cross sections, neutron flux, cylinders
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - HAMMER/LITHE/HELP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - HAMMER performs infinite lattice, one-dimensional cell multigroup calculations, followed (optionally) by one-dimensional, few-group, multiregion reactor calculations with neutron balance edits
4. METHOD OF SOLUTION - Infinite lattice parameters are calculated by means of multigroup transport theory, composite reactor parameters by few-group diffusion theory
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
 - Cell calculations - maxima of
 - 30 thermal groups
 - 54 epithermal groups
 - 20 space points
 - 20 regions
 - 18 isotopes
 - 10 mixtures
 - 3 thermal upscattering mixtures
 - 200 resonances per group
 - no overlap or interference
 - single level only
 - Reactor calculations - maxima of
 - 40 regions
 - 40 mixtures
 - 250 space points
 - 4 groups
6. TYPICAL RUNNING TIME - LITHE requires 1 minute, HELP 9 minutes, and HAMMER 2 minutes on the IBM360/65
7. UNUSUAL FEATURES OF THE PROGRAM - HAMMER combines THERMOS (NESC Abstract 184), MUFT, ZUT, TUZ, FOG (NESC Abstract 28), plus thermal Fourier transform, epithermal integral transport space-dependant group fluxes, and neutron balance edits from a single set of input data as well as a library of cell results, compatible reactor/exponential assembly criticality searches from the library
8. RELATED AND AUXILIARY PROGRAMS - LITHE prepares a thermal library for the HAMMER version of THERMOS and includes epithermal scattering sources. HELP prepares an epithermal library for the HAMMER versions of MUFT, ZUT, TUZ, and cell space-dependent calculations. It accepts slightly modified MUFT libraries plus resonance parameters, either probability matrix or inelastic cross sections
9. STATUS - Abstract first distributed December 1967
 - IBM7090 version submitted July 1967, deleted March 1971
 - IBM360 version submitted July 1967, replaced by second version March 1971, sample problem executed by NESC
10. REFERENCES - J. E. Suich and H. C. Honeck, The HAMMER System, DP-1064, January 1967
C. E. Bailey, HAMMER/LITHE/HELP Notes, DP Note, March 8, 1971
11. MACHINE REQUIREMENTS - 512K bytes and 10 sequential data sets
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and BAL
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. C. Honeck
Savannah River Laboratory
E. I. duPont de Nemours and Co., Inc.
Aiken, South Carolina 29801

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (HAMMER 13,157 cards, LITHE 440 cards, HELP 628 cards)
Sample problems (HAMMER 9 cards, LITHE 3911 cards, HELP 6162 cards)
Control information (JCL HAMMER 214 cards, LITHE 21 cards, HELP 22 cards)
Sample problem output (HAMMER 33 selected pages, LITHE 21 selected pages, HELP 47 selected pages)
Reference report and Note

17. CATEGORY - B

KEYWORDS - cell calculation, one-dimensional, epithermal neutrons, thermal neutrons, group constants, neutron flux, LITHE codes, HELP codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - WHAM6
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
IBM360,370, CDC6600,7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The unsteady fluid motion is described by the set of mass, momentum, and energy conservation laws, the equation of state for the fluid, and the initial and boundary conditions for all dependent variables. The well-known water-hammer equations for liquid-filled pipes are then evaluated by use of the wave superposition method. The frictionless case may be considered if desired.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 100 legs (see item 14)
 50 nodes per leg (see item 14)
 2 different valves or breaks (additional ones have the properties of the second one)
 4 pumps
 1 pressurizer
 1 case per execution
 Turbine operation range is not considered because it is assumed that each pump is provided with a check valve.
6. TYPICAL RUNNING TIME - To compile and execute the sample problem 3 minutes (IBM370/195), 40 CP seconds (CDC7600)
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - WATER-HAMMER, WHAM, WHAM2, BURST (NESC Abstract 435), and BAM. WATER-HAMMER, WHAM, and WHAM2 are earlier editions of WHAM6. S. Fabric developed the original WATER-HAMMER program at Kaiser Engineers. WHAM was prepared at Kaiser Engineers as a successor to WATER-HAMMER, and converted to the IBM360 at the University of Missouri-Columbia. The WHAM2 edition was written at Aerojet Nuclear Company.
9. STATUS - Abstract first distributed December 1967
 WATER-HAMMER
 CDC3600 version submitted May 1967, replaced by WHAM December 1967, deleted February 1976
 IBM360 version submitted July 1967, replaced by WHAM January 1974, deleted February 1976
 WHAM
 CDC3600 version submitted December 1967, revised September 1969, sample problem executed by NESC on a CDC3600, deleted February 1976
 IBM360 version submitted January 1974, sample problem executed by NESC May 1974, deleted February 1976
 WHAM2
 IBM360 version submitted August 1974, sample problem executed by NESC, deleted February 1976
 CDC6600 version converted from IBM360 version by NESC September 1974, sample problem executed by NESC, deleted February 1976
 WHAM6
 IBM360 version submitted October 1975, replaced by revised Edition 8 July 1977, sample problem executed by NESC July 1977 on an IBM370/195

CDC7600 version converted from IBM360 version by NESC November 1975, replaced by revised Edition B July 1977, sample problem executed by NESC July 1977 on a CDC7600

10. REFERENCES - Stanislaw Fabic, Computer Program WHAM for Calculation of Pressure, Velocity, and Force Transients in Liquid Filled Piping Networks, 67-49-R, November 1967
V T Beria, WHAM/MOD-006 Summary, Aerojet Nuclear Company, December 11, 1975
ACC Programming Note 76-24, March 3, 1976, revised July 11, 1977
11. MACHINE REQUIREMENTS - 480K bytes of memory (IBM370/195), 101,000 (octal) words (CDC7600)
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and BAL (IBM360), FORTRAN IV (CDC7600)
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 package as distributed provides for maxima of 100 legs and 50 nodes per leg. These limits are imposed by DIMENSION and DATA statements, and can be changed to accommodate other models whenever memory space is available. Applications using 244 legs, 26 nodes per leg, for the hydraulic model have been completed at EG&G
15. NAME AND ESTABLISHMENT OF AUTHORS -
360 WHAM6 V T Beria
EG&G Idaho, Inc
P O Box 1625
Idaho Falls, Idaho 83401

7600 WHAM6 H Edwards
National Energy Software Center
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (WHAM6 360-1379 cards, 7600-1396 cards, DATE 360-86 cards)
Sample problem input (56 cards)
Sample problem output (23 pages)
Reference reports and Note
17. CATEGORY - G
KEYWORDS - accidents, coolants, blowdown, liquids, LOFT reactors, heat transfer, WATER-HAMMER codes, WHAM codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - LEOPARD/SPOTS
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360, UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - LEOPARD is a unit cell homogenization and spectrum generation (MUFT-SOFOCATE type) program with a fuel depletion option
4. METHOD OF SOLUTION - The MUFT-SOFOCATE homogeneous medium spectrum analyses with heterogeneous corrections are used. The monoenergetic Amouyal-Benoist thermal disadvantage factor is applied at each of 172 SOFOCATE energy levels up to 0.625 eV. The U238 resonance integral is forced to agree with a generalized Hellstrand correlation.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - LEOPARD works with nuclides commonly used in water reactors. Thorium and U238 fuel chains are allowed.
6. TYPICAL RUNNING TIME - Running time is about 15 seconds per case on an IBM360/75. On a UNIVAC1108 the sample problem executes in 40 seconds.
7. UNUSUAL FEATURES OF THE PROGRAM - LEOPARD is an engineering design code featuring simple input requirements of physical data.
8. RELATED AND AUXILIARY PROGRAMS - SPOTS converts a cross section data deck into a LEOPARD library tape.
9. STATUS - Abstract first distributed December 1967.
IBM7090 version submitted May 1967, replaced by IBM360 version October 1968.
IBM360 version revised to Edition B December 1975, revised to Edition C February 1977, sample problem executed by NESC December 1975 on an IBM370/195.
UNIVAC1108 version submitted January 1971, revised to Edition B February 1977.
10. REFERENCES - L. E. Strawbridge and R. F. Barry, Criticality Calculations for Uniform Water-Moderated Lattices, Nuclear Science and Engineering, Vol. 23, pp. 58-73, 1965.
R. F. Barry, LEOPARD - A Spectrum Dependent Non-spatial Depletion Code for the IBM7094, WCAP-3269-26, September 1963, and Revisions, August 30, 1968.
11. MACHINE REQUIREMENTS - 50K (decimal) memory
12. PROGRAMMING LANGUAGES USED - FORTRAN IV(H) (IBM360) and FORTRAN V (UNIVAC1108)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 (IBM360) and EXEC2 (UNIVAC1108)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - IBM360 FORTRAN IV H-level compiler library file
15. NAME AND ESTABLISHMENT OF AUTHORS -
360 R. F. Barry
Atomic Power Division
Westinghouse Electric Corporation
Box 355
Pittsburgh, Pennsylvania 15230

1108 H. E. P. Krug, Jr.
Jersey Nuclear Company
*Present address-U. S. Nuclear Regulatory Commission
Washington, D. C. 20555
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (LEOPARD 360-2084 cards, 1108-2119 cards, SPOTS 360-828 cards, 1108-829 cards)
Sample problems (LEOPARD 360-37 cards, 1108-37 cards)
Libraries (SPOTS 360-3789 cards, 1108-3789 cards)

Control information (JCL LEOPARD 360-8 cards, SPOTS 360-8 cards)

Sample problem output (LEOPARD 42 pages, SPOTS 17 pages)

Reference reports and Revisions

17. CATEGORY - B

KEYWORDS - cell calculation, spectra, depletion, disadvantage factor, SPOTS codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - M0807
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - The spatial flux solution is obtained iteratively by a method termed extrapolated simultaneous iteration, the fitted diffusion constants are obtained by the straight power method. The approximation to the flux solution is made using the four-point difference equations in rectangular geometry, and the seven-point equations are used for the 60-degree parallelogram geometry
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Two geometries are permitted, rectangular and 60-degree parallelogram. In rectangular geometry 70x70 mesh points are permitted and 60x60 for parallelogram geometry. As many as 99 compositions are allowed per problem
6. TYPICAL RUNNING TIME - About two minutes are required for a 30x30 mesh problem having 40 compositions
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The fitted diffusion constants are usually used as input to the PDQ7 computer program (NESC Abstract 275) for an eigenvalue calculation. M0807 uses the Bellis Environmental Routines (NESC Abstract 476)
9. STATUS - Abstract first distributed December 1967
CDC6600 version submitted March 1968
10. REFERENCES - C. H. Rutherford, M0807 - A Diffusion Theory Fitting Program using FORTRAN-IV, WAPD-TM-671, September 1967
C. J. Pfeiler, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967
W. R. Cadwell, PDQ-7 Reference Manual, WAPD-TM-678, January 1967
11. MACHINE REQUIREMENTS - 64K core storage, card reader, printer, and one auxiliary storage unit
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 -
15. NAME AND ESTABLISHMENT OF AUTHOR -
C. H. Rutherford
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (803 cards)
Reference report, WAPD-TM-671
17. CATEGORY - B
KEYWORDS - two-dimensional, absorption, capture, cross sections, reaction kinetics, cell calculation, PDQ7 codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SEALSHELL2(M0110)
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600, 7600, IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - The SEALSHELL2 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.
4. METHOD OF SOLUTION - The shell is divided into 2 to 100 segments. Each segment is subjected to 11 deformation shapes, whose magnitudes are calculated by the principle of virtual work. That is, for small virtual changes in magnitude, the changes in strain energy and external work are determined. Then equating the energy to the work gives a set of simultaneous equations which may be solved for the magnitudes.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
100 segments
11 deformation shapes per segment
6. TYPICAL RUNNING TIME - Execution time on an IBM360/40 is 0.7 minutes per element. NESC executed the sample problem, without plotting, for the 7600 version in 20 CP seconds on a CDC7600.
7. UNUSUAL FEATURES OF THE PROGRAM - The program will handle thick shells of revolution, as well as the usual thin-shell structures. As discussed in Addendum I, an option allows the requestor to input influence coefficients of the flexibility matrix of any segment. The coefficients may be for any axisymmetric structure, such as a tube sheet in a heat exchanger. In this way, different branches of shells may be connected together. Another application is to condense a group of segments into a single element which may be used in a series of problems and so cut down running time on the computer. Also, using the condensed groups of segments as a single segment allows the user to specify more elements in the analysis of a critical region in the shell.
8. RELATED AND AUXILIARY PROGRAMS - The CDC6600 Version A uses the Battis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed December 1967
CDC6600 Version A submitted August 1967, revised July 1969
IBM360 version submitted January 1972, sample problem executed by NESC
CDC6600 version B submitted November 1972, replaced September 1978 by CDC7600 version submitted February 1975, sample problem executed by NESC September 1978 on a CDC7600 and a CDC6600
10. REFERENCES - C. M. Friedrich, SEAL-SHELL-2, A Computer Program for the Stress Analysis of a Thick Shell of Revolution with Axisymmetric Pressures, Temperatures, and Distributed Loads, WAPD-TM-398, December 1963, Addendum I, April 1967, and Addendum II, June 1969
C. J. Pfeiffer, CDC-6600 FORTRAN Programming - Battis Environmental Report, WAPD-TM-668, January 1967
L. Moran, Excerpt from Westinghouse Tele-Computer Center Standards and Facilities Report, 1969
Documentation Differences Pertaining to WTSC Version of SEALSHELL2, WTSC Note, November 1972
11. MACHINE REQUIREMENTS - 32K memory (CDC6600), 65K (octal) words memory (CDC7600), 185K bytes memory (IBM360)
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 2.0 (CDC6600) and OS/360 (IBM360)

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - An option is included to plot the shell geometry on the CDC280 microfilm recorder with the 6600 Version A or on the CalComp663 with the 360 version. The 7600 version includes an option for a shell geometry plot and a stress plot on either the CalComp or the Datagraphix plotter using the WTSC plot package of subroutines which are in the WTSC library and are described in reference 3, but are not included in the source deck. These subroutines include PLOT1, PLOT2, PLOT3, LINE, RAISE, PRESET, WXACNV, WXLABL, PSCHR, and PDVICE. NESC provided dummy routines by these names, as the program will not run if these subroutines are absent.

15. NAME AND ESTABLISHMENT OF AUTHORS -

6600A	C. M. Friedrich Bellis Atomic Power Laboratory Westinghouse Electric Corporation Box 79 West Mifflin, Pennsylvania 15122
360	P. G. Garzide Sleams-Roger Incorporated 700 South Ash P. O. Box 5888 Denver, Colorado 80217
7600	W. P. Kunkel Manager, Application Support Westinghouse Tele-Computer Systems Corporation 2040 Ardmore Boulevard Pittsburgh, Pennsylvania 15221

16. MATERIAL AVAILABLE - Restricted Distribution

Magnetic Tape Transmittal
Source decks (6600A-1999 cards, 360-2059 cards, 7600-2244 cards)
Sample problems (6600A-31 cards, 360-31 cards, 7600-31 cards)
Sample problems output (6600A-25 selected pages, 360-25 selected pages, 7600-57 pages)
Reference reports, WAPD-TM-398, Addendum I, Addendum II, and Excerpt and Note as appropriate to machine version

17. CATEGORY - 1

KEYWORDS - stresses, shells, pressure, temperature distribution, deformation, elasticity

18. SPONSOR - AEC Division of Naval Reactors

1. NAME OR DESIGNATION OF PROGRAM - M0552
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The foundation transient is specified for equal increments of time and either parabolic or linear interpolation is used to represent the transient for a given interval of time. This functional representation is substituted into the convolution integral and a subsequent evaluation is made to establish the transient modal coordinates. The remainder of the solution follows the classical normal mode superposition scheme. The direction of motion of the lumped masses is restricted to the direction of the foundation transient.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The total number of points used to describe the transient is limited to 2000. An option is provided to enable specification of a general trigonometric series having up to 20 terms, as the transient. The number of modes and mass points that can be considered is limited to 50.
6. TYPICAL RUNNING TIME - About 3 minutes are required.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - M0552 uses the Bettis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed December 1967
CDC6600 version submitted August 1967
10. REFERENCES - E. A. Zanol, M0552 A FORTRAN-4 Program for the Time Dependent Solution of Linear Elastic Systems using Normal Mode Theory, WAPD-TM-657, March 1967, and Errata
C. J. Pfeiffer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967
11. MACHINE REQUIREMENTS - Input tape, output tape, 2 scratch tapes, printer, CDC-280 microfilm plotter
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 -
15. NAME AND ESTABLISHMENT OF AUTHOR -
E. A. Zanol
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (634 cards)
Sample problem (31 cards)
Reference report, WAPD-TM-657 and Errata

17. CATEGORY - 1

KEYWORDS - stresses, transients, mechanical structures, elasticity, strains, damping

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - M0555(ACT1)
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The differential equations are solved by a forward-differencing technique.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - There are three regular inflow tables, one table for spray flow, 20 heat sinks, two linear and one log-log heat input tables, and two special inflow tables for FLASH output.
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - FLASH output may be used directly as input to special input tables to ACT1. ACT1 uses the Bettis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed December 1967
CDC6600 version submitted August 1967
10. REFERENCES - G. M. Fuls, ACT-1 A Digital Program for the Analysis of the Containment Transient during a Loss of Coolant Accident in LWB, WAPD-TM-693, May 1967
S. G. Margolis and J. A. Redfield, FLASH - A Program for Digital Simulation of the Loss-of-Coolant Accident, WAPD-TM-534, May 1966
C. J. Pleifer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967
11. MACHINE REQUIREMENTS -
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 -
15. NAME AND ESTABLISHMENT OF AUTHOR -
G. M. Fuls
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (3277 cards)
Sample problem (70 cards)
Reference report, WAPD-TM-693
17. CATEGORY - G
KEYWORDS - LWB reactors, containment, accidents, water, heating, pressure, temperature distribution, coolants, stresses, FLASH codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - RESQ2/RESQ0/DBF1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - RESQ2 calculates the resonance integral in a two-dimensional, hexagonal system consisting of fuel, clad and water with a reflecting boundary condition
4. METHOD OF SOLUTION - Using superposition, the resonance integral is decomposed into a sum of five terms. The first term is computed numerically and represents a large fraction of the total resonance integral. The four remaining terms are Monte Carlo corrections to the integral. Since the Monte Carlo correction terms represent only a small contribution to the resonance integral, fewer neutron histories are required to achieve a specific uncertainty than would be the case in an all Monte Carlo program. It is assumed there is no absorption in water and clad. All resonance isotopes are lumped into a single isotope having an averaged mass.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
Resonance isotopes are lumped together with an averaged mass.
Maximum number of energy points = 8001
Maximum number of isotopes = 15
6. TYPICAL RUNNING TIME - 2.5 minutes are required for 10,000 histories.
7. UNUSUAL FEATURES OF THE PROGRAM - RESQ2 is most efficient when the escape probability is close to one and when scattering is weak compared to resonance absorption. Therefore, RESQ2 should be used mainly for the study of resonances in the range from 0.625 to 100 eV, where resonance scattering is not a predominant effect.
8. RELATED AND AUXILIARY PROGRAMS - RESQ0 provides a library tape for RESQ2 problems. DBF1 calculates the Doppler-broadened $\psi(\chi, \beta)$ and $\phi(\chi, \beta)$ functions. These programs use the Bellis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed December 1967
CDC6600 version submitted August 1967
10. REFERENCES - B. L. Anderson, E. M. Gelbard, and J. Spanier, RESQ-2 A Combined Analytic-Monte Carlo Calculation of Resonance Absorption Based on Superposition, WAPD-TM-685, June 1967.
C. J. Pfeiffer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967.
11. MACHINE REQUIREMENTS - 40K memory, one tape for the library tape, one tape or disk for scratch.
12. PROGRAMMING LANGUAGES USED - FORTRAN IV (98%) and ASCENT (2%)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 2.0
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - In order to convert this program to another computer or operating system, it would be necessary to rewrite the input routine and the tape-handling routine.
15. NAME AND ESTABLISHMENT OF AUTHOR -
B. L. Anderson
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122

16. MATERIAL AVAILABLE - Restricted Distribution

Magnetic Tape Transmittal

Source decks (RESQ2 3895 cards, RESQ0 860 cards, DBF1 108 cards)

Sample problems (RESQ2 12 cards, RESQ0 41 cards, DBF1 9 cards)

Reference report, WAPD-TM-665

17. CATEGORY - B

KEYWORDS - resonance escape probability, two-dimensional, cylinders, hexagonal lattices, resonance, Doppler broadening, Monte Carlo method, Breit-Wigner formula, scattering, capture, cross sections

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - HOT2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - A nonuniform mesh is imposed on the region of solution, with mesh intervals chosen so that all region interfaces pass through and connect mesh points in either a horizontal, vertical, or diagonal manner. The differential equations are approximated by five-point difference equations at the mesh points, and the resulting matrix equation is solved by the alternating direction iterative technique.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Contact resistances are not included in the program computations, but must be approximated by use of thin regions of a low-conductivity material. Heat generation rates, boundary film coefficients, and boundary sink temperatures are assumed to be known. The program is intended to handle up to 99 regions, 5000 mesh points, 250 mesh points in each coordinate direction.
6. TYPICAL RUNNING TIME - A 1200 point problem was observed to average about 0.7 second per sweep (steady-state iteration or transient time-step) but this varied somewhat with different edit options.
7. UNUSUAL FEATURES OF THE PROGRAM - HOT2 solves the two-dimensional steady-state and transient heat conduction problem in (r,z) or (x,y) geometry with time-dependent heat generation rates, film coefficients, and sink temperatures.
8. RELATED AND AUXILIARY PROGRAMS - On request, files containing temperature distributions are saved for subsequent use either by HOT2 or other programs. HOT2 uses the Bellis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed December 1967
CDC6600 version submitted September 1967
10. REFERENCES - W. D. Peterson and J. Spanier, HOT-2: A Two-dimensional Transient Heat Conduction Program for the CDC-6600, WAPD-TM-889, June 1967.
C. J. Pfeifer, CDC-6600 FORTRAN Programming - Bellis Environmental Report, WAPD-TM-866, January 1967.
11. MACHINE REQUIREMENTS - 64K memory, card reader, printer, and punch, one system disk and 4 non-system disks, each on its own channel.
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 - The term overlay is associated with the SCOPE 2.0 operating system. Essentially an overlay determines the amount of program text in central memory at any memory load. With overlay loading, the main overlay is always in memory, and, in addition, a particular primary and one secondary overlay may also be in central memory. The HOT2 program contains a main overlay, fourteen primary overlays, and five secondary overlays. Overall program control is vested in the main overlay, and the primary overlays are loaded and executed through the use of the routine NEXT. With the exception of one labeled COMMON block HOT2, which resides with the main overlay, all storage allocation is performed in blank COMMON under the control of FTB (reference 2). Blank COMMON is declared in the main overlay and is given a length of one.

When this overlay is loaded, the actual length of blank COMMON is obtained from labeled COMMON block size and passed to FTB. All primary overlays are loaded at blank COMMON origin, and an FTB file (ID called TEXT) is reserved to hold these overlays. The five secondary overlays are loaded under the control of their associated primary overlays for certain program options and these secondaries are defined so that a certain portion of program text is loaded only when needed. The subroutine DUMMYO contained with the main overlay is not executed but is used to control the loading of program text. DUMMYO forces the loading of the FCHIP and FTB routines into the main overlay.

15. NAME AND ESTABLISHMENT OF AUTHOR -

W. D. Peterson
 Bellis Atomic Power Laboratory
 Westinghouse Electric Corporation
 Box 79
 West Mifflin, Pennsylvania 15122

16. MATERIAL AVAILABLE - Restricted Distribution

Magnetic Tape Transmittal
 Source deck (15,694 cards)
 Sample problem (39 cards)
 Reference report, WAPD-TM-669

17. CATEGORY - H

KEYWORDS - two-dimensional, x-y, r-z, heat transfer, temperature distribution, space-time

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - BISYN
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
GE635, UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - One or two initial one-dimensional flux solutions are run in the direction specified by the user. From the initial solution, group- and region-dependent bucklings are calculated for up to 5 one-dimensional flux and adjoint solutions in the orthogonal direction. These solutions are normalized to become shape functions. Each shape function is then used to calculate flux and adjoint weighted cross sections averaged over the full span of that shape function. Thus, region-dependent cross sections are obtained which vary only in the direction selected for the initial solution. A final solution is now performed in this direction to generate an eigenvalue and a mesh-dependent flux which represents the volume-integrated fluxes over the orthogonal direction. The shape functions are then combined with the final solution to synthesize a two-dimensional set of fluxes and adjoints. Extensive edit routines are available to calculate power distribution, neutron balance, etc.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
Maximum number of regions in each dimension = 8
Maximum number of mesh points in each dimension = 75
Maximum number of energy groups = 16
Maximum downscaler = 8
6. TYPICAL RUNNING TIME - An average 16-group problem takes about 3 minutes of processor time.
7. UNUSUAL FEATURES OF THE PROGRAM - Shape functions in non-multiplying regions (blankets, reflectors) may be calculated using a leakage source from the shape function of an adjacent region, or may be set up simply by copying a previous shape function with the fluxes in lethargy groups X+1 to IMAX set equal to the flux in group X. BISYN checks for negative flux values and prints out the group and region where they occur. The user may specify that, if negative fluxes occur in any solution, (a) the program terminate, (b) those buckling values which originally gave a negative total removal cross section be set to zero, or (c) those total removal cross sections which were originally negative be set to zero, and that solution re-run.
8. RELATED AND AUXILIARY PROGRAMS - BISYN uses either the FORTRAN or the machine language version of the NPOST-RWSBT input/output routines.
9. STATUS - Abstract first distributed December 1967
GE635 version submitted June 1967
UNIVAC1108 version submitted August 1969
10. REFERENCES - P. Greebler, M. D. Kelley, R. A. Davis, C. A. Keck, W. A. Duncan, BISYN - A Two Dimensional Synthesis Program, GEAP-4922, July 15, 1965, and Supplement, 1969
Mug File Tape Description, GE Note
BISYN Subroutine Descriptions including -
J. E. Van Eilen, Jr., ISUP, September 1, 1966
J. E. Van Eilen, Jr., FSUP, September 1, 1966
J. E. Van Eilen, Jr., GE-635 NPOST Specification, April 14, 1966
FLEXO, J3T001, January 21, 1965
Nels J. Anderson, Jr., IDFTAP, A FORTRAN IV Function Subprogram, S6T001, January 15, 1965
Nels J. Anderson, Jr., RESTRT, Q3T001, August 1965
SORT, L6T002
Nels J. Anderson, Jr., WRAPUP, A FORTRAN IV Subroutine, Q3T001, August 1965
BITA, L5T001, December 3, 1964

Nels J. Anderson, Jr. . FORTRAN IV Subroutine ERRSYS, S4T001, January 15, 1965
A. E. Scadden, ZERO, Division Overflow Modifier, Q4T001

11. **MACHINE REQUIREMENTS**, - 47,000 words of memory, disk, drum, and 2 tapes for the GE635 54K of fast memory, 2 tape drives, 510,000 words of peripheral storage and the ability to segment for the UNIVAC1108
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - GECOS III, SOL1 (GE635) and EXEC2 (UNIVAC1108)
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - An input library is required for the 635 version. The library program is not included. The 1108 version requires that the computer has the ability to use READ after WRITE instructions.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
P. Grebler, M. D. Kelley, R. A. Davis,
C. E. Keck, and W. A. Duncan
Nuclear Energy Division
General Electric Company
175 Currier Avenue
San Jose, California 95126
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (635-20,985 cards, 1108-22,257 cards)
Sample problems (635-122 cards, 1108-84 cards)
Library (635-415 cards)
Reference report, Note, and BISYN Subroutine Descriptions
17. **CATEGORY** - C
KEYWORDS - two-dimensional, multigroup, diffusion equations, x-y, r-z, flux synthesis, neutron flux
18. **SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - GAKER
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
75 energies
30 scattering angles
2 Legendre moments of the scattering kernel
3 vibrational oscillators
Only the latter may not be easily changed
6. TYPICAL RUNNING TIME - For 55 energies and 15 angles, 6 minutes is required on the UNIVAC1108
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1967
UNIVAC1108 version submitted July 1967
10. REFERENCES - M. S. Nelkin, The Scattering of Slow Neutrons by Water, Physical Review, 119, p. 741, 1960
J. R. Beyster, J. R. Brown, N. Corngold, et al., Integral Neutron Thermalization Annual Summary Report, GA-5798, pp. 155-162, October 1964
H. C. Honeck, THERMOS A Thermalization Transport Theory Code for Reactor Lattice Calculations, BNL-5826, September 1961
Input for Anisotropic Version of GAKER, GA Note
11. MACHINE REQUIREMENTS - 32K memory and 2 scratch files
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
D. H. Houston
General Atomic Company
P. O. Box 81608
San Diego, California 92139
16. MATERIAL AVAILABLE -
Source deck (390 cards)
Sample problem (15 cards)
Reference report, GA-5798 pp. 155-162, and Note
17. CATEGORY - A

KEYWORDS - inelastic scattering, cross sections, moderators, anisotropic scattering, water, thermal neutrons, JAG codes, DTOK codes, GAD codes, GANG codes, GAIN codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GASA (GA Stability Analysis)
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - GASA determines the roots of a set of first-order linear differential equations, according to the Lyapunov first approximation theorems, thereby determining the stability of the system.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The maximum number of equations that can be handled is 25.
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1967
UNIVAC1108 version submitted July 1967
10. REFERENCES - A. M. Baxter, GASA - A General Linear Stability Analysis Code, GAMD-7242, July 15, 1966
A. M. Letov, Stability in Non-linear Control Systems, Chapter 1, 1961
R. Bellman, Stability Theory of Differential Equations, Chapter 1, 1953
F. P. Inad and J. E. Van Ness, Eigenvalues by the QR Transform, SDP/3-Catalog of 704/7040/7044/7090/7094 Programs Distributed by SHARE (General Dynamics/Convair), page 48
E. P. Gyftopoulos, The Technology of Nuclear Reactor Safety, Vol. I, Chapter 3, 1964
11. MACHINE REQUIREMENTS - 64K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
A. Baxter
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE -
Source deck (1011 cards)
Sample problem (28 cards)
Reference report, GAMD-7242
17. CATEGORY - E
KEYWORDS - reactor kinetics, temperature feedback, transfer functions, reactor stability, computer graphics

1. NAME OR DESIGNATION OF PROGRAM - HEXSCAT
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
101 energy groups
24 Legendre moments
6. TYPICAL RUNNING TIME - About 1 minute is required for low energies, longer for high energies.
7. UNUSUAL FEATURES OF THE PROGRAM - The cross section becomes smooth at high energies and is usually obtained by interpolating within a small table of values, rather than calculating directly all needed values.
8. RELATED AND AUXILIARY PROGRAMS - A modified version of the code has been written to supply data in a general (nearly energy-mesh-independent) form for the evaluated nuclear data file (ENDF). This version calculates the P0 through P5 moments and provides for a larger number of point values of the cross sections. No group averaging is done in this version. The point values are to be averaged later by the FLANGE2 code at the time the inelastic data are treated.
9. STATUS - Abstract first distributed December 1967
UNIVAC1108 version submitted July 1967
10. REFERENCE - Y. D. Naliboff and J. U. Koppel, HEXSCAT Coherent Elastic Scattering of Neutrons by Hexagonal Lattices, GA-6026, December 15, 1964.
11. MACHINE REQUIREMENTS - 64K storage on the UNIVAC1108
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
Y. D. Naliboff
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE -
Source deck (358 cards)
Reference report
17. CATEGORY - B
KEYWORDS - elastic scattering, cross sections, hexagonal lattices, anisotropic scattering, averages, FLANGE2 codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - PSEUDO
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108, IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - Resonance parameters are constructed from average nuclear properties in the unresolved resonance region
4. METHOD OF SOLUTION - Random sampling techniques are used to select from assumed distribution functions for level spacings and widths
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
500 ladders
4000 resonances per ladder
6. TYPICAL RUNNING TIME - 9 seconds are required for one ladder of 1248 resonances
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - Output data may be prepared for the GAM2, GAROL, or GAR (NESC Abstract 316) programs
9. STATUS - Abstract first distributed December 1967
UNIVAC1108 version submitted July 1967
IBM360 version submitted June 1969, sample problem executed by NESC
10. REFERENCE - M W Dyes, Construction of Statistical Resonances in the Unresolved Resonance Region, The PSEUDO Code, GA-7136, May 26, 1966
11. MACHINE REQUIREMENTS - 15K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2 (UNIVAC1108), OS/360 (IBM360)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The user can choose either two or three degrees of freedom for the distribution of fission widths
15. NAME AND ESTABLISHMENT OF AUTHORS -
1108 D Mathews
General Atomic Company
P O Box 51608
San Diego, California 92138

360 L Garcia de Viedma
NEA Data Bank
Gif-sur-Yvette, France
16. MATERIAL AVAILABLE -
Source decks (1108-326 cards, 360-318 cards)
Sample problems (1108-6 cards, 360-6 cards)
Reference report
17. CATEGORY - A
KEYWORDS - statistics, nuclear properties, resonance integrals, GAM2 codes, GAROL codes, GAR codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - M0899/HOH
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - The thermodynamic data is stored as tables and values are obtained by bilinear interpolation in pressure and temperature. Transport properties are computed from curve fits
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - Less than one minute is required on the CDC6600
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - M0899 is an extension of subroutine HOH. It makes calls on HOH to get properties for pressures and temperatures supplied and then edits the properties. HOH can be used apart from M0899 by any other FORTRAN IV program to obtain water properties. M0899/HOH uses the Battis Environmental Routines (NESC Abstract 478)
9. STATUS - Abstract first distributed December 1967
CDC6600 version submitted August 1967
CDC1604 version submitted by ANL October 1968, deleted July 1979
10. REFERENCES - L. L. Lynn, A Digital Computer Program for Nuclear Reactor Design Water Properties, WAPD-TM-660, July 1967
C. J. Pflaffer, CDC-6600 FORTRAN Programming - Battis Environmental Report, WAPD-TM-668, January 1967
R. W. Bain, National Engineering Laboratory Steam Tables, Her Majesty's Stationery Office, Edinburgh, 1964
11. MACHINE REQUIREMENTS - On the CDC6600 a FORTRAN IV compiler plus about 3000 storage locations for subroutine HOH and 10,000 locations for the main program
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 -
15. NAME AND ESTABLISHMENT OF AUTHOR -
L. L. Lynn
Battis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (1022 cards)
Sample problem (7 cards)
Reference report, WAPD-TM-660
17. CATEGORY - H
KEYWORDS - thermodynamics, water, pressure, temperature, liquids, vapors
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FLASH3
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - FLASH3 determines the transient response of a water-cooled reactor to a loss-of-coolant accident or severe variable pressure operation
4. METHOD OF SOLUTION - The numerical integrations are done in a serial manner by a combination of forward differencing and implicit techniques. Fluid properties are obtained from program tables
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The reactor plant must be represented by 20 or less pressure-determining nodes and 40 or less flow paths. The plant and core geometry are assumed fixed in time. Hence, the solution is not applicable after significant core melting
6. TYPICAL RUNNING TIME - Running time varies between 1 to 100 times real time, depending on the complexity of the problem
7. UNUSUAL FEATURES OF THE PROGRAM - FLASH3 can be applied to any water-cooled reactor geometry or plant configuration. It includes acoustic effects for both subcooled and saturated blowdowns
8. RELATED AND AUXILIARY PROGRAMS - FLASH3 is an extension of FLASH and FLASH2 and uses the input processing subroutines FCHIP, CARDS, and INPF from the Bettis Environmental Routines (NESC Abstract 478)
9. STATUS - Abstract first distributed December 1967
CDC6600 version of FLASH2 submitted September 1967, replaced by CDC6600 version of FLASH3 January 1970
10. REFERENCES - J. H. Murphy, J. A. Redfield, and V. C. Davis, FLASH-3 A FORTRAN IV Program for the Simulation of Reactor Plant Transients in Space and Time, WAPD-TM-800, July 1968
J. A. Redfield, J. H. Murphy, and V. C. Davis, FLASH-2, A FORTRAN IV Program for the Digital Simulation of a Multinode Reactor Plant During Loss of Coolant, WAPD-TM-666, April 1967
S. G. Margolis and J. A. Redfield, FLASH, A Program for Digital Simulation of the Loss-of-Coolant Accident, WAPD-TM-534, May 1966
C. J. Pfeifer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967
11. MACHINE REQUIREMENTS - 64K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3 1
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
J. A. Redfield, J. H. Murphy, and V. C. Davis
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (10,806 cards)
Sample problem (61 cards)
Reference report, WAPD-TM-800

17. CATEGORY - G

KEYWORDS - accidents, containment, reactors, fuels, coolants, fluid flow, pressure, temperature distribution, blowdown, reactor safety

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GRDWRK
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - By punched card input, the user describes the structure, pressure loading, and type of grid desired. The code solves simple simultaneous linear equations to generate the coordinates of each grid node, numbers all nodes and elements by a system of indexing, computes external pressure loads on specified nodes by assuming axisymmetrical distribution, traces given uniaxial and biaxial elements across the background grid to establish approximations to these elements within the grid, and punches the results out as data cards to be used with a SAFE code.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
1200 grid nodes
3600 total grid, uniaxial, and biaxial element nodes
6. TYPICAL RUNNING TIME - 1 to 5 seconds are required
7. UNUSUAL FEATURES OF THE PROGRAM - GRDWRK generates the uniaxial and biaxial approximations.
8. RELATED AND AUXILIARY PROGRAMS - SAFE-PCRS, SAFE-AXISYM, SAFE-PLANE (NESC Abstract 252), SAFE-SHELL (NESC Abstract 253), and SAFE-CREEP (NESC Abstract 300).
9. STATUS - Abstract first distributed December 1967
UNIVAC1108 version submitted August 1967.
10. REFERENCES - D. A. Doering, GRDWRK, A Computer Program for the Generation of Two-dimensional Finite Element Grids, A Users Manual, GA-7856, June 30, 1967.
D. C. Cornell, SAFE-PCRS, A Computer Program for the Stress Analysis of Composite Bodies of Revolution, Input Instructions, GA-6588, August 1, 1965.
D. C. Cornell, SAFE-PLANE, A Computer Program for the Stress Analysis and Design of Two-dimensional Composite Bodies, A Users Manual, GA-7851, June 30, 1967.
D. C. Cornell, SAFE-SHELL, A Computer Program for the Stress Analysis of Thin Shell Bodies of Revolution, A Users Manual, GA-7852, June 30, 1967.
Y. Rashid and F. J. De Arriaga, SAFE-CREEP, Computer Program for the Viscoelastic Analysis of Axisymmetric and Plane Concrete Structures, A Users Manual, GA-7854, July 31, 1967.
Y. Rashid, D. C. Cornell, and K. B. Jadhav, SAFE-3D, A Computer Program for the Three-dimensional Stress Analysis of Composite Structures - A Users Manual, September 1, 1967.
11. MACHINE REQUIREMENTS - 20,100 words plus operating system
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2, GAX23B through GAX27
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The program is operable on any computer with FORTRAN IV and 25K core.
15. NAME AND ESTABLISHMENT OF AUTHOR -
D. A. Doering
General Atomic Company
P. O. Box 81608
San Diego, California 92138

16. MATERIAL AVAILABLE -

Source deck (1339 cards)
Sample problem (73 cards)
Reference report, GA-7856

17. CATEGORY - L

KEYWORDS - two-dimensional, geometry, stresses, finite element method, mechanical properties, SAFE codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GGC4
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108, CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - In the fast section either the P1 or the B1, B2, or B3 approximation is made to the transport equation using a single energy-independent buckling. In each approximation Legendre moments of the angular flux are computed by direct numerical integration of the slowing down equations. In the resonance calculations, Doppler broadened (at an input temperature) absorption and scattering cross sections are used. The resonance treatment allows up to two admixed moderators in an absorber lump imbedded in a surrounding moderator of finite size. The absorber in the lump is treated by using either the narrow resonance approximation, or a solution of the slowing down integral equations to determine the collision density through the resonance. The admixed moderators are treated by using either an asymptotic form of, or an integral solution for, the collision density. In the resonance calculation either standard geometry collision probabilities are used or tables of collision probabilities are entered. Dancoff corrections can also be made. In the region of unresolved resonances, resonance absorption is calculated by using Porter-Thomas distributions, but only s-wave neutrons are considered. Slowing down sources into the thermal section may be computed for H, D, Be, C, and O according to the free gas scattering model and user-supplied effective temperatures. In the thermal section either the B0, B1, P0, or P1 approximation to the transport equation is made, and in all options Legendre moments of the angular flux are computed. A trapezoidal energy integration mesh is used, and the resulting equations are solved iteratively by using a source-normalized, overrelaxed, Gauss-Seidel technique. Averages over broad groups are performed by simple numerical integration. The results obtained in the fast and thermal sections are stored on special tapes. These tapes may contain results for a number of problems, each problem including fine group cross section data for a number of nuclides. If the problem number is specified on these tapes, and a desired list of nuclides is given, the combining code will punch microscopic cross sections for the requested list of nuclides. The program also

treats mixtures. Given the atomic densities of the nuclides in a mixture, the code will punch macroscopic cross sections.

5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -

- 99 fast groups
- 101 thermal fine groups
- 99 fast broad groups
- 50 thermal broad groups
- 50 broad groups in the combining section
- 250 resonances per nuclide
- 2 moderators admixed with a resonance absorber
- 305 entries in the escape probability table for cylindrical geometries

505 entries in the escape probability table for slab geometries. The energy dependence of the input bucklings is restricted to separate energy-independent fast- and thermal-section values (positive, negative or zero values are allowed in either section).

6. TYPICAL RUNNING TIME - A B1 calculation in the fast section for 4 nuclides and 5 broad groups takes approximately 1 CPU minute on the UNIVAC1108 if a resonance calculation (1/2 minute) is performed for one nuclide. The thermal calculation for 4 broad groups requires approximately 17 CPU seconds, which includes about 1.5 CPU seconds for the iterative procedure. To punch standard diffusion and standard transport cross sections for this problem requires 2 seconds.

7. UNUSUAL FEATURES OF THE PROGRAM - There is no restriction on the number of problems that can be run consecutively in each section, nor is there a restriction on the number of nuclides per problem.

8. RELATED AND AUXILIARY PROGRAMS - GGC4 is a revision of the earlier program, GGC3. To prepare, handle, and update the basic cross section tapes which are used as input for GGC4, the following codes are utilized - MAKE, MST, PRINT, MIXER, WTFG, MGT3, SPRINT, and COMBIN. The "WTFG" option of the GAND2 code (NESC Abstract 596) is used to evaluate data for certain nuclides with resonances in the thermal neutron energy range.

9. STATUS - Abstract first distributed December 1967

UNIVAC1108 version of GGC3 submitted September 1967, deleted June 1968

UNIVAC1108 version of GGC4 submitted June 1968, replaced by first revision July 1969, replaced by second revision, Edition B, March 1975

CDC6600 version submitted October 1969

10. REFERENCES - J. Adir and K. D. Lathrop, Theory of Methods Used in the GGC-4 Multigroup Cross Section Code, GA-9021, October 1, 1968, and Errata, January 28, 1969 and March 21, 1975

J. Adir, S. S. Clark, R. Froehlich, and L. J. Todt, Users' and Programmers' Manual for the GGC-3 Multigroup Cross Section Code, Parts 1 and 2, GA-7157, July 1967

M. K. Drake, Description of Auxiliary Codes Used in the Preparation of Data for the GGC-3 Code, GA-7158, August 1967

D. Mathews and P. Koch, Revised Input Instructions for the GGC-4 Code, GGA Memorandum, October 16, 1972

D. Mathews and P. Koch, Slowing Down Sources for the Thermal Section of GGC, GGA Memorandum, May 7, 1970

P. Koch and D. Mathews, Changes to GGC-4 and GGC-5, GGA Memorandum, July 8, 1970

D. R. Mathews, Non-1/E Denominator Tests, GGA Memorandum, May 11, 1970

Simulation of Grain Effects in GGC-4, GGA Memorandum

R. J. Archibald and D. R. Mathews, The GAF/GAR/GAND Fast Reactor Cross Section Preparation System, Volume II, GAND2 and GFE2 - Computer Programs for Preparing Input Data for the GAFGAR, GGC and MICROX Codes from an ENDF/B Format Nuclear Data File, GA-7542, Vol. II, March 1973

Modifications to Implement the UNIVAC 1108 Version of the GGC-4 Program to the CDC 6600 Computer, WAML Note

11. MACHINE REQUIREMENTS - 64K memory with 11 tape units (some of which may be drum areas) on the UNIVAC1108
12. PROGRAMMING LANGUAGES USED - FORTRAN V (UNIVAC1108), FORTRAN IV (CDC6600)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC8, Level 27 (UNIVAC1108), SCOPE (CDC6600).

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

The latest UNIVAC1108 version of the GGC4 code is identified as the EXEC-8, Edition 8 version.

At least one nuclide with a thermal scattering kernel is required in the thermal section spectrum calculation. These nuclides are usually H, D, Be, C or O. Structural materials such as Fe, Cr and Ni as well as the actinides are usually treated as "absorber" nuclides without detailed scattering kernels although the code is capable of handling such nuclides with scattering kernels if desired.

There is an option in GGC-4 which makes it possible to shorten the punching process for large two-dimensional transfer arrays. This can be done by specifying a maximum number of desired upscattering and downscattering terms.

The CDC6600 version is organized into four overlays. With the buffer lengths set to 1030 (octal), the largest overlay requires 155,000 (octal) locations. It should be possible to reduce this requirement by a more efficient use of the COMMON area.

15. NAME AND ESTABLISHMENT OF AUTHORS -

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6600 D. W. Drawbaugh
Astronuclear Laboratory
Westinghouse Electric Corporation
Box 10864
Pittsburgh, Pennsylvania 15236

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal (4 tapes)

Source decks (GGC4 1108-12,560 cards, WTFG 1641 cards, MAKE 1028 cards, MST 456 cards, PRINT 764 cards, MIXER 495 cards, MGT3 246 cards, SPRINT 329 cards, COMBIN 474 cards, GGC4 6600-11,504 cards)

Sample problems (GGC4 1108-41 cards, 6600-38 cards)

Control information (1108-340 cards)

Fast data tape (60 nuclides - tape 2 - 1108-2772 binary records, 6600-1703 binary records)

Fast data tape (151 nuclides - tape 3 - 1108-7362 binary records, 6600-4436 binary records)

Thermal data tape (222 nuclides - tape 4 - 1108-2854 binary records, 6600-1539 binary records)

Reference reports, GA-9021 and Errata, GA-7157, GA-7158, Memoranda, and Note as appropriate to machine version

17. CATEGORY - B

KEYWORDS - multigroup, cross sections, averages, neutron spectra, Doppler broadening, Dancoff correction, angular distribution, resonance integrals, Porter-Thomas distribution, MAKE codes, MST codes, PRINT codes, MIXER codes, WTFG codes, MGT3 codes, SPRINT codes, COMBIN codes, GAND2 codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - LION4

2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600,7600, UNIVAC1108, IBM360,370

3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.

4. METHOD OF SOLUTION - The modeling is based on the concept of nodal points connected by one-dimensional thermal conductance equations in as many as six directions simultaneously. The explicit, or first forward difference method, is then used to obtain the solutions to these equations for the three-dimensional field. The temperature change for a surface node is calculated by applying the Ohm's law analogy for heat flow to a node with no capacitance.

5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Dynamic allocation is used. The more recent CDC6600 edition requires--

$11 \cdot D1 + 26 \cdot D2 + 20 \cdot D3 + 3 \cdot D4 + 17 \cdot D5 + 3 \cdot D6 + S1 + S2 + S3 + S4$
less than or equal to 24,500

variable number of external connections (D1)
variable number of internal nodes (D2)
variable number of surface nodes (D3)
variable number of boundary nodes (D4)
variable number of coolant nodes (D5)
variable number of interface nodes (D6)
S1=storage for temperature means and differences
S2=storage for heat flow subroutine
S3=storage for convective heat transfer calculation
S4=storage for variable libraries

Using increased nodal capability feature with admittance matrix in ECS this algorithm becomes--

$11 \cdot D1 + 10 \cdot D2 + 4 \cdot D3 + 3 \cdot D4 + 17 \cdot D5 + 3 \cdot D6 + S1 + S2 + S3 + S4$

The January 1970 edition requires--

$11 \cdot D1 + 25 \cdot D2 + 20 \cdot D3 + 62 \cdot D4 + 15 \cdot D5$
less than or equal to 21,000

15 materials
7-D2 internal connections
12 coolant channels (each with 4 sides maximum)
77 printouts
7 internal connections per internal node
6 surface connections per surface node
7 types of temperature means and differences sets
10 graphs (CDC6600,7600 only)
12 curves per graph (CDC6600,7600 only)
18 types of quantities graphable (CDC6600,7600 only)
4 sub-cooled nucleate boiling regions
5 types of heat flow rate sets

6. TYPICAL RUNNING TIME - The running time on the CDC6600 is strongly dependent on the number of nodes, their relative and absolute size, and the time range considered. The sample

problem executes in only a few seconds on the CDC6600. Execution of the UNIVAC1108A sample problem requires 5 seconds, while execution time for the IBM360 sample problem is 2 minutes.

7. **UNUSUAL FEATURES OF THE PROGRAM** - Subcooled nucleate boiling may be considered. However, this consideration is limited to water.
8. **RELATED AND AUXILIARY PROGRAMS** - Support programs include the PLI series of preprocessors for selected geometries, the GRAIL plotting package, HCAL2, which evaluates heat transfer coefficient equations for selected conditions, and CONLI, which rennumbers input data and inserts spare node numbers of 3 different kinds to permit consolidation of geometry input for entry into a large problem. LION supercedes earlier IBM704 and Philco-2000 programs called TIGER.
9. **STATUS** - Abstract first distributed December 1967.
CDC6600 version submitted October 1967, replaced by first revision August 1968, replaced by second revision January 1970, replaced by LION4 July 1973, plotting routines replaced September 1974, replaced by revised Edition B submitted June 1976, sample problem executed by NESC October 1977 on a CDC6600.
UNIVAC1108A version submitted June 1971, a conversion of the January 1970 edition.
UNIVAC1108B version submitted April 1975, a conversion of the January 1970 edition.
IBM360,370 version submitted January 1974, a conversion of the January 1970 edition, sample problem executed by NESC August 1975 on an IBM370/195.
10. **REFERENCES** - J. R. Schmid, G. L. Lechliter, and W. W. Fischer, LION Temperature Distributions for Arbitrary Shapes and Complicated Boundary Conditions, KAPL-M-6532, July 27, 1966.
W. W. Fischer, LION Tales A Users Manual for the LION Thermal-structural Evaluation Code, KAPL-M-6533, July 31, 1967.
E. J. Binney, Addendum to LION, KAPL-M-6532, revised January 1969.
E. J. Binney, Additions to LION Code, KAPL Note, September 30, 1969.
E. J. Binney, Additions to LION Code Effective with September 1970 Version, KAPL Note, September 22, 1970.
W. W. Fischer and M. N. Goldsmith, GRAPL A Gradient Plotter for LION, KAPL-M-7164(L), October 13, 1970.
E. J. Binney, Additions to LION Code Effective with the December 1970 Version, KAPL Note, December 18, 1970.
E. J. Binney, Additions to the LION Code Effective February 28, 1971, KAPL Note, February 26, 1971.
E. J. Binney, Modification to the LION Code Effective March 31, 1971, KAPL Note, April 8, 1971.
E. J. Binney, Heat Balance Capability in LION, KAPL Note, April 30, 1971.
E. J. Binney, Additions to the LION Code Effective February 29, 1972, KAPL Note, February 29, 1972.
E. J. Binney, LION Newsletter No. 1, KAPL Note, June 5, 1972.
E. J. Binney, LION4 Newsletter No. 2, KAPL Note, October 5, 1972.
E. J. Binney, LION4 Newsletter No. 3, December 31, 1973.
E. J. Binney, LION4 Newsletter No. 5, February 18, 1975.
E. J. Binney, LION4 Newsletter No. 6, May 27, 1975.
W. W. Fischer, Condensation Heat Transfer Coefficient Computational System for LION, KAPL-M-7438, December 1975.
E. J. Binney, LION4 Newsletter No. 7, May 28, 1976.
M. N. Goldsmith and W. W. Fischer, The PLI--Series of Preprocessors for the LION Code, KAPL-M-7289(L), July 6, 1972.
JPARAM Systems Programming Informal Program Description, excerpt from User's Guide to CDC Systems at KAPL, July 27, 1972.
W. W. Fischer, Convective Heat Transfer Coefficient Computational System for LION, KAPL-M-7301(L), December 18, 1972.
A. Peronilla, LION IV, IBM System/360 System/370 Version, Foster Wheeler Note, January 29, 1974.

G Krevolin, LION IV, UNIVAC 1108B Version and Addendum to LION4. June 22, 1973

11. **MACHINE REQUIREMENTS** - The CDC6600 version plotter routine LAPL4 is used to produce the input required by the associated CalComp plotter for graphical output. The IBM360 version requires 350K for execution and one additional input/output unit besides the standard units.
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV and ASCENT (CDC6600,7600), FORTRAN IV (UNIVAC1108A,B and IBM360,370)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE (CDC6600,7600), EXEC8 (UNIVAC1108A,B), OS/360,370 (IBM360,370)
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Data saving on tape and options to provide plotting of a variety of parameters versus time are included in the CDC6600 version of LION4. Because of the large size of this version of LION4, it was necessary to segment the program. The UNIVAC1108A,B and IBM360 versions are based on the January 1970 version and do not include the added features of the more recent KAPL edition nor do they include a plotting capability. The UNIVAC1108B and IBM360 version are written in double-precision.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -

6600,7600	E J Binney Knolls Atomic Power Laboratory General Electric Company Box 1072 Schenectady, New York 12301
1108A	Darrell Barikowski Chi Corporation 11000 Cedar Avenue Cleveland, Ohio 44106
1108B	Glenn Krevolin Foster Wheeler Corporation 110 South Orange Avenue Livingston, New Jersey 07039
360,370	Alberto Peronilla Foster Wheeler Corporation 110 South Orange Avenue Livingston, New Jersey 07039
16. **MATERIAL AVAILABLE** - Restricted Distribution
Magnetic Tape Transmittal
Source decks (6600-4622 cards, 1108A-2447 cards, 360-2538 cards, 1108B-3723 cards)
Sample problems (6600-161 cards, 1108A,B-156 cards, 360-158 cards)
Control information (JCL 360-14 cards)
Sample problem output (6600-33 pages, 1108A-22 pages)
Reference reports, Newsletters, Notes, and Addenda appropriate to the edition
17. **CATEGORY** - H
KEYWORDS - temperature distribution, thermal conductivity, fluid flow, three-dimensional, heat transfer, liquids, vapors, TIGER codes
18. **SPONSOR** - DOE Division of Naval Reactors

1. NAME OR DESIGNATION OF PROGRAM - SAFE-CREEP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - SAFE-CREEP performs a viscoelastic analysis of plane or axisymmetric composite concrete structures with age- and temperature-dependent creep data
4. METHOD OF SOLUTION - The program uses the finite-element method which reduces the problem to the solution of a system of coupled integral equations. The method of solution is iterative on the space variable and utilizes the trapezoidal rule integration for the time variable
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
350 nodes
750 elements
60 time increments
6. TYPICAL RUNNING TIME - 90 minutes are required for a full-capacity problem
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - GROWRK (NESC Abstract 296), SAFE-PLANE (NESC Abstract 252), SAFE-SHELL (NESC Abstract 253)
9. STATUS - Abstract first distributed December 1967
UNIVAC1108 version submitted October 1967
10. REFERENCES - Y. Rashid and W. Rothenhauser, Pressure Vessel Analysis by Finite Element Technique, GA-7610, 1967
R. D. Brown, Properties of Concrete in Reactor Vessels, Paper No. 13, Conference on Prestressed Concrete Pressure Vessels, London, March 13-17, 1967
F. J. De Arriaga and Y. R. Rashid, SAFE-CREEP, A Computer Program for the Viscoelastic Analysis of Axisymmetric and Plane Concrete Structures, A Users Manual, GA-8111, July 31, 1967
11. MACHINE REQUIREMENTS - 65K memory and 13 tapes
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - CALL TICKER refers to an 1108 system routine for logging job time used. A substitute routine will be required for use of this program on another machine
15. NAME AND ESTABLISHMENT OF AUTHOR -
F. De Arriaga
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE -
Source deck (1549 cards)
Sample problem (32 cards)
Reference report, GA-8111
17. CATEGORY - I
KEYWORDS - two-dimensional, elasticity, finite element method, mechanical structures, stresses, pressure vessels, GROWRK codes, SAFE-PCRS codes, SAFE-PLANE codes, SAFE-SHELL codes

1. NAME OR DESIGNATION OF PROGRAM - FREVAP6
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 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.
4. METHOD OF SOLUTION - A problem is defined as having a one-dimensional segment made up of three parts - (1) the fission product source (fuel particles) in series with, (2) a non-source and absorption part (element graphite) and (3) a surface for evaporation to the coolant (graphite-helium interface). More than one segment may be connected (possibly segments stacked axially) by way of the coolant. At any given segment, a continuity equation is solved assuming equilibrium between the source term, absorption term, evaporation at coolant interface and the partial pressure of the fission product isotope in the coolant.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 5 isotopes
 - 10 time intervals for time-dependent variable
 - 49 segments (times number of isotopes)
 - 5 different output print time-steps
6. TYPICAL RUNNING TIME - 15 minutes are required
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed June 1968
UNIVAC1108 version submitted October 1967
10. REFERENCE - L. R. Zumwalt, V. H. Pierce, and M. J. Gerber, FREVAP-6 Code for Estimating Metallic Fission Product Release, GAMD-7656, January 12, 1967
11. MACHINE REQUIREMENTS - 64K memory with 2 tapes (I/O)
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2, GAX27
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The RKGA subroutine provides the solution of the derivative equation by the Runge-Kutta-Gill method to use as the starting HAMDE value. The HAMDE subroutine is then used for the solution of the derivative equation using the Milne-Hanning method.
15. NAME AND ESTABLISHMENT OF AUTHOR -
 - V. H. Pierce
 - General Atomic Company
 - P. O. Box 81608
 - San Diego, California 92138

16. MATERIAL AVAILABLE -

Source deck (1104 cards)
Sample problem (95 cards)
Reference report

17. CATEGORY - D

KEYWORDS - fission products, HTGR reactors, fuel elements, one-dimensional, isotopes, temperature

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GAFFE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Depletion is computed for a single batch of fuel over the entire period it remains in the reactor using fluxes which are characteristic of the average composition of the equilibrium reactor. Beginning with an initial guess for feed or cycle time, a double set of iterations are performed. The outer iterations comprise the feed or time search to obtain the desired end of cycle keff. The inner iterations converge the average cycle flux and recycle composition, given a specific feed and cycle length. Once the searches are satisfied, then various neutronic characteristics of the equilibrium cycle can be calculated directly.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
18 energy groups
50 total nuclides
3 nuclides with full transfer matrix
6. TYPICAL RUNNING TIME - 30 seconds are required for a 15 energy group and 39 nuclide problem.
7. UNUSUAL FEATURES OF THE PROGRAM - GAFFE computes the characteristics of the equilibrium cycle without going through an approach to equilibrium calculation which would require following (depleting) a number of individual sets of fuel compositions equal to at least one set for each refueling which should occur during the entire residence period of a single batch.
8. RELATED AND AUXILIARY PROGRAMS - GAFFE punches cards for the WAMPUM equilibrium fuel cycle cost code (NESC Abstract 224). The VALANC code has been attached as a subroutine.
9. STATUS - Abstract first distributed June 1968
UNIVAC1108 version submitted October 1967
10. REFERENCE - Gulf General Atomic Draft, GAFFEE, A Computer Program for Determining Equilibrium Fuel Cycles, unpublished.
11. MACHINE REQUIREMENTS - 65K memory and 2 tapes (I/O)
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2, GAX27
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
S. Jaye
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (3871 cards)
Reference draft

17. CATEGORY - D

KEYWORDS - depletion, fuel cycle, multigroup, reactivity, iterative methods, WAMPUM codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - BLOOST6
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - A fourth-order Runge-Kutta integration is used for the kinetics equation. A Peaceman-Rachford iteration scheme is employed to solve the two-dimensional time-dependent heat conduction equation in r-z geometry. Coupling the r-z fuel element model to the spherical geometry heat transfer routine for the fuel particles is accomplished through a heat transfer coefficient, specified by an easily modified FORTRAN function statement.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Two-dimensional heat transfer routines are limited to r-z geometry, 36 regions, 19 materials, 15 radial mesh points, 20 axial mesh points, 6 radial region boundaries, 10 axial region boundaries, and inner and outer axial coolants. Kinetics equations allow 6 delayed groups and 2 temperature coefficients. Two types of fuel particles are permitted.
6. TYPICAL RUNNING TIME - For a step-change in reactivity of several dollars and a fairly detailed thermodynamic model of the fuel element, 5 to 10 minutes are required to follow the excursion for 10 to 15 seconds of real time.
7. UNUSUAL FEATURES OF THE PROGRAM - The material, gas, and coolant properties and heat generation rates are supplied as FORTRAN arithmetic statement functions in a subroutine called DATA. This subroutine is therefore unique to a particular fuel element design and may be considered as part of the input data. For cases in which the initial temperature distribution is unknown it is possible to run the BLOOST code as a pure heat transfer code omitting reactivity input to the kinetics portion and to obtain a temperature distribution appropriate to initial power conditions punched on cards suitable for later use in kinetics problems.
8. RELATED AND AUXILIARY PROGRAMS - BLOOST6, an earlier linkage of the kinetics portion and the two-dimensional heat transfer routine RAT, an earlier stand-alone heat transfer code.
9. STATUS - Abstract first distributed June 1968
UNIVAC1108 version submitted October 1967
10. REFERENCES - R. C. Dahlberg and M. H. Merrill, BLOOST-6 - A Kinetics Code Containing a Thermodynamic Model of Coated Particles for HTGR Applications, GAMO-8119, July 19, 1967
M. H. Merrill, BLOOST-6, A Combined Reactor Kinetics Heat Transfer Program, GA-8416, December 15, 1967
11. MACHINE REQUIREMENTS - 84K memory with 2 tapes (I/O)
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and Assembly language
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2, GAX27
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
M. H. Merrill
General Atomic Company
P. O. Box 81608
San Diego, California 92138

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (6693 cards)
Sample problem (484 cards)
Reference reports

17. CATEGORY - E

KEYWORDS - reactor kinetics, temperature distribution, thermodynamics, two-dimensional, r-z, heat transfer, fuel elements, RAT codes, FUGRA codes, HTGR reactors

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - PERT4
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Standard difference techniques are used.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - PERT4 will handle up to 26 energy groups with a 50 x 50 spatial mesh.
6. TYPICAL RUNNING TIME - About 30 seconds per case are required.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The input data (geometry, densities, cross sections) is compatible with the Los Alamos transport codes DTF4 (NESC Abstract 209) and 2DF (NESC Abstract 173).
9. STATUS - Abstract first distributed June 1968
UNIVAC1108 version submitted October 1967
10. REFERENCES - R. W. Hardie and W. W. Little, Jr., PERT-IV, A Two-dimensional Perturbation Code in FORTRAN-IV, BNWL-409, April 1967.
11. MACHINE REQUIREMENTS - 65K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
W. W. Little, Jr.
Pacific Northwest Laboratories
Battelle
P. O. Box 998
Richland, Washington 99352
16. MATERIAL AVAILABLE -
Source deck (1426 cards)
Sample problem (366 cards)
Reference report
17. CATEGORY - C
KEYWORDS - perturbation theory, fast reactors, two-dimensional, multigroup, reactivity, x-y, r-z, r-theta, DTF4 codes, 2DF codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FCC4
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - FCC4 will handle up to 40 energy groups and 10 downscattering terms with 14 isotopes.
6. TYPICAL RUNNING TIME - About 15 seconds per case are required.
7. UNUSUAL FEATURES OF THE PROGRAM - An extensive cross check (for consistency) of the input data is performed. By this check, numerous printing errors in the Russian data compilation have been detected.
8. RELATED AND AUXILIARY PROGRAMS - FCC4 is an extensive revision of the FCC code. The cross section tape is prepared by the PUP-IV code.
9. STATUS - Abstract first distributed June 1968
UNIVAC1108 version submitted October 1967
10. REFERENCES - W. W. Little, Jr. and R. W. Hardie, FCC-IV, A Revised Version of the FCC Fundamental Mode Fast Reactor Code, BNWL-450, August 1967
I. I. Bondarenko et al., Group Constants for Nuclear Reactor Calculations, Consultants Bureau, New York, 1964
11. MACHINE REQUIREMENTS - 65K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
W. W. Little, Jr. and R. W. Hardie
Pacific Northwest Laboratories
Battelle
P. O. Box 999
Richland, Washington 99352
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (2204 cards)
Sample problem (196 cards)
Reference report, BNWL-450
17. CATEGORY - B
KEYWORDS - fast reactors, averages, cross sections, neutron flux, multigroup, depletion, PUP4 codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - HWOOCR-SAFE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - HWOOCR-SAFE is a Monte Carlo thermal reactor analysis program designed for use with proposed HWOOCR 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.
4. METHOD OF SOLUTION - Neutrons are started from an initial source distribution in space, angle, and energy with a statistical weight of unity. They are followed from collision to collision until they are either captured or produce fission. K-infinity is the average number of neutrons produced per source neutron. The selection of the initial energy is based on assuming a spectrum for fission neutrons and tabulating the average energy between energy points defining equal probability intervals. The Cranberg spectrum for U235 has been used. The direction cosines defining particle motion are selected isotropically for the emergence of a neutron from a fission reaction. The mean free path of the neutron at its present energy determines the next collision. The determination of the neutron energy subsequent to a collision is based on the type of interaction which occurred. HWOOCR-SAFE divides the 0-10 MeV energy range into fast (1 keV to 10 MeV), resonance (1 eV to 1 keV), and thermal (0 to 1 eV) ranges. Elastic collisions in the fast and resonance ranges assume isotropic scattering. The evaporation model is used for inelastic collisions in the fast range. A modified free atom model is used for elastic scattering in the thermal energy range. Collision-type estimators are used except for thin regions where statistical estimation is supplemented with an improved treatment of scattering collisions.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The HWOOCR-SAFE program is a two-dimensional cell code in which the cell is assumed to be rectangular. Up to 20 material regions (zones) can be specified where one of the zones is completely described by the cell boundaries. All other zones are assigned concentric cylinders which lie within a cylinder described as outer wall boundary, or within the right circular cylindrical rods which are inserted in the innermost cylinder designated as the inner wall boundary. Up to 40 rods may be inserted, and 6 types of rod may be specified.
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The HWOOCR-SAFE program is an adaptation and extension of the Atomic International SAFE code written to handle identical cylindrical rods in three-dimensional finite or infinite arrays. Variations of this program have been prepared for the CDC6600 and IBM7094 computers.
9. STATUS - Abstract first distributed June 1965
IBM360 version submitted October 1967
10. REFERENCES - L. B. Levitt and R. C. Lewis, HWOOCR-SAFE, A Monte Carlo Reactor Analysis Code, AI-CE-MEMO-69, June 30, 1967
RELICS Input Description, AI Note
Input Description for HWOOCR-SAFE Cross Section Tape Maker, AI Note
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGES USED - FORTRAN IV (H) and BAL
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

16. NAME AND ESTABLISHMENT OF AUTHORS -

L B Levitt and R C Lewis
 HWOOR Program Office
 Atomics International
 P O Box 309
 Canoga Park, California 91304

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (SAFE 2662 cards, RELICS 76 cards, TAPE-MAKER 26 cards)
 Sample problems (SAFE 245 cards, RELICS 30 cards, TAPE-MAKER 1835 cards)
 Reference report and Notes

17. CATEGORY - 8

KEYWORDS - cell calculation, two-dimensional, Monte Carlo method, HWOOR reactors, reactivity, RELICS codes, TAPE-MAKER codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - JUPITOR1(JP1)
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - JUPITOR1 is used to perform coupled-channel calculations to evaluate the cross sections for the scattering of nuclear particles by various collective nuclei
4. METHOD OF SOLUTION - In solving the coupled differential equations the prediction-correction method due to Stormer is used
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of six states and 30 partial waves can be coupled at one time if the projectile energy becomes negative in some excited channels this maximum is reduced to 25 partial waves. The maximum value of the orbital angular momentum is 69. Differential cross sections for up to 100 angles for any number of states can be computed unless a polarized beam or target is considered, in which case the maximum is 35
6. TYPICAL RUNNING TIME - The sample problem requires about 2 minutes on the IBM360
7. UNUSUAL FEATURES OF THE PROGRAM - Spin of the projectile can be 0, 1/2, or 1 for non-adiabatic calculations, 0 or 1/2 for adiabatic. Targets can be either vibrational (spherical) or rotational (permanently deformed) and of either even or odd A. When the target is deformed, excitation of states belonging to higher (vibrational) bands can be considered. Coulomb excitation can be included, and the form factor can be either real or complex
8. RELATED AND AUXILIARY PROGRAMS - The original CDC1604 version of JUPITOR1 was prepared by Taro Tamura of Oak Ridge National Laboratory, Oak Ridge, Tennessee. JUPITOR2 is under preparation to handle smaller sets of equations more efficiently
9. STATUS - Abstract first distributed June 1968
CDC1604 version submitted by ORNL November 1967, deleted July 1978
IBM360 version submitted December 1970, sample problem executed by NESC
10. REFERENCES - T. Tamura, Computer Program JUPITOR-1 for Coupled-channel Calculations, ORNL-4152, August 1967, Addendum 1, August 14, 1967, Addenda/Corrigenda No. 2, November 27, 1967
T. Tamura, Reviews of Modern Physics, Vol. 37, p. 679, 1965
11. MACHINE REQUIREMENTS - 300K bytes of 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 -
L. Garcia de Viedma
NEA Data Bank
Gif-sur-Yvette, France
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (4216 cards)
Sample problem (18 cards)
Control information (JCL 37 cards)
Punched output (108 cards)
Sample problem printed output (5 pages)
Reference report, ORNL-4152 and Addenda

17. CATEGORY - A

KEYWORDS - scattering, cross sections, compound nuclei, angular distribution

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - TSN
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 IBM360 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.
4. METHOD OF SOLUTION - Carlson's SN method is used to solve the neutron transport equation. Analogous finite-difference techniques are used to solve the feedback equations. The variations in cross sections and densities with energy deposition are evaluated from polynomial coefficients supplied by the user.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - 2 velocity groups, 100 spatial intervals, 1-dimensional geometry S4 (cylindrical) or S6 (plane or sphere)
6. TYPICAL RUNNING TIME - A typical problem supplied with the documentation ran 15.1 minutes on the IBM360, Model 50. The time can be reduced by applying the optimization feature of the FORTRAN IV Level H compiler.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - TSN is based on and uses portions of ANISN. The original IBM7094 version was prepared by W. A. Rhoades of Atomic International, Canoga Park, California.
9. STATUS - Abstract first distributed June 1968.
IBM7094 version submitted by AI November 1967, deleted July 1978.
IBM360 version submitted November 1967.
10. REFERENCES - W. A. Rhoades and J. G. Morgan, The TSN Computer Code for Spatially Dependent Reactor Kinetics Calculations, NAA-SR-MEMO-12319, April 18, 1967.
M. A. Boling and W. A. Rhoades, ALCRT3-3, SPRNTV, and FLINGV, General Purpose Subroutines for Display of Digital Data, NAA-SR-TDR-11915, April 1968.
Notes on TSN for the IBM S/360, AI Note.
R. A. Blaine, Atomic International Environment Report, May 1967.
W. W. Engle, Jr., A Users Manual for ANISN, A One-dimensional Discrete Ordinates Transport Code with Anisotropic Scattering, K-1893, March 30, 1967.
M. A. Boling and W. A. Rhoades, ANISN/DTF II, Conversion to IBM System/360, AI-86-MEMO-171, April 1967.
J. F. Jackson, W. A. Rhoades, and L. I. Moes, Analysis of SNAPTRAN-1 and -2 Reactor Kinetics Experiments, NAA-SR-11850, June 26, 1967.
B. G. Carlson and K. D. Lathrop, Transport Theory - The Method of Discrete Ordinates, LAMS-3251-MS, October 22, 1965.
11. MACHINE REQUIREMENTS - IBM360 Model 50H or larger
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - TSN uses the NAA SC-4020 graphical package. The user can delete the CRT feature by supplying dummy subroutines.

16. NAME AND ESTABLISHMENT OF AUTHOR -

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18. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (1809 cards)
Sample problem (62 cards)
Reference report, NAA-SR-MEMO-12319, AI Environment Report, and AI Note

17. CATEGORY - f

KEYWORDS - two-group, discrete ordinate method, space-time, temperature coefficient, feedback, computer graphics, reactor kinetics, one-dimensional, SNAP reactors, ANISN codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GAKIN2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM370
3. DESCRIPTION OF PROBLEM OR FUNCTION - GAKIN2 solves the time-dependent multigroup neutron diffusion equations in one space dimension
4. METHOD OF SOLUTION - The space dimension is treated using the conventional finite difference approximation. Time integration is accomplished using an exponential transformation and semi-implicit differencing. The resulting equations are solved by first predicting the frequency for the time transformation and then correcting the solution by solving the full set of equations.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Variable dimensioning permits accommodation of any number of energy groups, space points, and material regions, within the limits of available storage. The number of delayed neutron groups is limited to 8. The number of bytes allocated for data storage is a function of the dimension of COMMON block A. The size of A, which is also the value of the variable MAX, must be greater than

$$8(P(G+D) + 2GD + 10G + G(G+1) + 25R + 19RG + RG+2 + 11P + 4PG + 2N + 50)$$
 where
 R is the number of regions,
 G is the number of neutron energy groups,
 D is the number of delayed neutron groups,
 P is the number of space points, and
 N is the number of test points for testing convergence and predicting transformation frequencies (recommended value is one or two times the number of material regions, R)
6. TYPICAL RUNNING TIME - Computation time per problem time-step is roughly approximated by $(2 + 10^{-(4)}) \cdot (P(G + 0.3D))$, where P, G, and D are defined as in item 5 above. NESC compiled and executed the sample problems in less than 2 minutes of CPU time on an IBM370/195.
7. UNUSUAL FEATURES OF THE PROGRAM - GAKIN2 permits an arbitrarily large number of neutron energy groups.
8. RELATED AND AUXILIARY PROGRAMS - GAKIN2 is a revision of the GAKIN code with improved temporal treatment. The original IBM370 version of GAKIN2 was submitted by John W. Mason and Karl F. Hansen of the Massachusetts Institute of Technology.
9. STATUS - Abstract first distributed June 1968.
 UNIVAC1100 version of GAKIN submitted November 1967, deleted December 1974.
 IBM370 version of GAKIN2 submitted December 1974, replaced December 1978 by revised Edition B submitted October 1978, sample problems executed by NESC November 1978 on an IBM370/195.
10. REFERENCES - J. H. Mason and K. F. Hansen, GAKIN II, A One-dimensional Multigroup Diffusion Theory Reactor Kinetics Code, MITNE-151, August 1973.
 E. T. Dugan, Errata MITNE-151, NESC Note 79-9, GAKIN2, December 6, 1978.
 K. F. Hansen and S. R. Johnson, GAKIN, A One-dimensional Multigroup Kinetics Code, GAMD-7543, August 1967.
11. MACHINE REQUIREMENTS - 275K bytes of storage on an IBM370/195.
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 AUTHOR -

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 University of Florida
 202 Nuclear Sciences Center
 Gainesville, Florida 32611

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (2592 cards)
 Sample problems (438 cards)
 Reference report, MITNE-151, and NESC Note 79-9

17. CATEGORY - F

KEYWORDS - one-dimensional, neutron diffusion equation, multigroup, slabs, cylinders, spheres, GAKIN codes

18. SPONSOR - NSF Division of Engineering

1. NAME OR DESIGNATION OF PROGRAM - BURNUP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - GE635
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - An iterative process is utilized whereby a correction for traces of uranium contamination as well as corrections based on exposure and decay factors are obtained on an initial pass through the data. The last iteration using the corrections obtained gives a final value for the calculations.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - A maximum of 50 samples can be run in any one case. Although a single sample can be processed, the averaging procedures for nuclear constants are most effective when 5 to 50 samples from the same fuel load are pooled in a single case.
6. TYPICAL RUNNING TIME - 2 to 3 seconds per sample are required.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed June 1968
GE635 version submitted December 1967 /
10. REFERENCES - B. F. Rider and C. P. Ruiz, Determination of Atom Percent Fission in Uranium Fuel, Progress in Nuclear Energy Series IX, Analytical Chemistry 3, Part 2, C. E. Crouthamel, Ed., Pergamon Press, 1962.
B. F. Rider, J. Paul Peterson, Jr., J. L. Jaech, C. P. Ruiz and F. R. Smith, Accurate Nuclear Burnup Analysis XV, GEAP-4950, September 1965.
B. F. Rider, C. P. Ruiz, J. P. Peterson, Jr., and F. R. Smith, BURNUP, A FORTRAN IV Code for Computing U and Pu Fuel BURNUP from U, Pu, and Nd Mass Spectrometric Measurements, GEAP-5355, October 31, 1967.
BURNUP Subroutine Descriptions including -
BITA, LST001, December 3, 1964.
A. E. Scadden, Zero Division Overflow Modifier, Q4T001
Nels J. Anderson, Jr., IDFTAP Function Subprogram Write-up, GE-NED Note, 1968.
11. MACHINE REQUIREMENTS - 32K memory and an on-line printer.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GECOS
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - A non-standard data loading routine (DTA) is utilized to read input cards. DTA is FORTRAN IV compatible and reads and loads numeric and Hollerith (BCD) data punched free style on the 80-column card.
15. NAME AND ESTABLISHMENT OF AUTHORS -
B. F. Rider, J. P. Peterson, Jr.,
F. R. Smith, and T. V. McLaughlin
Vallecitos Nucleonics Laboratory

General Electric Company
Pleasanton, California

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (4754 cards)
Sample problem (51 cards)
Reference report, GEAP-5355, and BURNUP Subroutine Descriptions
17. CATEGORY - O
KEYWORDS - fission products, mass spectrometers, burnup, fuels, uranium isotopes, plutonium isotopes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - CINDER(M0102)
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600, IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Time-dependent variations in nuclide cross sections and neutron fluxes are approximated by a user-specified sequential set of values which are considered constant during the duration of the user-specified associated time-increments. When a nuclide concentration is independent of the concentration of any of its progeny, it is possible to resolve the couplings so as to obtain nuclides fed by a single parent. These chains are referred to as linear.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The program is limited to 500 total nuclides formed in up to 240 chains of 20 or fewer nuclides each. Up to 10 nuclides may act as fission product sources, contributing to power, and as many as 99 time-steps of arbitrary length are permitted. All stable nuclides must have a cross section of zero power time-increments are anticipated.
6. TYPICAL RUNNING TIME - Two minutes for every time-step is a conservative estimate of running time on the IBM360.
7. UNUSUAL FEATURES OF THE PROGRAM - During the nuclide concentration calculation the program checks for errors originating from the finite word length of the computer.
8. RELATED AND AUXILIARY PROGRAMS - A previous version of CINDER existed for the Philco 2000.
9. STATUS - Abstract first distributed June 1968
CDC6600 version submitted December 1967
IBM360 version submitted April 1971, sample problem executed by NESC
10. REFERENCES - T. R. England, Time-dependent Fission-product Thermal and Resonance Absorption Cross Sections, WAPD-TM-333, November 1962 and Addendum 1, January 1965
T. R. England, CINDER - A One Point Depletion and Fission Product Program, WAPD-TM-334 (Revised), August 1962, Revised June 1964
J. A. Dugan, CINDER (M0102) Additional Options - Memorandum 2, WAPD-L-(PA)-89 Preliminary
T. C. Gorrell and J. H. Highlower, CINDER - Description and Application, SRL Report, March 8, 1971
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGES USED - FORTRAN IV (CDC6600), FORTRAN IV and BAL (IBM360)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
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Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122

360 T C Gorrell and J H Highlower
Savannah River Laboratory
E I duPont de Nemours and Company
Aiken, South Carolina 29801

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal (360 Version)

Source decks (6600-892 cards, 360-2298 cards)

Sample problems (6600-52 cards, 360-28 cards)

Sample problem output (360-34 pages)

Reference reports, Addendum, and Memorandum

17. CATEGORY - D

KEYWORDS - depletion, radioactivity, decay, fission products, multigroup, absorption, poisoning

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - GAFGAR/P3T/PROC/TAPCOP
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - UNIVAC1108
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - 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
4. **METHOD OF SOLUTION** - The B1 approximation to the Boltzmann equation is solved for the neutron flux and current spectra. The GAF section uses a large number of fine energy groups to represent the cross sections above the resolved resonance region. The GAR section uses a very large number of discrete velocities in the resonance region along with slowing-down sources from the GAF section to treat leakage-dependent resonance absorption more rigorously than previous codes
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The maximum of 1740 fine groups in the GAF section may be subdivided into 10 or less sets of fine groups having a constant lethargy width. The GAR section requires a uniform spacing between the maximum of 14,700 discrete velocities. The maximum number of nuclides in a problem is 20, and the maximum total number of broad groups (output for nuclear design calculations) is 99 with a maximum of 20 broad groups in the GAR section
6. **TYPICAL RUNNING TIME** - 4.6 minutes (1.1 minutes for GAF section and 3.5 minutes for GAR section) are required for a test problem involving hydrogen, carbon, oxygen, Pu239, and Pu240 with 731 fine groups above 10 keV in the GAF section ($\delta\tau=0.01$), 12,387 velocities below 10 keV in the GAR section ($\delta v=110$ m/sec), and 31 broad group output (11 in GAF section and 20 in GAR section)
7. **UNUSUAL FEATURES OF THE PROGRAM** - The GAF section allows downscatter by any process (anisotropic elastic scatter, inelastic scatter, (n,2n) processes, etc.) from any fine group to any lower energy fine group because the full P0 and P1 transfer arrays are used for all materials except hydrogen which is assumed to have only isotropic in the center-of-mass system elastic scatter. Data compression techniques are used to reduce the size of the transfer arrays. The GAR section uses a recursive scheme for the calculation of the P0 and P1 slowing-down source terms which decreases the running time for typical problems by a factor of 3 to 4 while still allowing isotropic in the center-of-mass system elastic scatter to any lower velocity to be treated rigorously. Either positive or negative buckling can be specified for each broad group in each section
8. **RELATED AND AUXILIARY PROGRAMS** - Cross section input for the GAFGAR code is prepared by the GAND code from ENDF/B format nuclear data file tapes. Data on the GAFGAR cross section tapes may be printed with the P3T code. PROC is used to copy selected problems from 1 or 2 GAF and/or GAR problem tapes or to list the problem tapes. TAPCOP is used to copy GAFGAR (packed record) data tapes
9. **STATUS** - Abstract first distributed June 1968
UNIVAC1108 version submitted January 1968, replaced by modified version August 1968
10. **REFERENCES** - D. R. Mathews and R. J. Archibald, GAF, A Computer Program for Calculation of Neutron Spectra and Average Cross Sections in the High Energy Range, GA-7169, January 20, 1967
C. A. Stevens and R. J. Archibald, GAR, A Computer Program for Evaluating Leakage Dependent Resonance Absorption, GA-6952, March 16, 1966
R. J. Archibald and D. R. Mathews, The GAF/GAR/GAND Fast Reactor Cross Section Preparation System, GAFGAR - A Program for the Calculation of Neutron Spectra and Group-averaged Cross Sections, GA-7542, Vol. 1, January 22, 1968, and Errata, May 1968

11. MACHINE REQUIREMENTS - 52K of available fast memory and 5 magnetic tape units plus 5 scratch files (drum files are used on the UNIVAC1108) totaling about 600K in capacity
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2, GAX33A
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - GAFGAR is overlayed in three segments consisting of the GAF section, the GAR section, and a combining and punching section. The UNIVAC1107/1108 FORTRAN IV NTRAN I/O routines are used to buffer the I/O in parallel with computing and to reduce the number of record gaps on the data tapes
15. NAME AND ESTABLISHMENT OF AUTHORS -
R J Archibald, D R Mathews, R T Shansirov,
C A Stevens, and R M Wagner
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16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (GAFGAR 4702 cards, P3T 328 cards, PROC 197 cards, TAPCOP 144 cards)
Sample problem input and output (242 cards)
Reference reports and Errata
17. CATEGORY - B
KEYWORDS - fast reactors, multigroup, cross sections, neutron flux, neutron spectra, resonance absorption, P3T codes, PROC codes, TAPCOP codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GAPOTKIN
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - GAPOTKIN is a point-kinetics code that solves the space-independent kinetics equations for a very general form of the reactivity function
4. METHOD OF SOLUTION - The form of the kinetics equations used is the reactivity-lifetime formulation. The reactivity is specified in terms of step, linear, and quadratic coefficients proportionate to the reactor power and/or total energy release. The numerical method for the integration of the kinetics equations is discussed in detail by Hansen, Koen, and Little (see reference 3). The operating life of the system is divided into various time zones, each with its own set of parameters, in order to treat sequences of events for which the system properties change
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - GAPOTKIN will handle up to 20 time zones and will allow for 50 power-dependent or energy-dependent reactivity coefficients per time zone if tables are used. General data are stored for up to 500 time-steps and time delay data are stored for 10,000 time-steps
6. TYPICAL RUNNING TIME - For a problem with two time zones, the first with a 60-second maximum operating time and no time delay, the second continuing to 160 seconds and with no time delay, the running time is about 20 seconds. With delay times for zone one of 0.1 second and 0.4 second, the running times are approximately 3.5 minutes and 5 minutes, respectively
7. UNUSUAL FEATURES OF THE PROGRAM - A unique feature of the energy feedback is the option of including time delays in the reactivity. There is also provision for including time-varying external sources. The overall versatility of the code allows for the handling of complex sequences of events such as a sudden loss of coolant followed by a control rod drop and delayed reactivity insertions due to energy buildup. Built-in data for U233, U235, and Pu239 are from ANL-5800 (reference 4)
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed June 1968
UNIVAC1108 version submitted January 1968
10. REFERENCES - K. F. Hansen and P. K. Koch, GAPOTKIN, A Point Kinetics Code for the UNIVAC 1108, GA-8204, October 25, 1967
G. R. Keepin, Physics of Nuclear Kinetics, Addison-Wesley Publishing Company, Inc., Reading, Massachusetts, 1965
K. F. Hansen, B. V. Koen, and W. W. Little, Jr., Stable Numerical Solution of the Reactor Kinetics Equations, Nuclear Science and Engineering, Vol. 22, No. 1, p. 51, 1965
Reactor Physics Constants, Second Edition, ANL-5800, 1963
11. MACHINE REQUIREMENTS - GAPOTKIN requires 4100 storage locations. The data storage requirement is roughly 33,000 locations. Two I/O devices are required for reading and printing and one additional I/O device is necessary if the program is loaded from tape
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2, GAX29
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The dimensions of most of the arrays are handled with parameter statements. Adaptation to a particular machine with a FORTRAN IV compiler can be made easily by either adjusting the parameters to allow for available memory or by eliminating the parameters and using explicit dimensions

15. NAME AND ESTABLISHMENT OF AUTHOR -

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16. MATERIAL AVAILABLE -

Source deck (1319 cards)
Sample problem (28 cards)
Reference report, GA-8204

17. CATEGORY - E

KEYWORDS - reactor kinetics, feedback, reactivity insertions, rod drop method

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FEVER7
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 dependant self-shielding factors may be applied to a number of lumped poisons.
4. METHOD OF SOLUTION - Flux distribution and multiplication factors are computed by means of a multigroup diffusion routine. The depletion calculations are performed assuming that the flux amplitude, spectrum, and spatial distribution remain constant for short time-steps. The flux in the thermal groups is re-normalized to the power prior to each short time-step and the spectrum is recalculated after a specified series of short time-steps. For the burnup, nuclides belonging to each subregion react to the average fluxes present in the region to which the subregion is assigned. The diffusion calculation is performed using group constants which are volume-weighted properties of one or more subregions homogenized into a diffusion region. The multigroup 1-dimensional diffusion routine DCALC, incorporated in FEVER7, is based on a direct march out technique with periodic reconditioning. The conventional fission source iteration has been replaced by Wieland iterations, solving all group fluxes simultaneously.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 7 energy groups
 - 151 mesh points
 - 20 regions
 - 60 subregions
 - 45 nuclides per subregion
 - fixed sets of heavy nuclides
6. TYPICAL RUNNING TIME - 10 seconds per large time-step are required for a problem with 3 fast groups, 4 thermal groups, and 151 mesh points.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - This code is an extension of the RELOAD FEVER program, from 4 to 7 neutron energy groups utilizing the DCALC diffusion equation routine.
9. STATUS - Abstract first distributed June 1968
UNIVAC1108 version submitted January 1968
10. REFERENCES - F. Todt, RELOAD FEVER, A One-dimensional, Few Group Depletion Program for Reactor Fuel Cycle Analysis, GA-6612, September 18, 1965
M. R. Wagner, DCALC, A Subroutine for One-dimensional Neutron Diffusion Theory Calculations, GA-8286, October 17, 1967
11. MACHINE REQUIREMENTS - 65K UNIVAC1108 or 1107 and 3 tapes (input, output, system)
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
 - M. R. Wagner
 - General Atomic Company

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16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (5941 cards)
Sample problem (786 cards)
Reference reports

17. CATEGORY - D

KEYWORDS - multigroup, one-dimensional, depletion, diffusion equations, reactivity, neutron flux, poisoning, RELOAD FEYER codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GASP7
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - A multigroup, one-dimensional diffusion theory calculation is performed with an assumed fissile and fertile fuel distribution. An iterative scheme is employed to adjust the fissile distribution to achieve the desired power distribution and to adjust the fertile distribution to achieve a burnup independent power distribution. The poison and poison distribution search are performed by an iterative scheme which maintains the same distribution as in the unpoisoned core. The one-dimensional diffusion routine DCALC, incorporated in GASP7, is based on a direct march out technique with periodic reconditioning, solving for all thermal group fluxes simultaneously.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 7 energy groups
 - 4 thermal neutron energy groups
 - 151 mesh points
 - 20 regions
 - 45 different materials in each region
 - 80 different cross section setsDownscattering from the fast groups into the next lower group only is permitted. The geometry assumed is cylindrical, and either radial or axial flux distributions may be calculated.
6. TYPICAL RUNNING TIME - 1 to 2 minutes are required for a 7-group case.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - GASP7 is an extension of GASP2 from 4 to 7 energy groups, utilizing the DCALC diffusion equation routine.
9. STATUS - Abstract first distributed June 1968
UNIVAC1108 version submitted January 1968
10. REFERENCES - W. A. Simon and K. R. Van Howe, GASP-II, A Computer Code for Burnup-independent Power Shaping by Fuel Zoning Incorporating a Poison Search, GA-5688, October 11, 1965
M. R. Wagner, DCALC, A Subroutine for One-dimensional Neutron Diffusion Theory Calculations, GA-5286, October 17, 1967
11. MACHINE REQUIREMENTS - 65K UNIVAC1108 or 1107 and 3 tapes (input, output, system)
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
 - W. A. Simon, K. R. Van Howe and M. R. Wagner
 - General Atomic Company
 - P. O. Box 81608
 - San Diego, California 92138

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (4918 cards)
Sample problem (404 cards)
Reference reports

17. CATEGORY - C

KEYWORDS - iterative methods, multigroup, one-dimensional, diffusion equations, power distribution, poisoning, GASP2 codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - TEMCO7
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - TEMCO7 computes reactor temperature coefficients
4. METHOD OF SOLUTION - Given cross sections for each temperature to be considered, the code performs a series of one-dimensional diffusion calculations and then uses the results to generate the temperature coefficient. The 1-dimensional diffusion subroutine DCALC is based on a direct march out technique with periodic reconditioning, solving for all thermal group fluxes simultaneously
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 25 temperatures
 - 3 fast energy groups
 - 1-4 thermal energy groups
 - 20 regions
 - 151 mesh points
 - 60 subregions
 - 40 nuclides per subregion
 - 80 cross section sets per temperature
6. TYPICAL RUNNING TIME - A time estimate for a 7 energy group case is 5 to 10 seconds per temperature
7. UNUSUAL FEATURES OF THE PROGRAM - TEMCO7 computes temperature derivatives of the four factors β , λ , ρ , β , and the contributions of each nuclide to the temperature coefficient
8. RELATED AND AUXILIARY PROGRAMS - TEMCO7 is an extension of TEMCO from 4 to 7 neutron energy groups utilizing the DCALC diffusion equation routine
9. STATUS - Abstract first distributed June 1968
UNIVAC1108 version submitted January 1969
10. REFERENCES - F. W. Todt, TEMCO, A FORTRAN Program for Computing Temperature Coefficients, GA-6734, December 28, 1965
M. R. Wagner, DCALC, A Subroutine for One-dimensional Neutron Diffusion Theory Calculations, GA-8288, October 17, 1967
11. MACHINE REQUIREMENTS - 65K UNIVAC1108 or 1107 and 3 tapes (input, output, system)
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
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 - General Atomic Company
 - P. O. Box 81608
 - San Diego, California 92138
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
 - Source deck (3705 cards)
 - Sample problem (2843 cards)
 - Reference reports
17. CATEGORY - C

KEYWORDS - temperature coefficient, multigroup, one-dimensional, diffusion equations, neutron flux, reactivity, resonance escape probability, thermal utilization, fast fission factor, TEMCO codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - EXPALS
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC7600, 6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - This program fits by least squares a function which is a linear combination of real exponential decay functions. The function is

$$y(k) = \text{summation over } j \text{ of } a(j) \cdot \exp(-\lambda(j) \cdot k)$$
 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 ($w(k) = 1/y(k)$)
4. METHOD OF SOLUTION - The Prony-Householder iteration method is used. For unequally-spaced data, a number of interpolation options are provided. This revision includes an option to call a differential correction subroutine REFINE to improve the approximation to unequally-spaced data when equal-interval interpolation is faulty. If convergence is achieved, the probable errors in the computed parameters are calculated also.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Generally, it is desirable to have at least $10n$ observations where n equals the number of terms and to input $k+n$ significant figures if k significant figures are expected.
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed June 1968
 IBM7030 version submitted January 1968, deleted August 1968
 IBM7094 version submitted August 1968, replaced by CDC7600 version submitted August 1978, sample problem executed by NESC October 1978 on a CDC7600
10. REFERENCES - C. Douglas Gardner, EXPALS-FORTRAN Code for Exponential Approximation by Least Squares, UCRL-14541, Rev. 2, August 1, 1978
 R. E. von Holdt, Minimize Linear Residuals, LLL Computer Information Center Report F3-001, March 1969
 J. D. Lawrence, Polynomial Root Finder, LLL Computer Information Center Report C2 2-001, December 16, 1966
11. MACHINE REQUIREMENTS - EXPALS requires about 74,062 (total) words with the maximum number of observations or interpolated values (NMX) set at 200 and the maximum number of values for the lambda calculation (NMK) set at 25.
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 -
15. NAME AND ESTABLISHMENT OF AUTHOR -
 C. Douglas Gardner
 Computation Department
 Lawrence Livermore Laboratory
 P. O. Box 808
 Livermore, California 94550
16. MATERIAL AVAILABLE -
 Source deck (1035 cards)
 Sample problem (52 cards)
 Sample problem output (8 pages)
 Reference reports

- 17. CATEGORY - P
KEYWORDS - least square fit, radioactivity, decay
- 18. SPONSOR - DOE Division of Military Application

1. NAME OR DESIGNATION OF PROGRAM - ISOSEARCH
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - The program is based on solutions to the Bateman equations for reaction and decay chains. The solutions for a chain containing two or three nuclides are combined to form a generalized solution applicable to most simple isotope-production or flux-determination problems. A searching procedure is used which starts with given maximum and minimum estimates for the unknown variable and converges to a value that fits the input data given for the known variables
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM - The input data are set up to facilitate the investigation of different values of irradiation time, disintegrations per second, or neutron flux for the chain considered
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed June 1968
IBM360 version submitted January 1968
CDC1604 version submitted by ORNL January 1968, deleted July 1978
10. REFERENCES - C W Friend, R E Lewis, and A R Jenkins, ISOSEARCH - Computer Program for Calculating Unknown Variables in Reaction and Decay Schemes, ORNL-3905, January 1967
R P Rennie, Character Manipulation Subroutines for the IBM/360, ORNL Memorandum No 2/360
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and BAL
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
C W Friend and R E Lewis
Isotopes Division
A R Jenkins
Mathematics Division
Oak Ridge National Laboratory
P O Box X
Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE -
Source deck (810 cards)
Sample problem (30 cards)
Reference report and Memo
17. CATEGORY - D
KEYWORDS - isotope production, decay, capture, cross sections, neutron flux
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FRANTIC
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM370
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - In order to use the least squares method the equations must be made linear by expanding each expression in a first-order Taylor series about the point defined by the best estimate of the parameters. A least squares analysis can then be made, and the results used to correct these estimates. This process is repeated until a specified convergence criterion is met.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The program is designed to accommodate up to 400 data points for a maximum of 10 components.
6. TYPICAL RUNNING TIME - A few seconds per decay curve are required.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The original IBM7090 version was prepared by P. C. Rogers of Brookhaven National Laboratory, Upton, New York.
9. STATUS - Abstract first distributed June 1968.
IBM7090 version submitted February 1968, replaced by IBM370 version July 1978.
10. REFERENCE - Paul C. Rogers, FRANTIC Program for Analysis of Exponential Growth and Decay Curves, MIT Laboratory for Nuclear Science Technical Report No. 76, June 1962.
11. MACHINE REQUIREMENTS - FRANTIC uses approximately 160K bytes of storage 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 - The program consists of 8 semi-independent subprograms each performing a specific set of operations. The system routine CLOCK causes the date and time to be printed and will have to be replaced by a local equivalent.
15. NAME AND ESTABLISHMENT OF AUTHOR -
A. J. Streck
National Energy Software Center
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. MATERIAL AVAILABLE -
Source deck (637 cards)
Sample problem (29 cards)
Reference report
17. CATEGORY - P
KEYWORDS - radioactivity, decay, isotope production, least square fit
18. SPONSOR - AEC

1. NAME OR DESIGNATION OF PROGRAM - 2DB
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108, CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - Standard source-iteration techniques are used. Group rebalancing and successive overrelaxation with line inversion are used to accelerate convergence. Material burnup is by reactor zone. The burnup rate is determined by the zone and energy (group) averaged cross sections which are recomputed after each time-step. The isotopic chains, which can contain any number of isotopes, are formed by the user. The code does not contain built-in or internal chains.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Since variable dimensioning is employed, no simple bounds can be stated. The current 1108 version, however, is nominally restricted to 50 energy groups in a 65K memory. In the 6600 version the power fraction, average burnup rate, and breeding ratio calculations are limited to reactors with a maximum of 50 zones.
6. TYPICAL RUNNING TIME - A keff calculation with a 30x30 mesh and 4 energy groups requires approximately one minute. A typical burnup calculation requires roughly twice the machine time of a keff calculation.
7. UNUSUAL FEATURES OF THE PROGRAM - The input data are arranged so the code can be easily used for keff and search calculations without burdening the user with burnup parameters.
8. RELATED AND AUXILIARY PROGRAMS - The input data (e.g., cross sections, flux dumps, geometry, and composition specifications) are compatible with the Los Alamos one- and two-dimensional transport codes, DTF4 (NESC Abstract 209) and 2DF, and the Battelle perturbation code, PERT4 (NESC Abstract 304). All four codes use the same input module. The logical flow of 2DB is patterned after the 2DF code.
9. STATUS - Abstract first distributed June 1968
UNIVAC1108 version submitted February 1968, revised April 1969
CDC6600 version submitted February 1969
CDC3600 version submitted by ANL February 1970, deleted July 1970
10. REFERENCES - W. W. Little, Jr. and R. W. Hardie, 2DB, A Two-dimensional Diffusion-Burnup Code for Fast Reactor Analysis, BNWL-640, January 1968, Addendum and Errata, April 12, 1968
W. W. Little, Jr. and R. W. Hardie, 2DB Users Manual - Revision 1, BNWL-831, Rev. 1, February 1969
T. J. Hiron and R. D. O'Dell, CDC-6600 Version of 2DB, A Two-dimensional Diffusion-burnup Code for Fast Reactor Analyses, LASL Note K-1-1-776, February 5, 1969
K. O. Lathrop, DTF-IV, A FORTRAN-IV Program for Solving the Multigroup Transport Equation with Anisotropic Scattering, LA-3373, July 15, 1965
2DF, A Two-dimensional Transport Code from the Los Alamos Scientific Laboratory (unpublished)
R. W. Hardie and W. W. Little, Jr., PERT-IV, A Two-dimensional Perturbation Code in FORTRAN-IV, BNWL-409, April 1967
11. MACHINE REQUIREMENTS - 65K memory and three peripheral storage devices

12. PROGRAMMING LANGUAGE USED - FORTRAN IV

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHORS -

1100 W W Little, Jr and R W Hardie
Pacific Northwest Laboratories
Battelle
P O Box 999
Richland, Washington 99352

8600 T J Hirone and R D O'Dell
Los Alamos Scientific Laboratory
P O Box 1663
Los Alamos, New Mexico 87544

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (1100-2422 cards, 8600-3107 cards)
Sample problems (1100-61 cards, 8600-167 cards)
Sample problem output (8600-75 pages)
Reference reports, BNWL-640 and BNWL-831, and LASL Note

17. CATEGORY - D

KEYWORDS - two-dimensional, multigroup, reactivity, criticality searches, depletion, diffusion equations, x-y, r-z, r-theta, DTF4 codes, PERT4 codes, 2DF codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - AIROS2A
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The numerical technique used to integrate the neutron and feedback differential equations is that developed by E. R. Cohen as previously used in the AIREK codes. An improved interval switching technique allows rapid calculations with predetermined accuracy.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
15 delayed neutron precursor groups
400 feedback variables
90 feedback variables printed out
Any number of channels and nodes per channel within the limitation above are allowed
6. TYPICAL RUNNING TIME - 1 to 2 minutes are required for a problem with 6 delayed neutron precursor groups and 50 feedback variables (including CRT)
7. UNUSUAL FEATURES OF THE PROGRAM -
 - (a) A special provision is made for reactor startup problems resulting in a large reduction in running time.
 - (b) Many of the required input data are pre-set but can be changed if desired.
 - (c) Addressable input data are used so that on multiple cases, only changes need be specified.
 - (d) A restart feature is provided wherein restart cards are punched upon abnormal problem termination and/or on an input option.
 - (e) Extensive printed and graphical displays are provided as follows - power, inverse period, reactivity and any 90 feedback variables. Printing and display of feedback variables is under the user's control and the latter can be grouped on CRT frames as desired.
 - (f) Conduction and convection coefficients may be input and/or calculated by means of an input generator which in addition performs an initial temperature calculation.
 - (g) Phenomenological models for change of phase are incorporated.
- *8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed June 1968
IBM360 version submitted February 1968, replaced by updated version December 1970

10. REFERENCES - R. A. Blaine and R. F. Berland, Simulation of Reactor Dynamics, Volume I - A Description of AIROS IIA, NAA-SR-12452, September 1967.
R. A. Blaine, AI Environment Report, May 1967.
R. A. Blaine, Modifications to Airos II-A, W00048, AI Computing Notice No. 118, April 4, 1968.
11. MACHINE REQUIREMENTS - 256K byte IBM360 and an SC-4020 graphical display device
12. PROGRAMMING LANGUAGES USED - FORTRAN IV (95%) and
Assembly language (5%)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Two new features have been added to the latest version of AIROS2A. A contact resistance term has been added in the calculation of the overall heat transfer coefficients, UA. A new subroutine has been added to simulate setback or controller action of a single bank of control rods. If an SC-4020 graphical display device is not available, the AICRT 3 display routine can be rewritten, or all routines but TAPOUT and PRINT can be deleted from the last link. The NAA SC-4020 (OS) subroutine package is available through -
UAIDE Librarian
c/o Stromberg-Carlson
P. O. Box 2449
San Diego, California 92112
15. NAME AND ESTABLISHMENT OF AUTHOR -
A. N. Nickols
Codes Coordinator
Atoms International
P. O. Box 309
Canoga Park, California 91304
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (4586 cards)
Sample problem (89 cards)
Reference reports and Notice
17. CATEGORY - E
KEYWORDS - reactor kinetics, reactivity, feedback, Cohen equation, delayed neutron precursors, computer graphics, AIRES codes, AIROS codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - DAFT1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Normal equations are solved by Gauss-Newton iteration using the pivotal method for matrix inversion. The choice of input and fitted parameters follows reference 1.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Data are fitted for a maximum of 3 fissile nuclides.
6. TYPICAL RUNNING TIME - 30 seconds are required for four iterations.
7. UNUSUAL FEATURES OF THE PROGRAM - Computations are carried out to aid in diagnosing particularly deviant data and particularly significant data.
8. RELATED AND AUXILIARY PROGRAMS - DAFT1 uses the Bellis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed June 1968.
CDC6600 version submitted March 1968.
10. REFERENCES - C. H. Westcott, et al., A Survey of Values of the 2200 m/s Constants for Four Fissile Nuclides, Atomic Energy Review, Vol. 3, No. 2, p. 1, 1965.
D. R. Harris, DAFT1 - A FORTRAN Program for Least Squares Fitting of 0.0253 EV Neutron Data for Fissile Nuclides, WAPD-TM-761, February 1968.
C. J. Pfeiffer, CDC-6600 FORTRAN Programming - Bellis Environmental Report, WAPD-TM-668, January 1967.
11. MACHINE REQUIREMENTS - 32000 (octal) central memory locations
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
D. R. Harris
Bellis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 78
West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (360 cards)
Sample problem (17 cards)
Reference report, WAPD-TM-761
17. CATEGORY - P
KEYWORDS - least square fit, cross sections, uranium, plutonium
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - NURLOC-1 0
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6400
3. DESCRIPTION OF PROBLEM OR FUNCTION - NURLOC-1 0 performs core/ pressure vessel thermal analysis for a nuclear reactor loss-of-coolant accident
4. METHOD OF SOLUTION - Explicit finite difference approximation is used
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Two-dimensional analyses, either single pins or cylindrical shells, are performed
6. TYPICAL RUNNING TIME - A typical problem with 1000 time-steps requires about 20 minutes on the CDC6400
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - ECCSA-1 (NESC Abstract 330), a blowdown and emergency-core-cooling heat transfer program
9. STATUS - Abstract first distributed June 1968
CDC6400 version submitted April 1968
10. REFERENCE - C T Walters and J M Genco, NURLOC-1 0 A Digital Computer Program for Thermal Analysis of a Nuclear-reactor Loss-of-Coolant Accident, BMI-1807, July 8, 1967
11. MACHINE REQUIREMENTS - 65K or 32K memory with overlay
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 -
C T Walters
Columbus Laboratories
Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (3881 cards)
Sample problem (271 cards)
Reference report
17. CATEGORY - G
KEYWORDS - two-dimensional, shells, water reactors, accidents, pressure vessels, LOCA, coolants, temperature distribution, ECCSA-1 codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - M0457(PIPE)
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - PIPE performs an elastic stress analysis of a 3-dimensional piping structure with thermal stresses, redundant loops, and concentrated loads
4. METHOD OF SOLUTION - Linear elastic theory is used Equations are set up in accordance with CTAC and trail theory
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 100 positions to locate forces and elements
 - 20 force-trails
 - 25 applied loads
 - 50 total loads
 - 20 joint-condition loads
 - 20 sets of material properties
 - 20 sets of stiffness data
 - 99 elastic elements
6. TYPICAL RUNNING TIME - One minute is required
7. UNUSUAL FEATURES OF THE PROGRAM - Trail theory allows the user to input geometric data from which the program calculates connection matrices for the CTAC equations
8. RELATED AND AUXILIARY PROGRAMS - PIPE is a simplification of the more basic program M0014 PIPE applies more directly to piping systems It uses the Battis Environmental Routines (NESC Abstract 478)
9. STATUS - Abstract first distributed June 1968
CDC6600 version submitted March 1968, replaced by updated CDC6600 version May 1970
10. REFERENCES - C M Friedrich, PIPE - A Computer Program for the Elastic Stress Analysis of a Piping Structure with Thermal Strains and External Loads, WAPD-TM-752, March 1968
C J Plester, CDC-6600 FORTRAN Programming - Battis Environmental Report, WAPD-TM-668, January 1967
11. MACHINE REQUIREMENTS - 100,000 (octal) central memory and 3 tapes (input, output, storage)
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
 - C M Friedrich
 - Battis Atomic Power Laboratory
 - Westinghouse Electric Corporation
 - Box 79
 - West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
 - Magnetic Tape Transmittal
 - Source deck (2174 cards)
 - Sample problem (50 cards)
 - Reference report, WAPD-TM-752

17. CATEGORY - 1

KEYWORDS - elasticity, thermal stresses, pipes, three-dimensional, pressure, M0014 codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ECCSA4
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6400
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - An explicit, finite-difference technique is used to solve the conservation equations describing the fluid behavior in the core channel. Fluid thermodynamic properties are determined from property tables incorporated in the code. Heat conduction in the fuel rod is determined using an explicit, finite-difference method.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The fuel rod can be represented by up to 11 radial nodes and 24 axial segments. Each axial segment has associated with it an equivalent axial segment of the fluid channel surrounding the fuel rod. Thus a maximum of 24 axial segments in the flow channel is allowed.
6. TYPICAL RUNNING TIME - Running time varies between 150 to 200 times real time, using 1-foot axial segments in the flow channel. Doubling the number of axial segments will increase running time by approximately a factor of 4.
7. UNUSUAL FEATURES OF THE PROGRAM - ECCSA4 solves the three conservation equations at each axial segment, thus accounting for local flow reversals and local flow stagnation.
8. RELATED AND AUXILIARY PROGRAMS - ECCSA4 supersedes the ECCSA1 computer program.
9. STATUS - Abstract first distributed June 1968
CDC6400 version of ECCSA1 submitted April 1968, deleted July 1968
CDC6400 version of ECCSA4 submitted November 1971
10. REFERENCES - R. A. Gudnik, ECCSA and MUCHA - Computer Codes for the Analysis of Emergency Core Cooling Systems, BM-1916, September 1971
6400 Programming Bulletin Number 11, March 21, 1971
11. MACHINE REQUIREMENTS - 110K octal memory, one tape for restart capability, one tape for plotting data if desired.
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 - ECCSA4 requires the use of CDC6400 FORTRAN function subprograms UNILIN and BILIN1. UNILIN, which is used in subroutines HTCHG and FLUID, performs linear interpolation from a table of values of y versus x. BILIN1, which is used in the function PHISQ, performs linear interpolation from a table of values of z versus x and y.
15. NAME AND ESTABLISHMENT OF AUTHOR -
Ronald A. Gudnik
Columbus Laboratories
Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (3812 cards)
Sample problem (53 cards)
Reference report and Bulletin

17. CATEGORY - G

KEYWORDS - accidents, coolants, fluid flow, heat transfer

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - M0219(FLOT1)
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The simultaneous differential equations of flow are solved by a matrix and, in conjunction with dynamic equations of the pump, are iterated to user-specified convergence criterion.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The mathematical model, upon which the program is based, is limited to four loops with a maximum of three pumps per loop in parallel.
6. TYPICAL RUNNING TIME - The running time for a three loop initial operation to a complete loss of flow requires 49 seconds with output consisting of initial steady-state flow and pressure-drop distribution and a printout every 50 milliseconds for 10 seconds.
7. UNUSUAL FEATURES OF THE PROGRAM - Empirical relations for the transfer of energy from the pump impeller to the fluid over the entire range of operation have been included in the program and the program results show good correlation with test data. The program results are used in core performance analysis and check valve pressure surge calculations.
8. RELATED AND AUXILIARY PROGRAMS - FLOT1 uses the Bettis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed June 1968
CDC6600 version submitted May 1968
10. REFERENCES - G. M. Fuhs, FLOT-1 Flow Transient Analysis of a Pressurized Water Reactor During Flow Coastdown, WAPD-TM-428, April 1968
C. J. Pfeiffer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967
11. MACHINE REQUIREMENTS - The program is designed for card input with both printed and plotted output. The number of core locations required is 55,000 octal.
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 -
15. NAME AND ESTABLISHMENT OF AUTHOR -
G. M. Fuhs
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (2126 cards)
Sample problem (36 cards)
Reference report, WAPD-TM-428

17. CATEGORY - H

KEYWORDS - fluid flow, pumps, steam generators, failures, PWR reactors

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SAFE-3D
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108, IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The finite-element variational method is used. Equilibrium equations are solved by the alternating component iterative method.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
5000 nodes
16000 elements
The program cannot be applied to incompressible solids and is not recommended for Poisson's ratio in the range of ν between 0.495 and 0.5.
6. TYPICAL RUNNING TIME - Execution of the sample problem on the IBM360/75 requires 15 minutes.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - SAFE-PCRS, SAFE-AXISYM, and SAFE-PLANE (NESC Abstract 252).
9. STATUS - Abstract first distributed June 1968
UNIVAC1108 version submitted April 1968
IBM360 version submitted February 1971, sample problem executed by NESC
10. REFERENCES - D. C. Cornell, K. B. Jadhav, and Y. R. Rashid, SAFE-3D, A Computer Program for the Three-dimensional Stress Analysis of Composite Structures - A Users Manual, GA-7855, September 1967.
Y. R. Rashid, Three-dimensional Analysis of Elastic Solids, GA-8419, February 1968.
NTRAN, I/O Routines for Tape and Drum, Excerpt from UNIVAC 1107 FORTRAN IV Programmers Reference Manual, UP-3589, Rev. 1.
J. S. Crowell, SAFE-3D 360 Overlay Structure and Miscellaneous Information, ORNL Note, January 1971.
11. MACHINE REQUIREMENTS - 52K fast memory storage and 8,000,000 auxiliary storage for the UNIVAC1108.
12. PROGRAMMING LANGUAGES USED - FORTRAN IV (UNIVAC1108), FORTRAN IV and BAL (IBM360).
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2, GAX33A (UNIVAC1108) and OS/360 (IBM360).
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
1108 D. C. Cornell and K. Jadhav
General Atomic Company
P. O. Box 81608
San Diego, California 92138

360 J. S. Crowell
Mathematics Division
Oak Ridge National Laboratory

P. O. Box X
Oak Ridge, Tennessee 37830

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (1108-5148 cards, 360-5880 cards)
Sample problems (1108-205 cards, 360-228 cards)
Reference reports, NTRAN Excerpt, and ORNL Note
17. CATEGORY - 1
KEYWORDS - three-dimensional, stresses, elasticity, mechanical structures, stresses, finite element method, SAFE-PCRS codes, SAFE-AXISYM codes, SAFE-PLANE codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - TOAD
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - TOAD is used to process and analyze gamma ray spectra
4. METHOD OF SOLUTION - Spectral data is read from magnetic (BCD) tape, paper tape, or cards, and smoothed. Peaks are located and integrated. Peak energies are determined. Additional calculations are performed.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - TOAD will handle up to 100 spectra at a time from analyzers with 4096 channels or fewer.
6. TYPICAL RUNNING TIME - 30 seconds to 5 minutes are required, depending upon the number and complexity of spectra processed.
7. UNUSUAL FEATURES OF THE PROGRAM - TOAD is tolerant of analyzer gain and base line shifts and changes in sample geometry and does not require a library of standard spectra.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed June 1968
UNIVAC1108 version submitted April 1968
10. REFERENCES - J. Drake, L. L. Stewart, and D. D. Busch, TOAD, A Computer Code for Processing Gamma-ray Spectra, GAMD-8266, April 3, 1968
H. P. Yule, Data Convolution and Peak Location, Peak Area, and Peak Energy Measurements in Scintillation Counting, Analytical Chemistry, Vol. 38, No. 1, p. 103, January 1, 1966
11. MACHINE REQUIREMENTS - 32K memory
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and ASSEMBLY LANGUAGE
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2, GAX33
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
D. D. Busch
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (1835 cards)
Sample problem (85 cards)
4096-channel analyzer data for sample problem (file 2-16 records of length 1542 BCD,
file 3-16 records of length 1542 BCD)
Reference report, GAMD-8266
17. CATEGORY - 0
KEYWORDS - gamma spectra, data processing, multi-channel analysers
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - STEM
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - STEM uses the consistent mass matrix which is derived by using the deformation function arising in the formulation of the stiffness matrix and includes the effects of shear deformation and rotary inertia.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The program is limited to a system of 14 beams. The maximum matrix size is 120 by 120. The number of beams plus the number of segments in one case cannot exceed 60.
6. TYPICAL RUNNING TIME - 5 seconds are required to compile and execute one case with 120 degrees of freedom.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The punched output containing the stiffness and internal load function matrices can be used directly as input to a GEM program (NESC Abstract 344) calculation in the dynamic design analysis method of shock analysis. The input preparation for STEM may be facilitated by use of the PAM2 program to calculate the cross sectional area, inertia, and shear form factor.
9. STATUS - Abstract first distributed March 1969
CDC6600 version submitted July 1968, replaced by second version May 1972
10. REFERENCES - F. C. Carlson and P. E. Duffy, STEM, A Computer Program to Generate a Consistent Mass and Stiffness Matrix for a System of Uniform Beam Segments, KAPL-M-6933, February 1971.
R. B. McCalley, Mass Matrix for a Prismatic Beam Segment, KAPL-M-6913, March 1968.
11. MACHINE REQUIREMENTS - Field length of 50,000 octal
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 -
15. NAME AND ESTABLISHMENT OF AUTHORS -
P. E. Duffy and F. C. Carlson
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (228 cards)
Sample problem (7 cards)
Reference report
17. CATEGORY - I
KEYWORDS - matrices, beams, mechanical vibrations, mechanical structures, deformation, shear, GAM codes, PAM2 codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - TWIGL/TWIGGLE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600, IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 non-boiling, one-pass model formulated in terms of regionwise-averaged coolant and fuel metal temperatures.
4. METHOD OF SOLUTION - TWIGL uses the cyclic Chebyshev polynomial method (see reference 2) to solve the spatial difference equations for each time-step.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 37 spatial mesh points in the x or r direction
 - 37 spatial mesh points in the y or z direction
 - 2 energy groups
 - 6 groups of delayed neutrons
 - 20 difference material compositions
 - 100 thermal-hydraulic regions for which the average temperatures are defined
6. TYPICAL RUNNING TIME - A cylindrical reactor transient problem with 15 radial and 21 axial mesh points required 223 seconds for 150 time-steps on the CDC6600. One group of delayed neutrons was employed and the step-size was 0.001 second for all time-steps.
7. UNUSUAL FEATURES OF THE PROGRAM - TWIGL solves transient neutron diffusion problems that are initiated by specified time variations of the reactor material parameters or by specified changes in the core inlet coolant temperature or flow rate. All transient problems are assumed to start from equilibrium, and TWIGL will, by either of two options, generate the steady-state fluxes and average temperatures. The initial flux distributions may be input by punched cards (6600 and 360 versions) or read from a PDQ7 (NESC Abstract 275) disk file (6600 version) via the file manager subroutines (see reference 5).
8. RELATED AND AUXILIARY PROGRAMS - TWIGL solves two-dimensional problems similar to the one-dimensional problems solved by the WIGL2 program (NESC Abstract 274). However, the methods of solution differ. The PDQ7 program may be used to generate initial flux distributions that can be saved on a disk file and read into the TWIGL program (6600 version). TWIGL uses the Bettis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed March 1969.
 - CDC6600 version submitted May 1968, replaced by modified version September 1968,
 - replaced by another modified version January 1969
 - IBM360 version submitted December 1968
10. REFERENCES - J. B. Yasinsky, M. Natelson, L. A. Hageman, TWIGL - A Program to Solve the Two-dimensional, Two-group, Space-time Neutron Diffusion Equations with Temperature Feedback, WAPD-TM-743, February 1968.
 - R. S. Varga, Matrix Iterative Analysis, Prentice Hall, Inc., Englewood Cliffs, New Jersey, 1962
 - A. F. Henry and A. V. Vola, 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
 - W. R. Cadwell, PDQ-7 Reference Manual, WAPD-TM-678, January 1967
 - C. J. Pfeiffer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967
11. MACHINE REQUIREMENTS - 64K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 2.0 (CDC6600) and OS/360.

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHORS -

6600 J. B. Yasinsky, M. Natelson,
and L. A. Hageman
Bell's Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania, 15122

360 T. J. Heames
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 (6600-1539 cards, 360-1745 cards)
Sample problems (6600-62 cards, 360-63 cards)
Reference report, WAPD-TM-743

17. CATEGORY - F

KEYWORDS - two-dimensional, two-group, space-time, diffusion, x-y, r-z, temperature
feedback, PQQ7 codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GAUGE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108 (see item 14)
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - A seven-point difference expression for a uniform 60-degree triangular mesh is used, assuming that the smallest homogeneous diffusion region has the form of a hex block which may represent an individual fuel element. The block inversion method is applied to calculate the line flux distribution for the basic cells of a coarse spatial mesh for given flux values at the boundaries of the cells. A coarse mesh rebalancing for the same supermesh is done after each fission source iteration. In addition, an asymptotic fission source extrapolation is used periodically to eliminate the next-to-lowest eigenfunction. A general and flexible burnup routine system was developed which allows an optimal choice of either a difference approximation or an analytical solution of the depletion equations. The code decides internally, for each time-step and every nuclide, which approximation is used. As the most general case a full triangular depletion matrix is allowed.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 1519 hexagonal fuel or reflector elements
 - 4405 mesh points
 - 4 energy groups with downscattering only into the next lower energy group
 - 280 burnup regions
 - 40 burnable nuclides
 - 80 microscopic cross section blocks
 - 5 variable self-shielding factor tablesThe flux is assumed to be zero at the outer reactor boundary.
6. TYPICAL RUNNING TIME - A 4-group problem with 637 hexagonal elements, 1201 mesh-points, 35 nuclides, 170 regions, and no control search requires 1 minute per long time-step. The same problem with a criticality search requires 2 minutes. A full-size problem takes 4 minutes per long time-step.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - As a counterpart to GAUGE a three-dimensional static diffusion theory program, GATT, for a hexagonal-z mesh was developed based on the same principles.
9. STATUS - Abstract first distributed March 1969
UNIVAC1108 version submitted May 1968
10. REFERENCES - M. R. Wagner, GAUGE, A Two-dimensional Few Group Neutron Diffusion-depletion Program for a Uniform Triangular Mesh, GA-8307, March 1968.
H. Kraetsch and M. R. Wagner, The Block Inversion Method, A New Approach to Multidimensional Reactor Calculations, Transactions of the American Nuclear Society, Vol 10, p. 173, 1967.
R. Froehlich, A Theoretical Foundation for Coarse Mesh Variational Techniques, GA-7870, March 1967.

H. Kraetsch and M. R. Wagner, GATT, A Three-dimensional Few Group Neutron Diffusion Theory Program for a Hexagonal-z Mesh, GA-8547, June 1968

11. MACHINE REQUIREMENTS - 85K memory, one drum (or scratch tape) unit, input, output, and restart tapes
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2 (UNIVAC1108)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Overlay loading is used. GAUGE contains a main overlay, 2 primary and 3 secondary overlay sections. With the exception of the edit segment, the diffusion calculation is completely core-contained. UNIVAC1107 and IBM360/65 versions can be prepared from the UNIVAC1108 version with only minor changes.
15. NAME AND ESTABLISHMENT OF AUTHOR -
M. R. Wagner
General Atomic Europe
Weinbergstrasse 109
8006 Zurich/Switzerland
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (4746 cards)
Sample problem (135 cards)
Reference report, GA-8307
17. CATEGORY - D
KEYWORDS - two-dimensional, few-group, diffusion equations, depletion, neutron flux, hexagonal configuration, burnup, control elements, GATT codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - POWERCO
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The cost calculation is based on the requirement that income received must provide for recovery of investment, return on investment, and all operating expenses. Equations are developed to calculate true fixed charge rates and true average fuel working capital.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maximum of - 180 time periods
6. TYPICAL RUNNING TIME - About 1 minute per problem is required
7. UNUSUAL FEATURES OF THE PROGRAM - POWERCO uses a present-worth cash flow procedure. Fixed charge rates and fuel working capital are not required. Income taxes are calculated internally.
8. RELATED AND AUXILIARY PROGRAMS - The original CDC1604A version of POWERCO was prepared by Royce Salmon, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
9. STATUS - Abstract first distributed March 1969
CDC1604A version submitted by ORNL June 1968, deleted July 1978
CDC6600 version submitted April 1973
10. REFERENCE - Royce Salmon, A Procedure and a Computer Code (POWERCO) for Calculating the Cost of Electricity Produced by Nuclear Power Stations, ORNL-3944, June 1966
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 -
15. NAME AND ESTABLISHMENT OF AUTHOR -
Frank D. Tyson
Technical Computer Services
United Engineers and Constructors, Inc
1404 Arch Street
Philadelphia, Pennsylvania 19105
16. MATERIAL AVAILABLE -
Source deck (442 cards)
Sample problem (36 cards)
Reference report
17. CATEGORY - D
KEYWORDS - nuclear power plants, economics, investment, cost, present worth method
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GANDY3
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - GANDY3 evaluates temperature-dependent effective neutron capture, fission, and scattering cross sections in the unresolved resonance region from average resonance parameters
4. METHOD OF SOLUTION - Effective cross sections are evaluated at specified energies and temperatures using the narrow resonance approximation and assuming isolated resonances. Resonance cross sections are treated on a statistical basis, using chi-squared distributions for the partial widths. The line shape functions, ψ_1 and χ_1 , are evaluated in a subroutine written by Naliboff which is based upon a method developed by Adler and Naliboff (see reference 3). The statistical averaging is carried out using a quadrature scheme introduced in the RAPTURE code
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - GANDY3 will handle as many temperatures as desired for a maximum of 100 energy points. Consideration is given to neutron orbital angular momenta through d-wave ($L=2$)
6. TYPICAL RUNNING TIME - For Pu239 with $L=0$ and 1, the denominator evaluated, and the exact interference scattering option selected, the approximate running time is 2 seconds for one energy point. Non-fissionable nuclides, which require statistical averaging only for the neutron width distribution, are an order of magnitude faster for the same degree of approximation. For reactor design calculations in which unresolved resonance cross sections are evaluated at one-quarter lethargy intervals, the effective cross sections in the unresolved resonance region for U238, Pu239, Pu240, Pu241, and Pu242 are evaluated by GANDY3 as implemented in the GGC5 code in approximately 45 seconds
7. UNUSUAL FEATURES OF THE PROGRAM - GANDY3 incorporates the following features which distinguish the present treatment from earlier unresolved resonance calculations -
 - (a) Computation of the unresolved resonance scattering cross section as well as the capture and fission cross sections
 - (b) Consideration of s-, p-, and d-wave ($L=0, 1$, and 2) neutron orbital angular momenta
 - (c) Consideration of arbitrary half-integer values of the target spin in addition to $I=0$
 - (d) Calculation of the fission cross sections for chi-squared fission width distributions with one, two, three, or four degrees of freedom
 - (e) Consideration of interference scattering
 - (f) Inclusion of the denominator in the calculation of the effective cross section
 - (g) Inclusion of a much faster j function evaluation algorithm than the original version of GANDY
 - (h) Inclusion of an optional procedure for the computation and printing of the differences between cross section calculations at different temperatures
 - (i) Adoption of the ENDF/B format conventions with respect to the computation of the reduced neutron wave length and the neutron penetrabilities
8. RELATED AND AUXILIARY PROGRAMS - GANDY3 is an extension of the GANDY code which was based upon the RAPTURE code. GANDY3 is incorporated in the GAND2 and GFE2 portions of the General Atomic fast cross section package, GAF/GAR/GAND (NESC Abstract 596) and in the fast section of the GGC5 code
9. STATUS - Abstract first distributed March 1969
UNIVAC1108 version of GANDY submitted June 1968, replaced by GANDY3 April 1974

10. REFERENCES - D R Mathews and P K Koch, GANDY3, A Computer Program for the Evaluation of Effective Cross Sections in the Unresolved Resonance Region, GA-A12826, January 1974
S C Cohen and P K Koch, GANDY, A Computer Program for the Evaluation of Effective Cross Sections in the Unresolved Resonance Region, GA-8003, May 1967
F T Adler and Y D Haliboff, A Direct Method for the Evaluation of the Resonance Line Shape Functions, Journal of Nuclear Energy, Paris A/B, Vol 14, pp 208-211, 1961
J H Ferziger, P Greebler, M D Kelley, and J W Walton, Resonance Integral Calculations for Evaluation of Doppler Coefficients, The RAPTURE Code, GEAP-3929, July 1962
R J Archibald and D R Mathews, The GAF/GAR/GAND Fast Reactor Cross Section Preparation System, GAND2 and GFE2 - Computer Programs for Preparing Input Data for the GAFGAR, GGC, and MICROX Codes from an ENDF/B Format Nuclear Data File, GA-7542, Vol 11, March 1973
D R Mathews, et al, GGC-5, A Computer Program for Calculating Neutron Spectra and Group Constants, GA-6671, September 27, 1971
11. MACHINE REQUIREMENTS - GANDY3 requires about 8300 locations for instructions and 22,700 locations for data. Two I/O devices are required for reading and printing and one additional I/O device is necessary if the program is loaded from tape.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC8
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Adaptation of the GANDY3 code to a smaller machine with a FORTRAN IV compiler can be made by changing array dimensions which will allow for calculations at lower energy points.
15. NAME AND ESTABLISHMENT OF AUTHORS -
P K Koch and D Mathews
General Atomic Company
P O Box 91608
San Diego, California 92136
16. MATERIAL AVAILABLE -
Source deck (1253 cards)
Sample problem (23 cards)
Reference report, GA-A12826
17. CATEGORY - A
KEYWORDS - capture, fission, scattering, resonance, cross sections, GAFGAR codes, GAND2 codes, RAPTURE codes, GGC5 codes, GFE2 codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - M0648
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - M0648 solves the one-dimensional slab transport problem with slowing-down for an arbitrary spatial external source and arbitrary scattering
4. METHOD OF SOLUTION - The double Legendre polynomial expansion of the flux is utilized to obtain a system of linear differential equations which is solved with a round-off free analytic technique (see reference 2). The energy group concept is utilized and the solution is repeated for each energy group in connection with the slowing-down matrix which must be provided as input
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 17 energy groups
 - 12 regions
 - 8 Legendre polynomial expansion coefficients
 - 99 equally-spaced mesh-points per region
 - 440 mesh points
 - 10 material compositionsNo composition can consist of a multiplying medium or of a pure absorber. The boundary conditions can be arbitrary incident on either end or symmetry on one or both ends of the slab
6. TYPICAL RUNNING TIME - For a typical problem of 7 energy groups, 350 mesh points, and 5 regions, central processor time is about 2 minutes
7. UNUSUAL FEATURES OF THE PROGRAM - M0648 is particularly suited for deep penetration problems and for problems where the angular distribution is required with good accuracy
8. RELATED AND AUXILIARY PROGRAMS - M0756 is similar to M0648 but for gamma rays only. M0648 uses the Bettis Environmental Routines (NESC Abstract 478)
9. STATUS - Abstract first distributed March 1969
CDC6600 version submitted June 1968
10. REFERENCES - L. Lois, A Solution of the Slab Transport Problem, WAPD-TM-661, November 1967
L. Lois, Numerical Solution of the One Velocity Boltzmann Neutron Transport Equation in Slab Geometry, Thesis, Columbia University, 1966
C. J. Pfeiffer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-669, January 1968
11. MACHINE REQUIREMENTS - 154K (octal) memory and 4 tape units for scratch storage
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 -
15. NAME AND ESTABLISHMENT OF AUTHOR -
 - L. Lois
 - Bettis Atomic Power Laboratory
 - Westinghouse Electric Corporation
 - Box 79
 - West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
 - Source deck (1561 cards)
 - Reference report, WAPD-TM-661

17. CATEGORY - C

KEYWORDS - one-dimensional, transport theory, distribution, Legendre polynomials, slabs, slowing-down, anisotropic scattering

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - M0758(LETO)
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - LETO utilizes a set of linear differential equations, obtained by an expansion of the flux in double range Legendre polynomials, and a round-off free analytic solution is obtained for the one velocity, one region problem. This is then extended to all regions and energy groups. The cross sections are obtained by a third-degree Lagrange interpolation at specified energy points from a 25-point table. The group cross sections and the slowing-down matrix are then obtained from an infinite medium solution in each of the material regions. The energy source can be constructed from program library spectra and the spatial source can be computed from thermal neutron flux input.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 12 regions
 - 10 materials
 - 13 groups
 - 151 mesh points per region
 - 436 total mesh points
 - 171 total energy mesh points
 - 8 terms in the double range Legendre polynomial expansion of the flux
 - 8 terms in the Legendre polynomial expansion of scattering
6. TYPICAL RUNNING TIME - Central processor time in seconds =

$$50 + \text{sum over number of material regions } (5 \cdot \text{NOEL} + 5 \cdot \text{NGR} \cdot \text{NGR} + 1.6 \cdot L \cdot L)$$
 where NOEL = number of elements in region,
 NGR = number of groups, and
 L = terms of the Legendre polynomial expansion
7. UNUSUAL FEATURES OF THE PROGRAM - LETO is suited for deep penetration problems. Usually it can cover an entire reactor and the shield in a single run. The energy absorbed by one isotope in any region can be computed.
8. RELATED AND AUXILIARY PROGRAMS - The infinite medium solution is obtained with a modified version of the code SIMPS (see reference 3), which is an integral part of LETO. The spatial solution is obtained via the M0648 program (NESC Abstract 342). LETO uses the Bellis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed March 1969
 CDC6600 version submitted June 1968
10. REFERENCES - L. Lois, A Solution of the Slab Transport Problem, WAPD-TM-661, November 1967.
 L. Lois, Numerical Solution of the One Velocity Boltzmann Neutron Transport Equation in Slab Geometry, Thesis, Columbia University, 1966.
 T. E. Dudley and M. R. Mandelson, Group Constants for Gamma Ray Heating, KAPL-M-6497, November 1965.
 C. J. Pfeifer, CDC-6600 FORTRAN Programming - Bellis Environmental Report, WAPD-TM-668, January 1968.
11. MACHINE REQUIREMENTS - 140K (octal) memory and 3 tape units for scratch storage
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 - The term overlay is associated with the SCOPE 2 0 operating system. An overlay determines the amount of program text in central memory of any memory load. The LETO program contains a main overlay and the primary overlays are loaded and executed through the use of the OVERLAY routine.
15. NAME AND ESTABLISHMENT OF AUTHOR -
L. Lois
Bellis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (3522 cards)
Sample problem (61 cards)
Reference report, WAPD-TM-861
17. CATEGORY - J
KEYWORDS - gamma radiation, one-dimensional, transport theory, Legendre polynomials, slabs, shielding, spectra, cross sections, M0648 codes, SIMPS codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GEM
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The VEP system is defined by mass and stiffness matrices. GEM has 47 operations available which include standard matrix operations, input/output operations, and operations for manipulating matrices. Capacity is 9 matrix locations of 3600 elements each and 6 vector locations of 60 elements each. Input to the program consists of a set of operations to be performed, the locations of the various matrices and the numerical values of the matrix elements. Output is available in printed form, or on punched cards or library tapes.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
60 degrees of freedom (VEP)
98 commands per case
6. TYPICAL RUNNING TIME - Normally, a case can be run in 30 seconds
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The STEM code (NESC Abstract 337) punches input for the GEM program
9. STATUS - Abstract first distributed March 1969
CDC6600 version submitted June 1968
10. REFERENCE - R. L. Fagan, GEM - General Matrix Manipulation Program, KAPL-M-EC-67, March 18, 1968
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and ASCENT
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 2.0
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - GEM analyzes each command as read and executes only legal operations with correct arguments. Diagnostic messages are printed if illegal operations or incorrect arguments are encountered. If in the process of executing VEP a negative eigenvalue is found in the mass or stiffness matrix, a diagnostic is written and execution of the case terminated. An error in a command may cause errors in remaining commands or incorrect answers since the storage area is not cleared between cases and results of a case may be used in the next case.
15. NAME AND ESTABLISHMENT OF AUTHORS -
R. L. Fagan and R. B. McCalley
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (2338 cards)

Sample problem (112 cards)
Reference report

17. CATEGORY - 1

KEYWORDS - mechanical vibrations, mechanical structures, matrices, stresses, design, STEM codes, SHD codes, VEP codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GAND
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - Fine-group cross sections and transfer coefficient arrays for use in the GAR code are prepared using modified versions of the routines used to prepare GGC4 (NESC Abstract 298) data tapes as well as the GANDY code (NESC Abstract 341) for unresolved resonance region cross section generation. Pointwise cross sections for use in the GAR code are prepared using the PSEUDO code (NESC Abstract 292) to generate statistical resonances in the unresolved resonance region and the FASDOP code (NESC Abstract 216) to generate the cross sections from both the statistical resonances and the resolved resonance parameters
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
20 ENDF/B materials processed in a single problem
35 resonance levels on either side of the incident neutron energy
6. TYPICAL RUNNING TIME - 30 minutes are required for a typical problem
7. UNUSUAL FEATURES OF THE PROGRAM - The resolved and unresolved resonance calculations can treat processes involving neutrons of orbital angular momenta zero through three (s-, p-, d-, and f-wave interactions). The version of the PSEUDO code used in this program has been modified to allow 1, 2, or 3 degrees of freedom for the distribution of fission widths
8. RELATED AND AUXILIARY PROGRAMS - The binary ENDF/B format nuclear data tapes required by the GAND code are prepared from cards or ENDF/B card image tapes by the ENDFB code. The output from the GAND code is intended for use in the GARFAR code (NESC Abstract 316). PROCOP copies selected problems from the GARFAR problem tapes or lists the tape
9. STATUS - Abstract first distributed March 1969
UNIVAC1108 version submitted August 1968
10. REFERENCES - R. J. Archibald and D. R. Mathews, The GAR/GAR/GAND Fast Reactor Cross Section Preparation System, GARFAR - A Program for the Calculation of Neutron Spectra and Group-averaged Cross Sections, GA-7542, Vol. I, January 22, 1968, and Errata, May 1968
R. J. Archibald and D. R. Mathews, The GAR/GAR/GAND Fast Reactor Cross Section Preparation System, GAND - A Computer Program for Preparing Input Data for the GARFAR Code from an ENDF/B Format Nuclear Data File, GA-7542, Vol. II, March 1973
M. K. Drake, C. V. Smith, and L. J. Todt, Description of Auxiliary Codes Used in the Preparation of Data for the GGC-3 Code, GA-7158, August 1967
S. C. Cohen and P. K. Koch, GANDY - A Computer Program for the Evaluation of Effective Cross Sections in the Unresolved Resonance Region, GA-8003, May 1967
M. W. Dyos, Construction of Statistical Resonances in the Unresolved Resonance Region - The PSEUDO Code, GA-7136, May 28, 1966
C. A. Stevens, FASDOP, A FORTRAN-IV Computer Program for Computing Cross Sections from Resonance Parameters, GAND-6562, August 9, 1965
11. MACHINE REQUIREMENTS - 52K memory and 4 to 8 magnetic tape units plus 5 scratch files (drum files are used on the UNIVAC1108) totaling about 1310K in capacity
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2, GAX35
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHORS -

R. J. Archibald and D. R. Mathews
General Atomic Company
P. O. Box 81608
San Diego, California 92138

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (6436 cards)
Sample problem (73 cards)
Auxiliary programs (ENDFB 212 cards, TRITE 30 cards, WCD 293 cards, CREAD 41 cards)
Reference report, selected portions only of GA-7542, Vol. II

17. CATEGORY - L

KEYWORDS - cross sections, fast reactors, ENDF/B, data processing, GAFGAR codes, PROCOP codes, PSEUDO codes, FASDOP codes, GANDY codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - CODILLI
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The least squares equations are solved first in their linearized form. The non-linear parameters (resonance energies and half widths, i.e., real and imaginary parts of the poles of the collision matrix) are fitted subsequently using the Gauss method of linearization. The convergence of this process depends strongly on the initial estimates for the non-linear parameters. Thus, the combined use of linear and non-linear fits, supported by inspection of graphical output from plotting devices, is often a requirement for a successful analysis.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The analysis is limited to s-wave neutrons. A maximum of 32 resonance levels can be fitted while a maximum of 20 known resonances can also be introduced. Currently the program allows for 1000 energy points and their corresponding cross section values.
6. TYPICAL RUNNING TIME - A reaction cross section fit (linear) of 2 resonances with 489 data points requires 40 seconds running time on the IBM360/75 system, with 717 lines printed on-line.
7. UNUSUAL FEATURES OF THE PROGRAM - The fitted parameters are punched on cards as input data for auxiliary programs. By input option the experimental and the fitted curves may be punched on cards, for independent graphing.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed March 1969
IBM360 version submitted August 1968
10. REFERENCES - D. B. Adler and F. T. Adler, Programs CODILLI, CURVEPLOT, and SIGMA, COO-1546-3, September 1966
D. B. Adler, Program CODILLI 360 - Version No. 1, Technical Report No. 2 AEC-BNL 150227, 1968
11. MACHINE REQUIREMENTS - IBM360 and auxiliary storage (tape or disk) referred to as logical unit 9 in the program.
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 -

D. B. Adler and F. T. Adler
Physics Department
University of Illinois
Urbana, Illinois 61801

16. MATERIAL AVAILABLE -

Source deck (1104 cards)
Sample problem (506 cards)
Reference reports

17. CATEGORY - A

KEYWORDS - least square fit, resonance, Breit-Wigner formula, multilevel analysis, cross sections, potential scattering

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - TOPS
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600.
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The equations for conservation of heat and mass, applied to the steam and water phases together with phenomenological heat and mass transfer laws, are solved by forward difference integration.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - 20 seconds are required.
7. UNUSUAL FEATURES OF THE PROGRAM - In the TOPS representation of the pressurizer, no a priori assumptions are made concerning the particular thermodynamic process followed during insurge or outsurges. This contrasts with most currently-used models, in which some pre-determined process (isentropic compression, saturation line, etc.) is built into the model. In the representation used here, the program itself determines the thermodynamic process at each instant of the transient. In addition, it is possible to simulate the special cases of isentropic and saturation line paths by appropriate selection of the heat and mass transfer coefficients.
8. RELATED AND AUXILIARY PROGRAMS - TOPS uses the Bettis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed March 1969
CDC6600 version submitted August 1968
10. REFERENCES - J. A. Redfield and S. G. Margolis, TOPS - A FORTRAN Program for the Transient Thermodynamics of Pressurizers, WAPD-TM-545, December 1965
G. J. Pfeifer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-658, January 1968
11. MACHINE REQUIREMENTS - Approximately 100,000 octal locations
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 -
15. NAME AND ESTABLISHMENT OF AUTHORS -
J. A. Redfield
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
S. G. Margolis
Division of Interdisciplinary Studies
and Research
State University of New York
Buffalo, New York 14214
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (1703 cards)

Sample problem (49 cards)
Reference report, WAPD-TM-545

17. CATEGORY - H
KEYWORDS - thermodynamics, heat transfer, pressure, gases, liquids
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - RAUMZEIT
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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)
4. METHOD OF SOLUTION - RAUMZEIT solves a basic source problem by forward elimination, backward substitution in an eigenvalue calculation the program iterates on the fission source. The source in a transient calculation is a function of quantities calculated at previous time-steps
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
6 energy groups (6 coupled diffusion-type equations)
300 mesh points
40 different material compositions
6 delayed neutron groups
6. TYPICAL RUNNING TIME - A 2-group, 240 mesh-point calculation with 6 delayed neutron groups requires 24 seconds for the eigenvalue problem and 16 time-steps
7. UNUSUAL FEATURES OF THE PROGRAM - The diffusion and removal terms are input as square matrices, allowing the code to be used for multi-energy-mode calculations as well as with conventional multigroup problems. A transient calculation is preceded by an eigenvalue calculation which normalizes the fission cross sections to obtain a critical configuration at the beginning of the time-dependent problem. The transient may be induced by changing individual cross sections, rearranging compositions, or moving an interface between regions. An option is available to neglect the prompt neutron lifetime (prompt-jump approximation). The code does not permit a time-dependent, externally specified neutron source
8. RELATED AND AUXILIARY PROGRAMS - RAUMZEIT is a modification of the static, one-dimensional code RAUM
9. STATUS - Abstract first distributed March 1969
CDC6600 version submitted November 1968
10. REFERENCES - C. H. Adams and W. M. Stacey, Jr., RAUMZEIT - A Program to Solve Coupled Time-dependent Neutron Diffusion Equations in One Space Dimension, KAPL-M-6728 (CHA-WMS-1), July 31, 1967
W. M. Stacey, Jr. and C. H. Adams, The Time-Integrated Method, A Quasi-static Neutron Space-time Approximation, Transactions of the American Nuclear Society, Vol. 10, p. 261, 1967
F. D. Federighi, RAUM - Solution of One-dimensional Coupled Diffusion-type Equations on the Philco-2000, KAPL-M-FDF-1, February 1962
11. MACHING REQUIREMENTS - 64K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 2.0 or SCOPE 3.1
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The user must supply a matrix inversion subroutine
15. NAME AND ESTABLISHMENT OF AUTHORS -
C. H. Adams* and W. M. Stacey, Jr. *
Knolls Atomic Power Laboratory
General Electric Company
Box 1072

Schenectady, New York 12301
 -Present address-Argonne National Laboratory
 Argonne, Illinois 60439

16. MATERIAL AVAILABLE - Restricted Distribution

Source deck (763 cards)
 Sample problem (158 cards)
 Reference report, KAPL-M-8728

17. CATEGORY - F

KEYWORDS - one-dimensional, multigroup, space-time, diffusion, neutron flux, RAUM codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - CINCAS
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
IBM360, CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 -
 - (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
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Government ownership or leasing of fuel is not allowed, and Th233 fuels are not covered, nor has consideration been given to breeder reactors. The in-core time spanned by all batches of a case must be no more than 40 years.
6. TYPICAL RUNNING TIME - Execution of the sample problem requires less than a minute on the IBM360/75
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed March 1969
IBM360 version submitted November 1968, replaced by revised version July 1969,
sample problem executed by NESC
CDC6600 version submitted December 1970
10. REFERENCES - T. W. Craig, CINCAS, A Nuclear Fuel Cycle Engineering Economy and Accounting Forecasting Code, Commonwealth Edison Report, November 15, 1968
Errata and Addenda to be Added to CINCAS, A Nuclear Fuel Cycle Engineering Economy and Accounting Forecasting Code, Commonwealth Edison Report, July 9, 1969
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 and SCOPE
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -

360	S. McLain and P. J. Fullford Purdue University Lafayette, Indiana
360	M. C. Edlund and T. W. Craig University of Michigan Ann Arbor, Michigan
6600	P. Hentling National Energy Software Center Argonne National Laboratory

9700 South Cass Avenue
Argonne, Illinois 60439

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (360-1840 cards, 6600-1882 cards)
Sample problems (360-40 cards, 6600-39 cards)
Reference report, Errata, and Addenda
17. CATEGORY - D
KEYWORDS - fuel cycle, economics, power plants, operation
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - MC+2-2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370, CDC7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - The extended transport P1, B1, consistent P1, and consistent B1 fundamental mode ultra-fine-group equations are solved using continuous slowing-down-theory and multigroup methods. Fast and accurate resonance integral methods are used in the narrow resonance resolved and unresolved resonance treatments. Multigroup neutron cross sections are generated for arbitrary group structures. A hyper-fine-group integral transport slowing-down calculation is available on option to treat the low-energy spectrum where the narrow resonance approximation is not valid.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Variable dimensioning is used throughout the program so that computer storage requirements depend on a variety of problem parameters. Space requirements range from 400K bytes to 800K bytes on IBM equipment depending on the complexity of the problem.
6. TYPICAL RUNNING TIME - A 1740 group consistent P1 homogeneous twelve-isotope problem with 27 broad groups requires about 4.2 minutes CPU on an IBM370/195. The same problem requires approximately 30% less CP time on the CDC7600.
7. UNUSUAL FEATURES OF THE PROGRAM - Extreme flexibility is provided in specifying the rigor of a calculation including a choice of four distinct slowing-down treatments: multigroup, improved and standard Greuling-Goertzel, continuous slowing-down, and integral transport theory. All binary data transfers are localized in CCCC standard subroutines REED/RITE. Broad group cross section files may be generated in the ARC System XS ISO (reference 2) and/or CCCC ISOTXS (reference 3) formats.
8. RELATED AND AUXILIARY PROGRAMS - MC+2-2 supercedes the original MC+2 program. Input data files required by MC+2-2 may be generated from ENDF/B data by the code ETOE2. The hyper-fine-group integral transport theory module of MC+2-2, RABANL, is an improved version of the RABBLE/RABID codes. Many of the MC+2-2 modules are used in the SDX code. The LIBGEN program included in the CDC7600 package reads BCD cards and writes the MC+2-2 binary library files.
9. STATUS - Abstract first distributed March 1969.
CDC3600 version of MC+2 submitted November 1968, deleted December 1977.
IBM360 version of MC+2 submitted July 1970, replaced December 1977 with IBM370 version of MC+2-2 submitted June 1976, sample problem executed by NESC November 1977 on an IBM370/195.
CDC7600 version of MC+2-2 submitted June 1976, sample problem executed by NESC April 1978 on a CDC7600.
10. REFERENCES - H. Henryson, II, B. J. Toppel, C. G. Stenberg, MC+2-2: A code to Calculate Fast Neutron Spectra and Multigroup Cross Sections, ANL-8144, June 1976.
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.
Standard Interface Files and Procedures for Reactor Physics Codes, Version III, LA-5486-MS, February 1974.
11. MACHINE REQUIREMENTS - A large amount of fast peripheral storage is required. Storage requirements depend on problem complexity but virtually any reasonable problem may be executed on IBM equipment with 800K bytes or CDC equipment with 50,000 words of SCM and 100,000 words of directly addressable LCM.

12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV (89%) and Assembly language (1%) (IBM370). FORTRAN IV (CDC7600)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - The IBM version of MC+2-2 may be executed under OS or VS operating systems and compiled using the FORTRAN H or program product compilers with the highest level of optimization. The CDC7600 version of MC+2-2 has been implemented on both the Lawrence Berkeley Laboratory and Brookhaven National Laboratory computers with their respective COKE/SCOPE operating systems. The SEGMENTATION LOADER is required and directly addressable LCM is used. The code was compiled using the FORTRAN Extended Compiler under OPT=2 optimization.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Subsequent CDC7600 system changes at BNL reduced the size of the directory tables used obsoleting the operating instructions given on pages 221-229 and Appendix F of ANL-8144. The three BCD input tapes used with LIBGEN to produce the binary libraries supplied with the package are available from the Center on request. They are not required for use of MC+2-2.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
H. Henryson, II, B. J. Toppel,
and C. G. Stenberg
Applied Physics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal (IBM370-2 tapes, CDC7600-3 tapes)
Source decks (370-FORTRAN 58,907 cards, Assembler 944 cards, 7600-FORTRAN 58,800 cards,
System FORTRAN and COMPASS 654 cards)
3330 load module (370-MCC2 OBJLIB 111 blocks)
Sample problems (7600-154 cards)
Sample problems and control information (370-605 cards)
Control information (7600-loader directives 48 cards)
Library (370-8 binary files+, 7600-Tape 1-6 binary files+, Tape 2-2 binary files+)
Auxiliary routines (7600-LIBGEN 1527 cards)
Sample problems output (370-65 selected pages and 1 microfiche, 7600-59 selected pages)
Reference report, ANL-8144
+RECFM=VBS,LRECL=X,BLKSIZE=6447
+variable-length records, maximum=5120 characters
17. **CATEGORY** - B
KEYWORDS - multigroup, cross sections, group constants, spectra, resonance, BL method, PL method, slowing-down, ENDF/B, cell calculation, MC+2 codes, ETOE2 codes, RABANL codes, SDX codes
18. **SPONSOR** - DOE Division of Reactor Research and Technology

1. NAME OR DESIGNATION OF PROGRAM - GAF/GAR Data Tapes used in GGA ZPR-III Assembly 48 Analysis ,
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 48 in the format of the GGA GAF/GAR program data tapes.
4. METHOD OF SOLUTION - The data were taken from ENDF/B data tapes 114 and 115 of 1967. Minor alterations of the ENDF/B data were made to conform with format requirements of the cross section preparation programs. A description of the nuclides contained on the tapes follows -

GAF tape 1 ID=725 20 nuclides 5 fission spectra				
1010	carbon	1047030 U235	at 300K	SIGMPO = 26 29
1013	oxygen	1047031 U235	at 300K	SIGMPO = 10 36
1015	aluminum	1047110 U235	at 1100K	SIGMPO = 26 29
1018	chromium	1047111 U238	at 1100K	SIGMPO = 10 36
1020	iron	1051030 Pu239	at 300K	SIGMPO = 155 516
1021	nickel	1051031 Pu239	at 300K	SIGMPO = 10 23
1025	molybdenum	1051110 Pu239	at 1100K	SIGMPO = 155 515
1044	U235	1051111 Pu239	at 1100K	SIGMPO = 10 23
1054	Pu241	1053030 Pu240	at 300K	SIGMPO = 2560 874
GAF tape 2 ID=61968 5 nuclides 2 fission spectra				
1009	boron 10	1035030 tantalum	at 300K	SIGMPO = 10--10
1041	U233	1043030 U234	at 300K	SIGMPO = 10--10
		1046030 U236	at 300K	SIGMPO = 10--10
GAR tape ID=62468 22 nuclides				
1001000	hydrogen	1041000 U233		
1009000	boron 10	1043030 U234	at 300K	
1010000	carbon	1044030 U235	at 300K	
1013000	oxygen	1046030 U236	at 300K	
1015000	aluminum	1047030 U238	at 300K	
1018000	chromium	1047110 U238	at 1100K	
1019030	manganese at 300K	1051030 Pu239	at 300K	
1020000	iron	1051110 Pu239	at 1100K	
1021000	nickel	1053030 Pu240	at 300K	
1025030	molybdenum at 300K	1054000 Pu241		
1035030	tantalum at 300K	1059030 sodium at 300K		

5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The two GAF tapes have 1038 fine groups starting at a lethargy of -0.4 with a deltau spacing of 0.01 for 960 groups to a lethargy of 9.2 followed by 78 groups with a spacing of 0.1 deltau to a lethargy of 17.0. The GAR tape has 14,457 points starting at 1.237663 times 10⁻⁶ m/s (8.007 keV) with a constant deltau of 05.0 m/s to 8.903 times 10⁻³ m/s (0.414 eV).
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The CRECT and GAND (NESC Abstract 345) programs were used to make the necessary alterations of the ENDF/B data tapes and to write the tapes in this package. These tapes are input data tapes for the GAFGAR program (NESC Abstract 316).
9. STATUS - Abstract first distributed March 1969
UNIVAC1108 version submitted August 1969

10. REFERENCES - D. Sargis, A. Baxter, and R. Archibald, A Benchmark Study of ZPR-III Assembly 48 Using ENDF/B Cross Sections, GA-8847, August 1968
R. J. Archibald and D. R. Mathews, The GAF/GAR/GAND Fast Reactor Cross Section Preparation System, GAFGAR - A Program for the Calculation of Neutron Spectra and Group-averaged Cross Sections, GA-7542, Volume I, January 1968
R. J. Archibald and D. R. Mathews, The GAF/GAR/GAND Fast Reactor Cross Section Preparation System, GAND - A Program for Preparing Input Data for the GAFGAR Program from an ENDF/B Format Nuclear Data Tape, GA-7542, Volume II, March 1973
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - Variable-length binary records
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
Alan Baxter
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal (3 tapes)
GAF1 (1085 records)
GAF2 (1052 records)
GAR (1469 records)
Reference report, GA-8847
17. CATEGORY - 2
KEYWORDS - fast reactors, data processing, cross sections, ENDF/B, GAFGAR codes, GAND codes, CRECT codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - TWOTRAN2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC7600, 8600, IBM360/195
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The discrete ordinates approximation for the angular variable is used in finite difference form which is solved with the central (diamond) difference approximation. Negative fluxes are eliminated by a local set-to-zero and correct algorithm. Standard inner (within-group) and outer iterative cycles are accelerated by a coarse-mesh rebalancing on a coarse mesh which may be independent of the material mesh.
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, TWOTRAN2 will execute in the 4-byte mode so that any combination of problem parameters leading to a container array less than MAXLEN can be accommodated. MAXLEN can be several hundred thousand and most problems can be core-contained. On the CDC machines MAXLEN can be slightly greater than 40,000 words and peripheral storage is used for most group-dependent data.
6. TYPICAL RUNNING TIME - A six-group, S4, 42 x 42 mesh point, keff calculation of an EBR-II model requires about 3.9 minutes of CDC7600 time. The sample problems require 6 minutes on the IBM360.
7. UNUSUAL FEATURES OF THE PROGRAM - Provision is made for creation of standard interface output files for SN constants, angle-integrated fluxes and angular fluxes. Standard interface input files for sources, fluxes, cross sections and SN constants may be read. All binary operations are localized in subroutines called REED and RITE. Detailed edit options, including angular fluxes, dumps and restart capability are provided. Optional use of an arbitrary rebalance mesh independent of the material mesh is allowed.
8. RELATED AND AUXILIARY PROGRAMS - TWOTRAN2 is an improved version of the TWOTRAN program. Many comment cards were added and much simplifying programming was performed to make TWOTRAN2 as easy to understand as possible.
9. STATUS - Abstract first distributed September 1969.
 UNIVAC1108 X-Y version submitted December 1968, replaced by updated edition June 1970, deleted June 1973.
 UNIVAC1108 R-Z version submitted October 1969, deleted June 1973.
 IBM360 X-Y version submitted April 1969, replaced by TWOTRAN2 June 1973, revised version B April 1974, revised version C December 1974, revised version D January 1975, sample problem executed by NESC.
 CDC6600 General Geometry version submitted July 1970, replaced by TWOTRAN2 July 1973, revised version B April 1974, revised version C December 1974, revised version D January 1975.
 CDC7600 version of TWOTRAN2 submitted June 1973, revised version B April 1974, revised version C December 1974, revised version D January 1975.
10. REFERENCES - K. D. Lathrop and F. W. Brinkley, TWOTRAN-II, An Interfaced, Exportable Version of the TWOTRAN Code for Two-dimensional Transport, LA-4648-MS, July 1973.
 K. D. Lathrop and F. W. Brinkley, Theory and Use of the General-Geometry TWOTRAN Program, LA-4432, April 1970.
 K. D. Lathrop, F. W. Brinkley, and P. Rood, Theory and Use of the Spherical Harmonics, First Collision Source, and Variable Weight Versions of the TWOTRAN Transport Program, LA-4600, March 1972.

11. MACHINE REQUIREMENTS - Five output units, five interface units (use of interface units is optional) and two system input/output units are required. A large bulk memory is desirable, but it can be replaced by disk, drum or tape storage.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
K. D. Lathrop and F. W. Brinkley
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87544
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (7600-7076 cards, 6600-7077 cards, 360-7495 cards)
Sample problems (7600-1985 cards, 6600-585 cards, 360-1985 cards)
Control information (JCL 360-61 cards)
IBM 2314 load module (360-330 blocks)
Sample problem output (360-50 selected pages, 6600,7600-51 selected pages)
Reference report, LA-4848-MS
17. CATEGORY - C
KEYWORDS - two-dimensional, transport theory, x-y, r-z, r-theta, discrete ordinate method, criticality searches, neutron flux, anisotropic scattering, 2DF codes, TWOTRAN codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - PUN1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The $\Psi(\theta, x)$ function is evaluated on the interval $(0, 20/\theta)$ by the DFB routine developed by Gelbard (see reference 2). The $J(\theta, \beta)$ function is obtained from the $\Psi(\theta, x)$ function by two trapezoidal integrations, followed by Richardson extrapolation plus a wing correction for x greater than $20/\theta$. The integral involving chi-square fluctuation of the reduced neutron width, $\gamma(n)$, is evaluated by Gaussian quadrature. The integration over the neutron weighting spectrum is approximated by Gauss quadrature for the $1/e$ case and trapezoidal integration for other weighting spectra.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - No more than 20 spin states per case and 54 energy groups are allowed. An arbitrary energy-weighting spectrum of up to 498 points may be used, but all points must be positive ($w(e)$ greater than 0).
6. TYPICAL RUNNING TIME - Less than 1/4 second per spin state per group is required.
7. UNUSUAL FEATURES OF THE PROGRAM -
 - (a) Angular momentum quantum number $L = 0, 1, 2, 3, 4$ permitted
 - (b) $\gamma(n)$ permitted to fluctuate with a chi-square distribution of up to 8 degrees of freedom for each spin state
 - (c) Evaluation of the integral contribution from levels with $\gamma(n)$ less than some fraction of the average permitted
 - (d) An arbitrary gross energy-weighting spectrum permitted
 - (e) Dancoff correction is computed internally for either hexagonal or square lattice arrays of cylindrical clad fuel rods
8. RELATED AND AUXILIARY PROGRAMS - PUN1 uses the Bettis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed September 1969
CDC6600 version submitted April 1969
10. REFERENCES - N. M. Steen, PUN-1 - A FORTRAN-IV Program for the Evaluation of Unresolved Resonance Integrals and Related Multigroup Cross Sections (LWBR Development Program), WAPD-TM-768, March 1969, and Errata.
E. Gelbard, The Computation of Doppler Broadened Cross Sections, Transactions of the American Nuclear Society, Vol. 6, No. 2, pp. 257-258, 1963.
C. J. Pfeifer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967.
11. MACHINE REQUIREMENTS - 40,000 (octal) locations of central memory storage are required.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
N. M. Steen
Bettis Atomic Power Laboratory

Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122

16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (1648 cards)
Sample problem (38 cards)
Reference report, WAPC-TM-760 and Errata
17. CATEGORY - A
KEYWORDS - resonance integrals, multigroup, cross sections, Doppler broadening, capture
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - TOR
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - The TOR program calculates the scattering law for a crystalline material in the incoherent approximation, from the phonon frequency distribution and a specified 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.
4. METHOD OF SOLUTION - The scattering law is evaluated by direct numerical computation of the Fourier integrals involved. A new method of calculation (Numerische Mathematik, Volume 8, p. 422, 1966) makes possible rapid and accurate determination of these integrals even for large values of the frequency parameter. An independent check based on the detailed balance condition is made for each value of the scattering law computed.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The phonon frequency distribution is specified by 4 to 201 points.
6. TYPICAL RUNNING TIME - 20 to 30 minutes are required on the CDC6600.
7. UNUSUAL FEATURES OF THE PROGRAM - The two parameter table of values proportional to the scattering law has a mesh size which varies systematically from one interval to the next with the magnitude of the independent variables. A quadratic interpolation formula has been developed for this mesh. This computing system makes possible greater accuracy in interpolation with a given number of mesh points.
8. RELATED AND AUXILIARY PROGRAMS - The GLEN program (NESC Abstract 361) uses the punched output of TOR as input, and obtains values of the total scattering cross section, transport cross section, and coefficients of expansion of the double differential cross section Legendre polynomials of the scattering angle for $L = 0, 1, 2, 3$. For each of a series of isotopic compositions (up to 10 compositions) the program calculates the diffusion length, and flux-weighted group average macroscopic scattering, absorption, fission, and transfer cross sections.
9. STATUS - Abstract first distributed September 1969
CDC6600 version submitted January 1969
10. REFERENCES - W. W. Clendenin, Calculation of Thermal Neutron Scattering Cross Sections for Crystalline Materials - The TOR Program, LA-3823, December 1967.
W. W. Clendenin, Sample Problem for Program TOR, Los Alamos Memorandum
W. W. Clendenin, Note on the Incoherent Approximation for Crystalline Scattering and the Detailed Balance Condition, Nukleonik, Vol. 10, p. 331, January 1968.
11. MACHINE REQUIREMENTS - 32K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Logical tape 10 is input, logical tape 9 is output, logical tape 11 is punch.
15. NAME AND ESTABLISHMENT OF AUTHOR -
Author: W. W. Clendenin
Group: T-1
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87544

Contact Raphael Labauve
 Group K-1
 Los Alamos Scientific Laboratory
 P O Box 1663
 Los Alamos, New Mexico 87544

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (2109 cards)
 Sample problem (25 cards)
 Reference report and Memorandum

17. CATEGORY - A

KEYWORDS - scattering law, crystals, gases, incoherent scattering, temperature, cross sections, GLEN codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GLEN
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The table of values on which the differential cross section is based has a mesh which varies in interval with the two independent variables. A quadratic interpolation formula has been developed for this mesh. Angular integrations are based on a total of 40 points, used in Gauss integrations over subintervals of the angular range. The diffusion length is determined in an eigenvalue calculation using Gauss-Seidel iteration. Energy spectra corresponding to the composition and a specified buckling are calculated in the P3 approximation for determination of group cross sections. Alternatively, spectra corresponding to a Maxwell distribution scalar flux, or an input scalar flux may be used.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - A maximum of 87 energy points, and 20 groups in the collapsed structure are allowed. Each composition is limited to four heavy, non-moderating isotopes besides the moderator.
6. TYPICAL RUNNING TIME - Running time is 3 minutes on the CDC6600 plus about 12 seconds per composition.
7. UNUSUAL FEATURES OF THE PROGRAM - The diffusion length is calculated in a P11 approximation to the transport equation, in a formulation which makes possible an accurate determination of the existence or non-existence of the diffusion length.
8. RELATED AND AUXILIARY PROGRAMS - The TOR program carries out the computation of the scattering law on which the cross sections of GLEN are based, generating the table referred to above.
9. STATUS - Abstract first distributed September 1969
CDC6600 version submitted January 1969
10. REFERENCES - W. W. Clendenin, Calculation of Thermal Neutron Diffusion Length and Group Cross Sections, The GLEN Program, LA-3893, May 1968
W. W. Clendenin, Sample Problem for Program GLEN, Los Alamos Memorandum
11. MACHINE REQUIREMENTS - 84K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Logical tape 10 is input, logical tape 9 is output, logical tape 11 is punch.
15. NAME AND ESTABLISHMENT OF AUTHOR -
Author: W. W. Clendenin
Group T-1
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87544

Contact Raphael Labauve
 Group K-1
 Los Alamos Scientific Laboratory
 P. O. Box 1663
 Los Alamos, New Mexico 87544

16. MATERIAL AVAILABLE - Magnetic Tape Transmitted
 Source deck (1912 cards)
 Sample problem (477 cards)
 Reference report, LA-3893, and Memorandum
17. CATEGORY - B
 KEYWORDS - group constants, scattering, cross sections, absorption, fission, angular
 distribution, TOR codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - WELWING
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The method used is an analytical solution of the one-group diffusion equations with various corrections and approximations.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Up to 32 different materials in the fuel element may be used.
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed September 1969
IBM360 version submitted September 1968
10. REFERENCE - A. Koster, A FORTRAN IV Computer Code for Buckling Calculations on Cylindrical Fuel Elements, PEL 183, May 1969.
11. MACHINE REQUIREMENTS -
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 -
O. G. P. Grosskopf
South African Atomic Energy Board
Private Bag 256
Pelindaba, Pretoria, South Africa
16. MATERIAL AVAILABLE -
Source deck (813 cards)
Sample problem (62 cards)
Reference report
17. CATEGORY - B
KEYWORDS - buckling, one-group theory, diffusion equations, fuel elements, heavy water
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - BLAST
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The computational method consists of computing the neutron flux over short time intervals during which the reactivity is considered to be constant. The fact that the reactivity does change during such time intervals is duly corrected for. The temperature rise during this time interval is calculated from the average neutron flux during the time interval, and the reactivity change due to the temperature coefficients of the system is calculated. The process is then repeated.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - The average time per step is about 1.25 seconds for the sample problem.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed September 1969
IBM360 version submitted September 1969
10. REFERENCES - R. Van Der Walt and J. G. Mohr, The Time Dependence of the Neutron Flux and Temperature of a Thermal Multiplying System Following a Step Change in Reactivity, PEL-152, May 1967, and Errata.
11. MACHINE REQUIREMENTS - 128K bytes of 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 -
O. G. P. Groeskopf
South African Atomic Energy Board
Private Bag 256
Pretoria, Pretoria, South Africa
16. MATERIAL AVAILABLE -
Source deck (303 cards)
Sample problem (15 cards)
Reference report and Errata
17. CATEGORY - E
KEYWORDS - kinetics, reactivity, temperature coefficient, thermal neutrons, excursions
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SNEQ
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - SNAP uses (1) direct iteration, (2) Newton-Raphson, (3) secant, and (4) steepest descent methods to solve nonlinear, algebraic equations.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - In SNAP the maximum number of unknowns is 50. In EQPLT the pseudo-FORTRAN equation is two-dimensional, having an independent variable, a dependent variable, and a parameter. The parameter may assume up to 6 values for any one graph, 100 constant values, and up to 200 values for the independent variables.
6. TYPICAL RUNNING TIME - Approximately 1 second per problem is required.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - SNAP uses CODEGEN to compile input equations. EQPLT uses CODEGEN to compile input equations and the CDC 6600 plotter routines for plotting the calculated data.
9. STATUS - Abstract first distributed September 1969
CDC6600 version submitted February 1969
10. REFERENCES - G. L. Lechliter, SNEQ, A Combination of Programs to Plot Curves and/or Solve Nonlinear Algebraic Equations, KAPL-M-6709, May 30, 1967
R. J. Cullen, 6600 CalComp Plotter Routines, KAPL Note, July 25, 1966
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and ASCENT
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
G. L. Lechliter
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (2018 cards)
Sample problem (66 cards)
Reference report and Note
17. CATEGORY - P
KEYWORDS - nonlinear problems, computer graphics, data processing, SNAP codes, EQPLT codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ISOGEN
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - ISOGEN calculates radioisotope generation and decay, using two-group neutron cross sections
4. METHOD OF SOLUTION - Bateman equations modified to prevent excessive truncation error and assure 0.1 percent accuracy are used and a chain tracing technique which allows feedback and branching at any nuclide
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
30 time-steps involving either irradiation or decay
50 members in a single chain
500 nuclides in a single case
6. TYPICAL RUNNING TIME - The test case requires about 3.5 minutes and includes thorium irradiation for six times with 12 nuclides, two cases of californium production by irradiating natural uranium in eight time-steps with 39 nuclides, calculation of the flux required to achieve 30,000 Mw/ton at 20 Mw/ton in seven time-steps (four irradiation and three refueling) with 29 nuclides and calculation of over 200 fission product nuclides at reactor discharge and five cooling times
7. UNUSUAL FEATURES OF THE PROGRAM - Accuracy is within 0.1 percent for any transmutation chain involving decay and/or neutron reactions. Decay constants may be similar or even identical without affecting accuracy. Nuclides may decay through any number of half lives without loss of accuracy. Two-group neutron cross sections and limited capability for handling resonance and thermal flux depression make it unsuited for detailed neutron balance calculations
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed September 1969
UNIVAC1108 version submitted February 1969
10. REFERENCES - H. H. Van Tuyt, ISOGEN - A Computer Code for Radioisotope Generation Calculations, HW-83785, September 1964
H. H. Van Tuyt, Supplemental Information on Program ISOGEN, BNWL Note
11. MACHINE REQUIREMENTS - 65K memory and one tape very helpful, but not essential
12. PROGRAMMING LANGUAGE USED - FORTRAN V
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - A call to SETEOF is completely unnecessary but eliminates an unnecessary diagnostic on the 1108
15. NAME AND ESTABLISHMENT OF AUTHOR -
H. H. Van Tuyt
Pacific Northwest Laboratories
Battelle
P. O. Box 999
Richland, Washington 99352
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (1175 cards)
Binary deck (505 cards)
Sample problem (71 cards)
Library (1512 cards)
Reference report and Note

17. CATEGORY - D

KEYWORDS - two-group, isotopes, production, decay, fission products, reaction kinetics

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FLANGE2(71-1)
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - Direct integration of the scattering law is used to obtain Legendre moments
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
Maximum energy groups = 200
Maximum Legendre order = 5
6. TYPICAL RUNNING TIME - A smooth cross section calculation requires approximately 1 minute, while a full scattering matrix problem (L=5) for 30 energy groups takes about 12 minutes on the IBM360/65
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - KERINT(71-1) generates scattering matrices at temperatures intermediate between matrices generated by FLANGE2
9. STATUS - Abstract first distributed September 1969
IBM360 version of FLANGE2 submitted January 1969, replaced by FLANGE2(71-1) March 1972, LFIT subroutine replaced November 1974, sample problem executed by NESC
UNIVAC1108 version of FLANGE2 submitted May 1970, deleted March 1972
UNIVAC1108 version of FLANGE2/SC submitted December 1970, deleted March 1972
10. REFERENCES - H. C. Honeck and D. R. Finch, FLANGE-II (Version 71-1), A Code to Process Thermal Neutron Data from an ENDF/B Tape, DP-1278 (ENDF-152), October 1971, and Correction Notice
11. MACHINE REQUIREMENTS - 40K single-precision words of high-speed core plus 3 tape (or 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 - FLANGE2 requires for input the ENDF/B library which is available from the National Nuclear Data Center at Brookhaven National Laboratory
15. NAME AND ESTABLISHMENT OF AUTHORS -
H. C. Honeck and D. R. Finch
Computer Applications Division
Savannah River Laboratory
E. I. duPont de Nemours and Co., Inc.
Aiken, South Carolina 29801
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (FLANGE2 3251 cards, KERINT 351 cards)
Sample problems (FLANGE2 23 cards, KERINT 75 cards)
Control information (JOL FLANGE2 78 cards, KERINT 21 cards)
Reference report and Correction Notice
17. CATEGORY - B

KEYWORDS - multigroup, cross sections, scattering law, angular distribution, resonance, KERINT codes

1B. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - RELAP4/MOD6
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370, CDC7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The RELAP4 user must define the geometric features of the system to be analyzed as well as an appropriate set of initial conditions. RELAP4 then solves an integral form of the fluid conservation and state equations applied to each user-defined control volume.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 9 minor edit variables
 - 20 time-step cards
 - 20 trip control cards
 - 100 junctions (flow paths) between volumes
 - 5 bubble-parameter sets
 - 5 time-dependent volume descriptions on cards
 - 12 pumps
 - 75 control volumes
 - 10 check valve types
 - 5 normalized leak-area-versus-time curves
 - 20 fill system curves
 - 50 heat slabs
 - 20 heat slab geometries
 - 7 heat slab materials
 - 50 core sections
 - 99 data sets for heat exchangers without conduction
6. TYPICAL RUNNING TIME - For a PWR modeled with 30 to 40 fluid volumes, running time through reflood may range from 15 to 60 minutes or more on the CDC7600 and from 2 to 8 hours or more on the IBM360/75.
7. UNUSUAL FEATURES OF THE PROGRAM - RELAP4 provides the following features: a fully-implicit integration technique, steam tables that contain derivatives, heat conduction between fluid volumes, momentum flux terms in the hydraulic equations, a pump model with inertia and friction, a limited air flow capability, a separate hot channel calculation, and core cross flow.

RELAP4/MOD6 contains the following four program operations - standard RELAP4 (minimum controls), RELAP4-EM (a part of the NRC evaluation model), RELAP4-FLOOD (reflooding rates), and RELAP4-CONTAINMENT (special containment models).
8. RELATED AND AUXILIARY PROGRAMS - RELAP4/MOD6 uses PLOT4M to produce both CalComp and microfilm plots of appropriate variables versus time from data stored on a RELAP4 output data tape. STH20G is used to generate tables of water properties in the proper RELAP4 format for the IBM360 version. PRELOAD reduces the amount of storage required to run RELAP4.
9. STATUS - Abstract first distributed September 1969
IBM7044 version of RELAP2 submitted February 1969, deleted December 1971

IBM360 version of RELAP3 submitted December 1971, 1st revision June 1972, 2nd revision January 1973, 3rd revision July 1973, replaced by RELAP4 submitted March 1974, replaced by Edition B May 1974, and revised September 1974, replaced by Edition C November 1974, replaced by Edition D February 1975, replaced by RELAP4/MOD5 Edition E submitted September 1976, replaced by RELAP4/MOD6 Edition F September 1978, sample problem executed by NESC June 1978 on an IBM370/195 and an IBM370/165

UNIVAC1108 version of RELAP3 submitted January 1972, deleted March 1974

CDC6600 version of RELAP3 submitted January 1972, deleted March 1974

CDC7600 version of RELAP4/MOD5 submitted September 1976, replaced by revised Edition B June 1977 and Edition C April 1977, replaced by RELAP4/MOD6 revised Edition D and Edition E September 1978

10. REFERENCES - RELAP4/MOD5, A Computer Program for Transient Thermal-hydraulic Analysis of Nuclear Reactors and Related Systems, User's Manual, Volume I RELAP4/MOD5 Description, Volume II Program Implementation, Volume III Checkout Applications, ANCR-NUREG-1335, September 1978

RELAP4/MOD6, A Computer Program for Transient Thermal-hydraulic Analysis of Nuclear Reactors and Related Systems, User's Manual, CDAP TR 003, January 1978, with Errata August 1978

Demonstration Problems for RELAP4/MOD6, Update 3, CDAP-TR-008, April 1978

RELAP4/MOD6 Update 4, NESC No 369 7600D, Tape Contents Description and Implementation Instructions, NESC Note 79-13, September 5, 1978

RELAP4/MOD6 Update 4, NESC No 369 7600E, Tape Contents Description, NESC Note 79-14, September 5, 1978

RELAP4/MOD6 Update 4, NESC No 369 360F, Tape Contents Description and Implementation Instructions, NESC Note 79-12, September 5, 1978

W H Rettig, UPD - A Program to Update Source Decks, PD1752, Addendum 1 to UPD by R C Young and N H Marshall, Addendum 2 to UPD by G L Singer, and Addendum 3 to UPD by W H Rettig

G D Brown, C H Bush, and R A Gorman, The Integrated Graphics System for the SC4080 I User's Manual, RM-5860-PR, December 1968

11. MACHINE REQUIREMENTS - 850K bytes (IBM360), 160,000 (octal) words of SCM and 200,000 (octal) words of LCM (CDC7600), 3 tape drives, and a CalComp plotter

12. PROGRAMMING LANGUAGES USED - FORTRAN IV (95%) and BAL (5%) (IBM360), FORTRAN IV (95%) and COMPASS (5%) (CDC7600)

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360,370 (IBM360,370), SCOPE (CDC7600)

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - PLOT4M as executed at NRTS makes use of the SC-4080 integrated graphics system for microfilm output in addition to the CalComp graphical output. The IGS subroutines SUBJEG, TITLEG, MODESG, SETUPG, GRIDG, LABELG, LINEG, POINTG, ERRZZ, SETSMG, PAGEG, and EXITG are included in the environmental subroutines file for the IBM360 version only

The IBM360 transmittal tape contains 2314 and 3330 load modules of a special FORTRAN (H) compiler equivalent to the standard (H) compiler except that it uses a large table area allowing compilation of all RELAP4 source routines, including the large MIXFLO subroutine. A compilation region of 400K is sufficient for RELAP4, the OPT=2 option should be invoked.

The CDC7600 version is available in two editions: 7600D for reading on 7600 systems, 7600E for reading on 6600 systems. Both these editions are intended for use on CDC equipment only.

15. NAME AND ESTABLISHMENT OF AUTHORS -

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EG&G Idaho, Inc
P O Box 1625
Idaho Falls, Idaho 83401

* 7600 contact

+ 360 contact

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (RELAP4 360-73,866 cards, 7600D-1298 records*, 7600E-1299 records*)
 2314 and 3330 load modules (RLP4 MOD6 360-1300 blocks, ENV MOD6 360-83 blocks,
 FORT H LARGE 360-578 blocks)
 Object deck (BUFIO 360-52 cards)
 Sample problems (RELAP4 360-1310 cards, 7600D-38 records*, 7600E-29 records*, PLOTR4M
 360-11 cards, 7600D-2 records*, 7600E-2 records*)
 Water property library (360-79 blocks, 7600D-15 records*, 7600E-17 records*)
 Auxiliary source decks (PLOTR4M 360-2190 cards, 7600D-24 records*, 7600E-23 records*,
 UPD 360-1528 cards, 7600D-15 records*, 7600E-15 records*, conversion program 360-24
 cards, 7600D-2 records*, 7600E-3 records*, PRELOAD 360-1113 cards, 7600D-18
 records*, 7600E-18 records*)
 Environmental subroutines (360-22,131 cards, 7600D-71 records*, 7600E-71 records*)
 Control information (JCL RELAP4 360-133 cards, PLOTR4M 360-61 cards, UPD 360-58 cards)
 Sample problems output (RELAP4 360-1183 blocks*, 7600D-745 records*, 7600E-366 records*)
 Reference reports, ANCR-NUREG-1335, CDAP TR 003, CDAP-TR-008, NESC Note for appropriate
 version, and P01752 Description with Addenda

* 512-word maximum length

+ RECFM=FB,LRECL=133,BLKSIZE=1596

17. CATEGORY - G

KEYWORDS - accidents, blowdown, excursions, heat transfer, hydrodynamics, power plants,
 reactor safety, transients, BWR reactors, PWR reactors, PLOTR4M codes, RELAP2 codes, RELAP3
 codes, RELAP4 codes, STH20G codes, PRELOAD codes

18. SPONSOR - NRC Division of Reactor Safety Research

1. NAME OR DESIGNATION OF PROGRAM - GAKIT
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The multigroup, one-dimensional, time-dependent diffusion theory kinetics equations are solved by a semi-implicit time integration method (see references 1, 2, and 3). The heat transfer equations are solved by a quasi two-dimensional method, assuming the axial heat conduction is negligible compared with the heat transport due to coolant flow. For the numerical solution of the kinetics equations and also for the solution of the heat transfer equations finite difference methods in space and time are employed. The material properties are assumed to be regionwise constant and the time-step size is held constant in each time zone.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
 - One-dimensional kinetics calculation - maxima of -
 - 10 prompt neutron energy groups
 - 6 delayed neutron groups
 - 10 homogeneous regions (channels)
 - 100 mesh points
 - Fuel element geometry for heat transfer calculation - in the axial direction the fuel element may consist of a bottom reflector, a core section, and a top reflector. The bottom and top reflectors must have uniform densities and uniform thermal properties, while within the core section of the fuel element up to five radial regions may be used. Maxima of -
 - 15 radial mesh points
 - 20 axial mesh points
 - The fuel elements in all the channels must have the same geometry, the same thermal properties, and the same inlet temperature, but the fuel elements of different channels may have different coolant flow rates and different axial power shapes.
6. TYPICAL RUNNING TIME - For a typical HTGR rod withdrawal accident problem (2 energy groups, 6 delayed groups, 49 kinetics mesh points, 180 = 18*10 heat transfer mesh points) the running time per time-step on the UNIVAC1108 is approximately 0.3 second. The rod removal was completed in 180 seconds and the solution was calculated for 300 seconds taking 20 minutes of UNIVAC1108 computer time.
7. UNUSUAL FEATURES OF THE PROGRAM -
 - (a) The time integration procedure is numerically stable for relatively large time-steps. The procedure is asymptotically stable for time-steps of arbitrary length.
 - (b) The method is especially suited for multigroup calculations because the running time increases roughly linearly with the number of energy groups.
 - (c) The code has the capability of calculating steady-state conditions for the combined diffusion and heat transfer equations assuming a certain power level.
 - (d) The limits for the number of energy groups, mesh points,

etc. can easily be changed by recompiling the FORTRAN program
(e) The input of the code is flexible. For example, the user
can supply his temperature-dependent cross sections in
table-form, or he can generate transients by piecewise
linear time-dependent cross sections.

8. **RELATED AND AUXILIARY PROGRAMS** - GAKIN, a one-dimensional kinetics code without temperature feedback (NESC Abstract 310)
9. **STATUS** - Abstract first distributed September 1969
UNIVAC1100 version submitted February 1969
10. **REFERENCES** - R. Froehlich, S. R. Johnson, M. H. Merrill, GAKIT, A One Dimensional Multigroup Kinetics Code with Temperature Feedback, GA-8576, September 1968
J. B. Andrews and K. F. Hansen, Numerical Solution of the Time-dependent Multigroup Diffusion Equations, Nuclear Science and Engineering, Vol. 31, pp. 304-313, 1968
J. B. Andrews, Numerical Solution of the Space Dependent Reactor Kinetics Equations, Ph.D. Thesis M.I.T., May 1967
K. F. Hansen and S. R. Johnson, GAKIN, A One Dimensional Multigroup Kinetics Code, GA-7543, August 1967
11. **MACHINE REQUIREMENTS** - 65,536 words of core storage and the facility for segmenting programs
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - EXEC2, GAX 23, but any other system with a segmenting facility can be used
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** -
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
R. Froehlich, S. R. Johnson, and M. H. Merrill
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (7455 cards)
Sample problem (95 cards)
Reference report, GA-8576
17. **CATEGORY** - F
KEYWORDS - one-dimensional, multigroup, diffusion, kinetics, temperature feedback, two-dimensional, r-z, heat transfer, fuel elements, GAKIN codes
18. **SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - NOWIG
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The appropriate kinetics and temperature equations are solved by a specified theta time-differencing technique.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - 2 energy groups must be used and up to 6 groups of delayed neutron precursors may be used. The maximum number of spatial mesh points is 250 and up to 20 material compositions and 50 thermal-hydraulic channels may be specified.
6. TYPICAL RUNNING TIME - A transient problem with 31 spatial mesh points, 7 thermal-hydraulic channels, 1 delayed group, and 2000 time-steps requires 39 seconds on a CDC6600.
7. UNUSUAL FEATURES OF THE PROGRAM - For the class of problems considered, NOWIG solves the same problem (using the same techniques) as the WIGL2 program, except that the assumption is made that the flux shape does not change during the transient time of interest. Hence, in the case where the true flux shape (and flux ratio) does not change, the NOWIG and WIGL2 solutions will be identical. This feature will permit the evaluation of shape change effects during transient conditions by means of NOWIG-WIGL2 comparisons.
8. RELATED AND AUXILIARY PROGRAMS - The initial conditions required for a NOWIG problem may be generated by use of the steady-state option of the WIGL3 program (NESC Abstract 708). The WANDA program may also be used to generate the initial NOWIG shape functions and adjoint weight functions. NOWIG uses the Bettis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed September 1969
CDC6600 version submitted March 1969
10. REFERENCES - J. B. Yasinsky, NOWIG - A Program to Solve the Point Kinetics Approximation to the One-dimensional, Two-group Diffusion Equations with Temperature Feedback, WAPD-TM-806, January 1969.
A. F. Henry, A. V. Vola, 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, N. J. Curlee, Jr., A. V. Vola, 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, February 1969.
O. J. Marlowe, M. G. Suggs, WANDA-5, A One-dimensional Neutron Diffusion Program for the Philco-2000 Computer, WAPD-TM-241, November 1960.
C. J. Pfeiler, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-866, January 1967.
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3 1
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

16. NAME AND ESTABLISHMENT OF AUTHOR -

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Bellis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 78
West Mifflin, Pennsylvania 15122

16. MATERIAL AVAILABLE - Restricted Distribution

Source deck (923 cards)
Sample problem (35 cards)
Reference report, WAPD-TM-606

17. CATEGORY - F

KEYWORDS - one-dimensional, two-group, diffusion, kinetics, temperature feedback, WIGL2 codes, WIGL3 codes, WANDA codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - RAPFU
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - GE635
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Four plutonium recycle schemes are available. The most complicated of these uses two core isotopic zones plus a zone containing the blanket zones. The other three use only a single core isotopic zone and allow a selection to be made from three alternate mixtures in the plutonium discharged from the core and blanket regions and recycled back into the core regions. Up to 100 regions of different composition may be used, and the regions within any zone of fixed plutonium input isotopic composition do not have to be connected.
6. TYPICAL RUNNING TIME - For a typical case using five core and blanket regions and the most complicated recycle scheme, the computation converged after 12 iterations and total running time was less than one minute.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - RAPFU is intended to be used with a separate multigroup diffusion theory code such as GRAM or BISYN [NESC Abstract 287].
9. STATUS - Abstract first distributed September 1969
GE635 version submitted March 1969
10. REFERENCES - P. Greebler and C. L. Cowan, RAPFU, A Computer Code for Rapid Calculation of Fuel Cycle Physics Parameters in Fast Breeder Reactors with Variable Fissile Recycle Schemes, GEAP-5494, May 1967.
A. Hassitt, A Computer Program to Solve the Multigroup Diffusion Equations, TRG Report 229(R), March 1962.
P. Greebler, M. D. Kelley, R. A. Davis, C. A. Keck, and W. A. Duncan, BISYN - A Two Dimensional Synthesis Program, GEAP-4922, July 1965.
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
P. Greebler and C. Cowan
Advanced Products Operation
General Electric Company
175 Curtner Avenue
San Jose, California 95125
16. MATERIAL AVAILABLE -
Source deck (1091 cards)
Sample problem (60 cards)
Reference report, GEAP-5494

17. CATEGORY - D

KEYWORDS - fuel cycle, fast reactors, breeding, isotopes, economics, CRAM codes, BISYN codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - BL47
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - From given data, BL47 sets up parametric data for points, straight lines, parabolas, and ellipses.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
1000 points
1000 lines
1000 words
6. TYPICAL RUNNING TIME - 15 seconds are required
7. UNUSUAL FEATURES OF THE PROGRAM - A point is located by intersection of two lines, by the normal from a point to a line, or by rotated coordinates from a given point. A line is located by parameters in a rotated coordinate system.
8. RELATED AND AUXILIARY PROGRAMS - SEALSHELL2 (NESC Abstract 282) and a plot routine from the Bettis Environmental Routines (NESC Abstract 478)
9. STATUS - Abstract first distributed September 1989
CDC6600 version submitted April 1969
10. REFERENCES - C. M. Friedrich and J. J. Cullens, Computer Program BL47 for Plotting Plane Structures, WAPD-TM-783, February 1969
C. J. Pfeiffer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-688, January 1967
C. M. Friedrich, SEAL-SHELL-2, A Computer Program for the Stress Analysis of a Thick Shell of Revolution with Axisymmetric Pressures, Temperatures, and Distributed Loads, WAPD-TM-398, December 1963
11. MACHINE REQUIREMENTS - 20,000 words of high-speed 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 -
C. M. Friedrich and J. J. Cullens
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (938 cards)
Sample problem (189 cards)
Reference report, WAPD-TM-783
17. CATEGORY - L

KEYWORDS - computer graphics, stresses, design, geometry, mechanical structures, SEALSHELL2 codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - 1DX
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108, IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - Resonance shielded cross sections are calculated using data (infinite dilution cross sections and resonance shielding factors) in the Russian format. Interpolation schemes are used to compute shielding factors applicable to specific compositions. A flux iteration option for computing the elastic removal cross section is also included. Group-collapsed cross sections by reactor zone are calculated using flux weighting. The eigenvalue and spatial flux profiles are computed using standard source-iteration techniques. Convergence is accelerated using fission source overrelaxation. 1DX will also accept input cross sections in the DTF format (i.e., resonance shielded cross sections).
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - 1DX uses variable dimensioning to make maximum use of existing core storage. All subscripted variables are stored in one array dimensioned to 35,000 on the UNIVAC1108. Allocation is dynamic in the IBM version.
6. TYPICAL RUNNING TIME - A representative 26-group problem with 30 spatial intervals using data in the Russian format requires about 50 seconds on a UNIVAC1108. If the cross section data is already in the DTF format, the same problem would require about 5 seconds. The sample problem requires 12 seconds of CPU time on an IBM370/195.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The format of the input data (e.g., flux dumps, geometry and composition specifications, etc.) is compatible with Los Alamos one- and two-dimensional transport codes DTF4 (NESC Abstract 209) and 2DF (NESC Abstract 173), the BNW two-dimensional burnup code 2DB (NESC Abstract 325), and the BNW perturbation code PERT4 (NESC Abstract 304). The computer code ETOX will prepare cross section data in the Russian format from the ENDF/B data tape. PUPX is an auxiliary program that prints, updates, and punches cross section data in the Russian format using a binary tape.
9. STATUS - Abstract first distributed September 1969
UNIVAC1108 version submitted May 1969
IBM360,370 version submitted October 1974, sample problem executed by NESC April 1975 on an IBM370/195
10. REFERENCES - R. W. Hardie and W. W. Little, Jr., 1DX, A One-dimensional Diffusion Code for Generating Effective Nuclear Cross Sections, BNWL-954, March 1969
I. I. Bondarenko, et al., Group Constants for Nuclear Reactor Calculations, Consultants Bureau, New York, 1964
K. D. Lathrop, DTF-IV, A FORTRAN-IV Program for Solving the Multigroup Transport Equation with Anisotropic Scattering, LA-3373, July 15, 1965
2DF, A Two-dimensional Transport Code from the Los Alamos Scientific Laboratory (unpublished)
W. W. Little, Jr. and R. W. Hardie, 2DB User's Manual, BNWL-831, July 1968

R W Hardie and W W Little, Jr , PERT-IV, A Two-dimensional Perturbation Code in FORTRAN-IV, BNWL-409, April 1967

R E Schenler, J L Baker, and R B Kidman, ETOX, A Code to Calculate Group Constants for Nuclear Reactor Calculations, BNWL-1002, May 1969

11. MACHINE REQUIREMENTS - 65K memory and 7 peripheral storage devices (UNIVAC1108), 145K and maximum of 8 storage devices (IBM360,370)
12. PROGRAMMING LANGUAGES USED - FORTRAN IV (UNIVAC1108), FORTRAN IV and BAL (IBM360,370)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360,370 (IBM360,370)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
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16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (10X 1108-2373 cards, 360-FORTRAN 3070 cards, BAL 309 cards, PUPX 1108-212 cards, 360-281 cards)
Object deck (10X 360-1978 cards)
Sample problems (10X 1108-435 cards, 360-433 cards)
Control information (360-39 cards)
Sample problem output (360-28 pages)
Reference report, BNWL-854
17. CATEGORY - B
KEYWORDS - one-dimensional, diffusion, cross sections, fast reactors, criticality searches, iterative methods, DTF4 codes, 2DF codes, 2DB codes, PERT4 codes, ETOX codes, PUPX codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SCORE3
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - SCORE3 is an interactive neutron cross section evaluation system
4. METHOD OF SOLUTION - Experimental neutron cross section data can be retrieved and displayed on an active graphics console. Many bookkeeping operations may be initiated by option selection at the console. Evaluated data analysis modules, permitting the production of evaluated data curves or resonance parameters, are available. The evaluated data curve module includes linear, cubic spline, or least squares cubic spline (see reference 2) curve generation. The resonance analysis module permits single-level, Reich-Moore or Adler multilevel analysis.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - SCORE can display up to 500 experimental data points with their associated error bars. Up to 2 smooth curves may be overlayed on a display of experimental data points. Each curve is restricted to 150 points.
6. TYPICAL RUNNING TIME - Approximately 6 to 12 minutes per hour at the console are required on an IBM360/50.
7. UNUSUAL FEATURES OF THE PROGRAM - SCORE employs interactive graphics for control of execution paths.
8. RELATED AND AUXILIARY PROGRAMS - Three programs are needed to produce the required data libraries. SAP is used to construct experimental data libraries from SCISRS. SCOFF constructs evaluated data libraries from ENDF/B. RAP constructs the resonance parameter library.
9. STATUS - Abstract first distributed September 1969.
IBM360 version of SCORE2 submitted April 1989, replaced by SCORE3 June 1971.
10. REFERENCES - C. L. Dunford, SCORE, An Interactive Cross Section Evaluation System, Volume I Operator's Guide, AI-AEC-12994, Vol. 1, May 15, 1971.
C. L. Dunford, SCORE, An Interactive Cross Section Evaluation System, Volume II System Guide, AI-AEC-12994, Vol. 2, June 15, 1971.
A. Horsley, J. B. Parker, K. Parker, and J. A. Price, Curve Fitting and Statistical Techniques for Use in the Mechanized Evaluation of Neutron Cross Sections, Nuclear Instruments and Methods, Vol. 62, p. 29, 1968.
J. M. Friedman and M. Platt, SCISRS, Sigma Center Information Storage and Retrieval System, BNL-885, July 1964.
H. C. Honeck, Specifications for an Evaluated Nuclear Data File for Reactor Applications, ENDF/B, BNL-50066, July 1967.
11. MACHINE REQUIREMENTS - IBM360 Model 50 or higher with 125,000 bytes of fast memory, an IBM2250 graphics console, Models 1, 2, or 3, 2 9-track tape drives, and 1 disk.
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and BAL.
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360, Version 14 or higher.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
C. L. Dunford
Atomics International
P. O. Box 309
Canoga Park, California 91304

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (13,265 cards, PDS SCORE.SOURCE-1379 blocks)

Load module (SCORE.GO-459 blocks)

Libraries (SCISRS data tape-7 files of 3744-character records, ENDF/B data tape-5 files of 3608-character records, Resonance Parameters-1 file of 400-character maximum length records)

DADS libraries (SCISRS-520 blocks of 3520-bytes maximum length records, ENDF/B-40 blocks of 3600-bytes maximum length records)

Control information (JCL to move data sets from transmittal tape-84 cards, JCL for execution-137 cards)

Reference reports AI-AEC-12994, Vols. 1 and 2

17. CATEGORY - M

KEYWORDS - cross sections, computer graphics, ENDF/B, SCISRS, libraries, Reich-Moore formula, multilevel analysis, SAP codes, SCOFF codes, RAP codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - AVERAGE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - The theory of average cross section due to Lane and Lynn is used
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - AVERAGE calculates average cross sections for up to 100 energy values in the unresolved region. It does not allow for inelastic scattering and calculates only s- and p-wave contributions. Width-fluctuation corrections can vary from 1 to 4
6. TYPICAL RUNNING TIME - A test run calculating s- and p-wave contributions to average scattering, capture, and fission cross sections of Pu239 at 16 energy points and s- and p-wave contributions to average scattering at capture cross sections of U238 at 100 energy points requires 5 seconds on the CDC6600
7. UNUSUAL FEATURES OF THE PROGRAM - AVERAGE can allow for different degrees of freedom for fission width distribution of resonances of different spins
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed September 1969
CDC6600 version submitted May 1969
IBM7094 version submitted by BNL May 1969, deleted July 1976
10. REFERENCES - Mulik, R. Bhat, Program AVERAGE, BNL Note, September 1969
A. M. Lane and J. E. Lynn, Fast Neutron Capture below 1 MeV The Cross
Sections for U238 and Th232, Proceedings of the Physical Society of London, Vol A70, pp
557-570, 1957
11. MACHINE REQUIREMENTS - 18K (octal) memory
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 -
15. NAME AND ESTABLISHMENT OF AUTHOR -
M. R. Bhat
National Nuclear Data Center
Brookhaven National Laboratory
Upton, Long Island, New York 11073
16. MATERIAL AVAILABLE -
Source deck (441 cards)
Sample problem (94 cards)
Reference Note
17. CATEGORY - A
KEYWORDS - averages, resonance, scattering, capture, fission, cross sections
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SIGPLOT
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The multilevel Breit-Wigner formula is used (see reference 2).
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - SIGPLOT can handle resonance data up to a maximum of 10 different isotopes with a total number of 500 resonances and an L value not exceeding five. It further assumes that the resolved resonance parameters are given for one energy range which is the same for all the isotopes of an element. The mesh points at which the cross sections are calculated can be varied. Since the calculated data are not stored, an increase in the number of mesh points does not conflict with any storage requirements.
6. TYPICAL RUNNING TIME - Calculations of the cross sections of mono-isotopic manganese from its resonance data with 27 resonances and with 20 mesh points between the positive energy resonance, require 14 seconds on the CDC6600.
7. UNUSUAL FEATURES OF THE PROGRAM -
 - (a) In calculating scattering cross sections with level-level interference, resonances are grouped according to their spins for the same L value. Thus for s-wave resonances, for example, the spins are 3 and 4. It is possible that there are a number of resonances whose spins have not been measured, and these are given an average spin of 3.5. The program normally calculates scattering cross sections with level-level interference among the spin-3 group and the spin-4 group. Contributions of the spin-3.5 resonances are calculated as a sum of single-level Breit-Wigner terms. If, however, it is desired to include the level-level interference terms among these resonances, this may be indicated on the control card.
 - (b) The method of numerical integration used to Doppler-broaden cross sections is very general and is designed to take care of situations where the fine structure of the cross section is rapidly varying.
8. RELATED AND AUXILIARY PROGRAMS - SIGPLOT has been patterned after the MLBW program (ENEA Abstract 076) with certain corrections and changes in the subroutines ORDER, FACTS, and SIGMA.
9. STATUS - Abstract first distributed September 1969.
CDC6600 version submitted May 1969, replaced by revised version December 1971.
IBM7094 version submitted May 1969, deleted December 1971.
10. REFERENCES - M. R. Bhat, ENDF/B Processing Codes for the Resonance Region, BNL-50296 (ENDF-140), June 1971.
K. Gregson, M. F. James, and D. S. Norton, MLBW - A Multi-level Breit-Wigner Computer Program, AEEW-MS17, March 1965.
11. MACHINE REQUIREMENTS - 37K (octal) memory.
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 -

15. NAME AND ESTABLISHMENT OF AUTHORS -

M R Bhat and D Cullen
National Nuclear Data Center
Brookhaven National Laboratory
Upton, Long Island, New York 11073

16. MATERIAL AVAILABLE -

Source deck (1032 cards)
Sample problem (80 cards)
Reference report, BNL-50296

17. CATEGORY - A

KEYWORDS - scattering, capture, fission, cross sections, resonance scattering, Doppler broadening, multilevel analysis, Breit-Wigner formula, MLBW codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - TUBE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - TUBE performs an interaction analysis based on structural mismatches, due to pressure and temperature, using the usual method of matching rotations and deflections at the junctions of the structural elements. Average temperatures are used in the head and tubesheet for this portion of the analysis so that the resulting stresses are axisymmetric. The only non-axisymmetric stresses calculated are for the tubesheet. These are the divider lane stress originating from the difference in temperature between the inlet and outlet halves of the tubesheet, and the skin stress due to the temperature profile through the thickness of the tubesheet. Primary pressure stresses are calculated by means of Lane's thick shell equations.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - The average running time on the CDC6600 is approximately 5 seconds per case.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed September 1969
CDC6600 version submitted May 1969
10. REFERENCE - A. E. Spivak and G. L. Lechlitter, TUBE Stress Analysis of U-Tube Type Heat Exchangers, KAPL-M-6459, May 3, 1965
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
A. E. Spivak and G. L. Lechlitter
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (1011 cards)
Sample problem (20 cards)
Reference report
17. CATEGORY - 1
KEYWORDS - stresses, design, pressure, temperature, cylinders, heat exchangers
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SAFE-2D
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - SAFE-2D performs the elastic stress analysis of general axisymmetric, plane, and combined axisymmetric and plane composite structures
4. METHOD OF SOLUTION - The finite-element variational method is used. Equilibrium equations are solved by block or tri-diagonalization of the stiffness matrices
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
2 degrees of freedom (radial or horizontal translation and
axial or vertical translation)
1200 nodal points
2400 finite elements
6. TYPICAL RUNNING TIME - 8 minutes are required for a full capacity problem
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - SAFE-3D (NESC Abstract 332), and SAFE-PLANE (NESC Abstract 252). In most cases SAFE-PLANE is to be replaced by SAFE-2D. SAFE-2D has larger capacities and offers a more desirable technique for solution of the equations. However, SAFE-2D does impose a few more restrictions on the input data and does not handle polar coordinate systems
9. STATUS - Abstract first distributed September 1969
UNIVAC1108 version submitted May 1969
10. REFERENCES - D. C. Cornell, SAFE-2D A Computer Program for the Stress Analysis of Plane and Axisymmetric Composite Structures, A User's Manual, GA-9076, February 12, 1969
Y. R. Rashid, Analysis of Axisymmetric Composite Structures by the Finite Element Method, GA-6763, October 15, 1965
11. MACHINE REQUIREMENTS - SAFE-2D requires 50K, fast memory storage, and 500,000 words of auxiliary storage
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - SAFE-2D consists of two overlays
15. NAME AND ESTABLISHMENT OF AUTHOR -
D. C. Cornell
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (1902 cards)
Sample problem (48 cards)
Reference report, GA-9076
17. CATEGORY - 1
KEYWORDS - finite element method, stresses, elasticity, mechanical structures, matrices, SAFE codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GATT
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - GATT makes use of the direct block inversion technique for multidimensional reactor calculations (see reference 3). This method leads to an improved convergence of the inner spatial flux iteration. The outer fission source iteration is accelerated by an asymptotic source extrapolation which is applied periodically to damp out the next higher eigenmode.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - GATT allows downscaling from one group into the next and a maxima of -
 - 81 z-planes
 - 104,487 mesh points
 - 4 energy groups
 - 40 macroscopic cross section sets (mixtures)It is assumed that all fission neutrons are born in group 1.
6. TYPICAL RUNNING TIME - A four-group problem with 42,000 mesh points, representing a 330 MW(e) HTGR reactor, with four fully and three partially-inserted control rods requires 80 minutes.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - GAUGE (NESC Abstract 339) is the two-dimensional counterpart of GATT.
9. STATUS - Abstract first distributed September 1969
UNIVAC1108 version submitted May 1969
10. REFERENCES - H. Kraetsch and M. R. Wagner, GATT, A Three-dimensional Few-group Neutron Diffusion Theory Program for a Hexagonal-Z Mesh, GA-8547, January 1, 1969
M. R. Wagner, GAUGE, A Two-dimensional Few Group Neutron Diffusion-depletion Program for a Uniform Triangular Mesh, GA-8307, March 1968
H. Kraetsch and M. R. Wagner, The Block Inversion Method, A New Approach to Multidimensional Reactor Calculations, Transactions of the American Nuclear Society, Vol. 10, p. 173, 1967.
11. MACHINE REQUIREMENTS - 65K memory and 10 files of drum storage with a total of 500,000 words capacity.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - It is not possible to use tape units in place of drum storage.
15. NAME AND ESTABLISHMENT OF AUTHORS -
 - H. Kraetsch and M. R. Wagner
 - General Atomic Company
 - P. O. Box 81608
 - San Diego, California 92138

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (3203 cards)

Sample problem (39 cards)

Reference report, GA-8547

17. CATEGORY - C

KEYWORDS - three-dimensional, few-group, diffusion, neutron flux, hexagonal configuration, power distribution, HTGR reactors, GAUGE codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - RAPP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The program uses the first and second laws of thermodynamics to either compute mass flow when pressures and resistances are specified for a constant-area flow path or compute pressure distribution in a piping run when flow is specified. Major assumptions are that the differential loss of available energy is proportional to kinetic energy and differential increase in a geometric (k) factor, that slip ratio is proportional to specific volume ratio raised to a constant (input) power, and that thermodynamic equilibrium is present.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
6 flow areas for computing pressure distribution with known flow
2000 pressure increments
6. TYPICAL RUNNING TIME - 0.1 to 5 seconds per case are required
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed September 1968
CDC6600 version submitted June 1969
10. REFERENCE - Charles W. Sorenson, RAPP, A Digital Computer Program for Computing Flow Resistance and Pressure for High Velocity Flow of Steam-Water Mixtures, KAPL-M-6955, January 1969
11. MACHINE REQUIREMENTS - 45K to compile and execute
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - RAPP consists of the main program which performs all flow calculations and two subroutines, STEAMR, which computes steam and water properties, and LINTPW, a general interpolation routine.
15. NAME AND ESTABLISHMENT OF AUTHOR -
C. W. Sorenson
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (480 cards)
Sample problem (11 cards)
Reference report
17. CATEGORY - H
KEYWORDS - fluid flow, pressure, liquids, vapors, thermodynamics, water, coolants, pipes

1. NAME OR DESIGNATION OF PROGRAM - M0266
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - The connection and flexibility matrices which are input to the program by the user are converted into a final flexibility matrix using CTAC matrix manipulation. The modal frequencies are then calculated by means of the MATVEC subroutine. A dynamic analysis may then be performed given the response spectrum using the normal mode-spectrum method.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - M0266 is limited to a 50 x 50 mass-flexibility matrix. Other maxima include -
 - 50 masses plus redundants
 - 20 redundants
 - 999 flexible elements
 - 20 effects per elementThe dynamic analysis is limited to a spectrum-type analysis, which is limited to a one-directional motion of the foundation.
6. TYPICAL RUNNING TIME - Large problems may have running times as long as 15 minutes. However, most problems will run in less than 1 minute.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - M0552 (NESC Abstract 283), M0753, MADAR, GEM (NESC Abstract 344), and the Bellis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed September 1969.
CDC6600 version submitted July 1969.
10. REFERENCES - E. A. Zanon, M0266, A FORTRAN-IV Structural Dynamics Program for Linear Elastic Lumped Mass Systems, WAPD-TM-739(L), March 1969.
N. M. Greene, et al., XLACS - A Program to Produce Weighted Multigroup Neutron Cross Sections from ENDF/B, ORNL-TM-3646, April 3, 1972.
Description of XSORN Tape Contents, ACC Note, May 1970.
11. MACHINE REQUIREMENTS - 105,000 (octal) locations, input tape, output tape, one scratch tape, and printer.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.1
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
 - W. A. Wenzel
 - Bellis Atomic Power Laboratory
 - Westinghouse Electric Corporation
 - Box 79
 - West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution.
Source deck (946 cards)

Sample problem (30 cards)
Reference report, WAPD-TM-739(L)

17. CATEGORY - I
KEYWORDS - stresses, beams, elasticity, mechanical structures, design, M0552 codes, M0753 codes, MADAR codes, GEM codes
18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - CHECKER/CRECT/DAMMET/PLOTFB/SLAVE3
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - This package of five programs is designed for processing ENDF/B (Evaluated Nuclear Data File Version B) Version 1 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.
4. **METHOD OF SOLUTION** - In CHECKER most data are submitted to range limit checks to ensure the structure agrees with ENDF/B-defined specifications. The deviant point check (detection of mispunched values) is accomplished by sequentially checking five data points, two points on either side of the point under scrutiny, forward extrapolation on the first two points, reverse extrapolation on the fourth and fifth, and interpolations between the second and fourth points. If the third point does not fall within the range of the values calculated by extrapolations and interpolation, the value is listed as deviant. In essence, the above procedure merely simulates a checking of graphical data by eye. Checking of Legendre coefficients for feasibility and positivity is accomplished by converting the coefficients to moments, checking whether moments are physically possible and testing whether the Legendre expansion is negative within the interval -1 to 1 by the Sturm sequence method. If the Legendre expansion is negative, it is defined over the negative region(s) and integrated, thus determining the total negative probability.

CRECT accepts a data tape to be corrected as input and locates areas to be corrected by sequence and material numbers. A corrected tape is then generated reflecting the insertions and deletions.

When merging two tapes and converting to a data format other than that of either input tape, DAMMET performs a two-pass operation. The first pass consists of selecting only the data required and converting it to the format of the final tape, with storage of the data on an intermediate tape. Upon completion of the first pass on both tapes, resulting in two intermediate tapes, the second pass merges both intermediate tapes to the final data tape.

In PLOTFB the specified structure of the library allows data to be subclassified under nuclides, classes of data, and reaction types. The well-defined structure permits the associated information to be accessed by converting material numbers to Hollerith titles, etc. Plots are generated utilizing a plotting package which includes scaling, grid, and normalization routines. Plots can be generated in either linear-log axis or a mixture of both.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** -

In CHECKER correct structure of the data tape is assumed and minor anomalies are noted. Common and major irregularities cause termination of execution accompanied by a core dump.

In CRECT correct sequence and material fields of the data tape are assumed. In both CHECKER and CRECT data must be in ENDF/B BCD standard arrangement card image format.

In DAMMET a specific reaction cannot be extracted from a tape unless it is within a file or material selected.
6. **TYPICAL RUNNING TIME** - 0.007 second of CPU time is required to process one record of BCD information in CHECKER. Typical CPU to PP time ratio for the short form output is 1 to 4, for long form output, 1 to 6.

In CRECT 2 seconds of CPU time are required. Typical CPU to PP time ratio is 1 to 5.
 In DAMMET 3 to 7 minutes of CPU time are required to process 13 nuclides. Typical CPU to PP time ratio is approximately 3 to 1.
 In PLOTFB 4 minutes of CPU time and 10 minutes of PP time are required to list and plot 35 materials (approximately 3500 data cards).
 In SLAVE3 running time is dependent on the selection of subroutines and processing requirements. Typical CPU to PP time ratio is 1 to 3, and an average run is 4 minutes.

7. **UNUSUAL FEATURES OF THE PROGRAM** - In CHECKER there are two output options - (a) long form, which lists each card image as well as the anomalies encountered, and (b) short form, which lists only the anomalies encountered by the program (minimum output option).
8. **RELATED AND AUXILIARY PROGRAMS** - All five programs perform an independent operation on ENDF/B data. CRECT may be used to correct errors detected by CHECKER.
9. **STATUS** - Abstract first distributed September 1969.
CDC6600 version submitted April 1969, CRECT replaced by later version August 1972.
10. **REFERENCES** - National Neutron Cross Section Center, Description of the ENDF/B Processing Codes CHECKER, CRECT, DAMMET, PLOTFB, and Retrieval Subroutines, ENDF-110, BNL-13582, September 1967, Revised April 1969.
H. C. Honeck, ENDF/B - Specifications for an Evaluated Nuclear Data File for Reactor Applications, BNL-50066, May 1966, Revised July 1967.
11. **MACHINE REQUIREMENTS** - For CHECKER 56,300 octal (approximately 24,000 decimal) words of core storage and one tape (or disk) unit (besides input and output units).
For CRECT 13,000 octal words of core storage and two data storage units.
For DAMMET 81,000 octal (about 25,000 decimal) words of core storage and a maximum of five tape (or disk) units.
For PLOTFB 73,700 octal (about 30,000 decimal) words of core storage and three tape (or disk) units.
For SLAVE3 40,000 octal (approximately 18,000 decimal) words of core storage and one or two tape (or disk) units will be required for a typical job.
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV.
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE3 (locally modified).
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - When using non-CDC6600 versions of FORTRAN IV the implementation of and/or operations and EOF testing operations should be checked.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
D. E. Cullen, W. Kropp, S. Pearlstein,
and O. Ozer
National Nuclear Data Center
Brookhaven National Laboratory
Upton, Long Island, New York 11973.
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal.
Source decks (CHECKER 2355 cards, CRECT 259 cards, DAMMET 1867 cards, PLOTFB 4037 cards, SLAVE3 2245 cards).
Reference report, BNL-13582.
17. **CATEGORY** - M.
KEYWORDS - data processing, cross sections, computer graphics, libraries, maintenance, information retrieval, ENDF/B.
18. **SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - COMBE/PREP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - The programs, PREP and COMBE 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 $\exp(-2 \cdot w \cdot \alpha^2)$ in the scattering law.
4. METHOD OF SOLUTION - The frequencies and the polarization vectors for an irreducible Brillouin zone are obtained using the Slutsky and Garland form of the dynamical matrix with force constants determined by Schmunk, et al. These values for a coarse mesh are written on magnetic tape. The code then computes the scattering law by summing over reciprocal lattice vectors, the number of which depends on α max. For each reciprocal lattice vector the structure factors are computed for all points of the coarse mesh, and the contribution to the scattering law is calculated for each point on a fine mesh by linear interpolation of the structure factors. The contributions are stored in a region $\delta\alpha$, $\delta\beta$ around the appropriate α, β to give the scattering law $s(\alpha, \beta)$ as a double histogram.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
90 α groups
40 β groups
6. TYPICAL RUNNING TIME - The maximum value of α at which the scattering law is computed determines computation time, which increases approximately as α to the 3/2 power. A typical problem may require 30 minutes.
7. UNUSUAL FEATURES OF THE PROGRAM - COMBE reduces mesh-size dependence of results, associated with coherent scattering law calculations.
8. RELATED AND AUXILIARY PROGRAMS - PREP prepares the magnetic tape with the frequencies and polarization vectors for beryllium. COMBE writes the scattering law on a magnetic tape suitable for input to the FLANGE code (NESC Abstract 247).
9. STATUS - Abstract first distributed May 1970
UNIVAC1108 version submitted August 1969
10. REFERENCE - G. M. Borgonovi, Coherent Scattering Law for Polycrystalline Beryllium, GA-9364, May 16, 1969.
11. MACHINE REQUIREMENTS - 45K memory and 2 magnetic tapes
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
G. M. Borgonovi
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE -
Source decks (COMBE 1108-230 cards, PREP 1108-319 cards)
Sample problems (COMBE 1108-37 cards, PREP 1108-3 cards)
Reference report

17. CATEGORY - A

KEYWORDS - inelastic scattering, crystals, beryllium, scattering law, cross sections, PREP codes, FLANGE codes

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM - DATATRAN2**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC6600, 7600, CYBER176
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** 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.
4. **METHOD OF SOLUTION -** Modules perform tasks such as plotting, solving partial differential equations, and even entire reactor life studies. Modules performing complex tasks are constructed by linking elementary modules. Collections of data may be assigned a name and manipulated by name being created in one module and supplied for use in another.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** The program size is limited only by auxiliary storage capacity and available computer time.
6. **TYPICAL RUNNING TIME -** This varies from a few seconds to several hours depending upon the nature of the problem.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -** DATATRAN2 RAD1 Geometry Modules (NESC Abstract 406) and DATATRAN2 Utility Plotting Modules (NESC Abstract 407)
9. **STATUS -** Abstract first distributed May 1970
CDC6600 version of DATATRAN submitted July 1969, replaced by DATATRAN2 submitted May 1976, processed December 1976, replaced by Edition B for CDC6600 and 7600 systems using RUN or FTN compilers submitted January 1978, processed December 1978
CDC7600 version Edition C of DATATRAN2 for CDC7600 or CYBER176 systems using FTN4 compiler submitted June 1978, processed December 1978
10. **REFERENCES -** H. J. Kopp, DATATRAN 2 Primer, KAPL-M-7313, August 1973
H. J. Kopp, Editor, DATATRAN User's Guide, KAPL-M-7372, (Rev. 1), August 1977
H. J. Kopp, W. E. Schilling, D. S. Selengut, R. G. Stieglitz, K. L. Hanawalt and J. J. Urbanak, DATATRAN 2 Implementation, KAPL-M-7386, October 1974
NESC Note 79-37, Description of DATATRAN2 System Transmittal Tape and Implementation Information, NESC No. 386 6600B, 7600B, May 23, 1979
NESC Note 79-38, Description of DATATRAN2 Transmittal Tape, NESC No. 386 7600C, May 23, 1979
11. **MACHINE REQUIREMENTS -** 64K memory, 2 disks, and permanent storage media such as tapes are required, in addition, CDC6600 usage requires 30K words of ECS and CDC7600 usage 20K words of LCM.
12. **PROGRAMMING LANGUAGES USED -** FORTRAN (85%), COMPASS (15%)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -** SCOPE 3 1, 3 2, 3 3 or SCOPE 3 4 (CDC6600 Edition B); SCOPE 1 1 (CDC7600 Edition B), and SCOPE 2 1 (CDC7600, CYBER176 Edition C)
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -** Normal user resource allocation is 140,000 (local) central memory, 200,000 words of ECS, and disk as available.
The transmittal tapes are written to be used in conjunction with the CDC UPDATE utility since this software is applicable to CDC computers only.
Edition B assumes use of CDC's RUN or FTN compilers. Edition C assumes use of CDC's FTN4 compiler.

15. NAME AND ESTABLISHMENT OF AUTHORS -

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*Present address-Technology Development Corporation
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16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (Edition B-341 records*, Edition C-220 records*)
Environmental routines (Edition B-48 records*)
Test problems (Edition B-42 records*)

Reference reports and NESC Note, as appropriate to edition

* 512-word maximum length

17. CATEGORY - M

KEYWORDS - data base systems, programming languages, engineering, DATATran codes, DATATran2 codes

18. SPONSOR - DOE Division of Naval Reactors

1. NAME OR DESIGNATION OF PROGRAM - CITATION
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Explicit, finite-difference approximations in space and time have been implemented. The neutron-flux-eigenvalue problems are solved by direct iteration to determine the multiplication factor or the nuclide densities required for a critical system.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - CITATION has been designed to attack problems which can be run in a reasonable amount of time. Storage of data is allocated dynamically to give the user flexibility in dimensioning. Typically, a finite-difference diffusion problem could have 200 depleting zones, 10,000 nuclide densities, and 30,000 space-energy point flux values.
6. TYPICAL RUNNING TIME - The two-dimensional finite-difference diffusion theory eigenvalue problems iterate at a rate of about 0.1 millisecond per point per iteration with alternating-direction line relaxation (two sweeps per iteration) with 8-byte words on the IBM360/91 (0.5 on the 360/75). Since about 30 iterations are required for each succeeding eigenvalue problem, machine time for a depletion problem is about 0.003 second per point per time-step. Machine time for most auxiliary calculations is usually insignificant. For a representative fast breeder depletion problem, 65 percent of the machine CPU time is spent in solving eigenvalue problems.
7. UNUSUAL FEATURES OF THE PROGRAM - CITATION is considered unusual in that it should be relatively easy to modify the contents or to add routines. Effective techniques are incorporated to determine a critical system. More than one set of microscopic cross sections may be used in a system and nuclide behavior can be followed on a sub-zone scale within depletion regions. The user has flexible control over the route of a calculation as well as the edit of results.
8. RELATED AND AUXILIARY PROGRAMS - The microscopic cross section tape for this program may be generated by various codes, but XSDRN is designed specifically for this purpose. The microscopic cross section routines, formerly an auxiliary program, were integrated into the code to permit such data to be supplied from cards or modified in the same run in which the problem is solved.
9. STATUS - Abstract first distributed May 1970.
IBM360 version submitted July 1969, revised January 1970, 2nd revision April 1970, 3rd revision November 1971, 4th revision April 1972, 5th revision June 1972, 6th revision August 1972, 7th revision November 1972, 8th revision August 1974, 9th revision, Edition I, November 1976, sample problem executed by NESC December 1976 on an IBM370/195.
10. REFERENCES - T. B. Fowler, D. R. Vondy, and G. W. Cunningham, Nuclear Reactor Core Analysis Code CITATION, ORNL-TM-2496, Revision 2, July 1971, Supplement 1, October 1971, Supplement 2, March 1972, Supplement 3, July 1972.
N. M. Greene and C. W. Craven, Jr., XSDRN, A Discrete Ordinates Spectral Averaging Code, ORNL-TM-2500, July 1969.
D. R. Vondy and T. B. Fowler, Job Stream of Cases for the Computer Code CITATION, ORNL-TM-3793, July 1972.

11. MACHINE REQUIREMENTS - IBM360/91 or equivalent with at least 128,000 32-bit words of directly-addressable main storage, 7 to 32 I/O devices depending upon the calculation, excluding input and output devices and system requirements
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Now CITATION contains about 25,000 source statements. Without overlay, storage for the code instructions would approach 150,000 32-bit words, but with overlay of storage requirement is about 43,000 for the program and fixed storage, including 10,000 for system library routines
15. NAME AND ESTABLISHMENT OF AUTHORS -
T. B. Fowler, D. R. Vondy, and G. W. Cunningham
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (28,480 cards)
Sample problem (850 cards)
Reference report, ORNL-TM-2496, Rev. 2, Supplements 1, 2, and 3
Reference report, ORNL-TM-3793, available upon request
17. CATEGORY - K
KEYWORDS - one-dimensional, two-dimensional, three-dimensional, multigroup, diffusion, criticality searches, buckling, hexagonal configuration, x-y-z, r-theta, depletion, fuel management, XSDRN codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ETOX3
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108, IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - ETOX3 (ENDF/B to 10X) 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 sigma₀₀ (total cross section per atom) in the Russian (Bondarenko) format, and
 - (c) inelastic-scattering probability matrices
4. METHOD OF SOLUTION - Microscopic cross section values are constructed as specified by ENDF/B. Group constants are obtained by integrating the microscopic data over group intervals using the flux weighting scheme— $\phi(u)$ is proportional to $1/\sigma(u)$, $\sigma(u)=n(j)\cdot\text{microscopic } \sigma(j)+n(j)\cdot\text{microscopic } \sigma_{00}$. Integration methods used include Romberg, Gaussian quadrature, n-point, Simpson, and trapezoidal. The code allows as input arbitrary sets of values of group energies, temperatures, and microscopic sigma₀₀, sigma₀₁.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - The UNIVAC1108 ETOX3 calculation using 26-group data for a representative set of 14 isotopes required about 28 minutes. On the IBM370/195 a U238 90-group sample problem took 75 seconds of CPU time.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - WL18 is a short program included with ETOX3. It creates a table of complex integrals used by ETOX3. ETOX3 requires the ENDF/B tape in standard arrangement binary mode. Since the ENDF/B tapes do not normally come in this mode, they must be processed by the RIGEL code (NESC Abstracts 475 and 571) prior to using them with ETOX3. The format of the ETOX3 output is compatible for input to the computer code 10X (NESC Abstract 374), a multipurpose diffusion code for generating cross sections to be used in fast reactor analysis.
9. STATUS - Abstract first distributed May 1970.
 UNIVAC1108 version of ETOX submitted July 1969, revised April 1970, replaced by ETOX2 December 1970, replaced by ETOX3 June 1973.
 IBM360,370 version of ETOX3 submitted October 1974, sample problem executed by NESC June 1975 on an IBM370/195.
10. REFERENCES - R. E. Schenter, J. L. Baker, and R. B. Kidman, ETOX, A Code to Calculate Group Constants for Nuclear Reactor Calculations, BNWL-1002, May 1969.
 R. B. Kidman, ETOX-3 Operating Instructions, Overlay Structure, and Card Input Instructions, WADCO Note.
 H. C. Honeck, ENDF/B, Specification for an Evaluated Nuclear Data File for Reactor Applications, BNWL-50066, May 1966, Revised July 1967.
 R. W. Hardie and W. W. Little, Jr., 10X, A One-dimensional Diffusion Code for Generating Effective Nuclear Cross Sections, BNWL-954, March 1969.
 I. I. Bondarenko (Editor), Group Constants for Nuclear Reactor Calculations, Consultants Bureau, New York, 1964.
 W. Romberg, Vereinfachte Numerische Integration, Det Kong Norske Videnskaber Selskab Forhandlinger, Band 28, Nr. 7, 1955.
 M. Abramowitz and I. A. Stegun, Eds., Handbook of Mathematical Functions, Dover Publications, Inc., p. 918, 1965.

D. M. O'Shea, B. J. Toppel, and A. L. Rago, MC-2. A Code to Calculate Multigroup Cross Sections, ANL-7318, June 1967.

R. B. Kidman and R. E. Schenter, Group Constants for Fast Reactor Calculations, HEDL-TME-71-36, March 1971.

11. **MACHINE REQUIREMENTS** - Five tape units or equivalent random-access storage devices are required (3 are scratch units). The UNIVAC1108 version uses 65K words and IBM360,370 300K bytes of main memory.

12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV

13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** -

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - ETOX3 uses random drum storage to make maximum use of core. The tape of complex integrals prepared by WL1B should be mounted as logical unit 9. The ENDF/B tape in standard arrangement binary mode should be mounted as logical unit 12.

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

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16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (ETOX3 1108-4909 cards, 360-4941 cards)
Object decks (ETOX3 360-2707 cards)
Auxiliary routines (WL1B 1108-205 cards, 360-208 cards)
Control information (JCL 360-68 cards, overlay 360-14 cards)
Sample problems (ETOX3 1108-11 cards, 360-10 cards)
Punched output (ETOX3 1108-200 cards, 360-199 cards)
Sample problem output (ETOX3 360-13 pages)
Reference report, BNWL-1002, and WADCO Note

17. **CATEGORY** - B

KEYWORDS - group constants, inelastic scattering, fast reactors, temperature, ENDF/B, 10X codes, WL1B codes, RIGEL codes

18. **SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - STINT3
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The system of difference equations is solved by the forward-elimination, backward-substitution method.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
6 equations (groups + modes)
50 axial mesh intervals
6 delayed neutron groups
40 control rod and temperature feedback channels
6. TYPICAL RUNNING TIME - 3 seconds per time-step are required for the largest possible problem.
7. UNUSUAL FEATURES OF THE PROGRAM -
 - (a) Every transient calculation is automatically preceded by an eigenvalue problem to establish critical initial conditions. The critical power distribution is used to calculate an initial temperature distribution.
 - (b) The code calculates thermal feedback using a simple open-loop thermalhydraulic model.
 - (c) STINT3 can also be used for one-dimensional, few-group transient calculations.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed May 1970
CDC6600 version submitted July 1969
10. REFERENCE - C. H. Adams, R. A. Rydin, and W. M. Stacey, Jr., STINT - Single-channel, Space-time Synthesis Codes for Multidimensional Neutron Diffusion Problems, KAPL-3449, May 1969.
11. MACHINE REQUIREMENTS - 64K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.1
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - STINT3 solves the synthesis equations only. The task of generating the synthesis expansion functions and performing the required integrals must be done elsewhere. The sole function of one of the subroutines, INVERT, is to invert a matrix. In the process it calls a system inversion subroutine, F4MAIN, which is not generally available outside of KAPL. The user will have to supply an equivalent inversion routine.
15. NAME AND ESTABLISHMENT OF AUTHORS -
 1. C. H. Adams*, R. A. Rydin, and W. M. Stacey, Jr. -
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16. MATERIAL AVAILABLE - Restricted Distribution

Source deck (1296 cards)

Sample problem (299 cards)

Reference report

17. CATEGORY - F

KEYWORDS - kinetics, synthesis, space-time, diffusion equations, feedback, control elements, temperature distribution, one-dimensional, three-dimensional

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - CORGAM
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360/50
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - A backward elimination least-squares method is employed. The elimination criterion is one in which the Student's *t* value of each intensity is compared to a *t* value at a prescribed level of significance. The calculation of the standard deviation for each intensity coefficient accounts for randomness in both the complex and reference gamma-ray spectra.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Currently, the program is restricted to a problem of 400 channels and 15 reference spectra. There would be no difficulty in expanding this to as many as 4096 channels. However, the number of reference spectra is limited by the accuracy desired in the inversion procedure. The inversion program currently being used would suffer (from the accuracy standpoint) if the number of reference spectra were greater than 25.
6. TYPICAL RUNNING TIME - A typical analysis, involving 256 channels and 14 reference spectra and using reference spectra which were suitably aligned, requires less than 1 minute of execution time.
7. UNUSUAL FEATURES OF THE PROGRAM - CORGAM is a novel method of unfolding complex gamma-ray spectra because the variance calculations include contributions from both the complex and reference spectra. Also, only reference spectra that have intensity coefficients which are significant at a preselected level are retained in the final solution. The intermediate results can be printed, and the level of significance of each of the intensity coefficients can be observed.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed May 1970
IBM360 version submitted July 1969
10. REFERENCES - N. D. Eckhoff, Optimal Neutron Activation Analysis, TID-24581, 1968
N. D. Eckhoff, CORGAM - An Operator's Manual, KSU Report, July 7, 1969
N. R. Draper and H. Smith, Applied Regression Analysis, John Wiley and Sons, Inc., 1966
M. H. Young and N. S. Singhal, Gamma-ray Spectral Unfolding by the Stepwise Statistical Method, Nuclear Instruments and Methods, Vol. 45, p. 287, 1966
J. I. Trombka and R. L. Schmadebeck, A Method for the Analysis of Pulse-Height Spectra Containing Gain Shift and Zero-drift Compensation, Transactions of the American Nuclear Society, Vol. 10, p. 33, June 1967
R. M. Parr and H. F. Lucas, Jr., A Rigorous Least-squares Analysis of Complex Gamma-ray Spectra with Partial Compensation for Instrumental Instability, IEEE Transactions Nuclear Science, NS-11, p. 349, June 1964

G. D. O'Kelley, Ed., Applications of Computers to Nuclear and Radiochemistry, Gatlinburg Conference, NAS-NS-3107, 1963.

11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV Level G
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Disk storage is required.
15. NAME AND ESTABLISHMENT OF AUTHOR -
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16. MATERIAL AVAILABLE -
Source deck (1303 cards)
Sample problem (550 cards)
Reference report, KSU report
17. CATEGORY - 0
KEYWORDS - data processing, least square fit, gamma spectra, activation analysis
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SORSDB
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The procedures of paragraphs N414 and N415.2 of the ASME Code are used to calculate primary and secondary stresses, stress differences and stress intensities for comparison with allowed values. Calculations are based on a set of unit load input cases for a fixed geometry.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - As many as 100 points on the vessel may be evaluated for a maximum of 15 operating conditions and 50 fatigue cycles.
6. TYPICAL RUNNING TIME - 10 seconds to 1 minute are required, depending on problem size.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - SOR2
9. STATUS - Abstract first distributed May 1970
CDC6600 version submitted July 1969
10. REFERENCES - F. C. Carlson and R. E. Dobson, SORSDB, A Computer Program for the Stress and Fatigue Evaluation of Shells of Revolution, KAPL-M-6729, April 1969
J. A. Mirabal and D. G. Dighl, SOR-II - A Program to Perform Stress Analysis of Shells of Revolution, KAPL-M-2292, September 15, 1963
R. L. Fagan, Punched card from SOR-2 for SORSDB, KE-ZAP-2393, June 20, 1969
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
F. C. Carlson and R. E. Dobson
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (609 cards)
Reference report, KAPL-M-6729
17. CATEGORY - 1
KEYWORDS - stresses, shells, pressure vessels, mechanical structures, fatigue, SOR codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - RAFFLE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370/195
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Each axial subdivision of each region and rod is characterized by a number which designates its material, and thereby the nuclear total cross section. The Monte Carlo method is used, in which neutron histories are started at random within material number 1 and continued until a collision or escape occurs. If desired, successive cases may be run in which the histories are started in any material of the cell merely by renumbering the materials.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 20 regions
 - 10 different types of rods (differing in either geometry or materials)
 - 50 rods per region
 - 20 subregions per rod
 - 12 regions with rods (only the first 12 regions counting from the cell center)
 - 8 materials
6. TYPICAL RUNNING TIME - Simple geometries may require 2 minutes for a case consisting of 25,000 histories on the IBM360. Problems in which the source region is a small fraction of the total or the mean free paths are long compared to the dimensions of the regions may take several times as long.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - Much of the basic information and some parts of the code itself are taken from the more general Monte Carlo code, OSR.
9. STATUS - Abstract first distributed May 1970.
 - IBM7090 version submitted October 1969, deleted February 1975
 - IBM360 version submitted October 1969, replaced by Edition B February 1975, sample problem executed by NESC
10. REFERENCES - O. W. Hermann and R. S. Carlsmith, RAFFLE, A Monte Carlo Code for Calculation of First Flight Collision Probabilities, ORNL-TM-1699, December 1966.
 - D. C. Irving, R. M. Freestone, Jr., and F. B. K. Kam, OSR, A General-purpose Monte Carlo Neutron Transport Code, ORNL-3622, February 1965
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and BAL
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360,370
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Assembly language is used for the random number generation routines.
15. NAME AND ESTABLISHMENT OF AUTHORS -
 - O. W. Hermann and R. S. Carlsmith
 - Oak Ridge National Laboratory
 - Oak Ridge, Tennessee 37830

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (3442 cards)

Sample problem (26 cards)

Reference report, ORNL-TM-1699

17. CATEGORY - B

KEYWORDS - cell calculation, neutron transport theory, Monte Carlo method, reactor lattices, OSR codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - JITER
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - The computation is done as an expansion in terms of the decaying modes of a one-dimensional, few-group kinetics model
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The kinetics model may have as many as 4 energy groups and up to 6 groups of delayed neutrons. Half the reactor core can be described with up to 300 spatial mesh points and as many as 5 different materials distributed in at most 50 spatial regions. A total of 10 modes can be used in the expansions
6. TYPICAL RUNNING TIME - 30 seconds are required with 6 modes
7. UNUSUAL FEATURES OF THE PROGRAM - Any order spherical harmonics transport approximation can be used for the modes so long as time derivatives are ignored in all but one P0 equation
8. RELATED AND AUXILIARY PROGRAMS - Modes can be produced with BE21 (NESC Abstract 398) or MULE. JITER uses the Bettis Environmental Routines (NESC Abstract 478)
9. STATUS - Abstract first distributed May 1970
CDC6600 version submitted August 1969
10. REFERENCES - M Natelson and D R Harris, JITER, A FORTRAN IV Program for the Computation, from One-dimensional Modal Kinetics Models, of Statistical Parameters Measured in Reactor Fluctuation Experiments, WAPD-TM-877, June 1969
C J Pfeifer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-688, January 1967
11. MACHINE REQUIREMENTS - 120,000 (octal) memory locations
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
M Natelson and D R Harris
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (435 cards)
Sample problem (961 cards)
Reference report, WAPD-TM-877
17. CATEGORY - O
KEYWORDS - spectral density, data processing, correlations, statistics, one-dimensional, kinetics, BE21 codes, MULE codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FLAC
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108, IBM370
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The equations that are solved are the one-dimensional momentum equation for incompressible flow in a duct and the conservation equations for flow and energy at each node. Density changes due to heat addition are included according to the perfect gas law. The method for solving the set of algebraic equations is a variation of the point relaxation technique.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The FLAC program does not consider two-phase flow or open-channel flow, as in hydraulics.
6. TYPICAL RUNNING TIME - Approximately 30 seconds are required for a problem consisting of 100 branches. NESC executed the sample problem in 20 seconds on an IBM370/195.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed May 1970
UNIVAC1108 version submitted August 1969
IBM370 version submitted June 1976, sample problem executed by NESC April 1979 on an IBM370/195
10. REFERENCE - G. J. Malek, Development of the Flow Analysis Code FLAC, GA-B482, June 1969
11. MACHINE REQUIREMENTS - The computer storage requirements for FLAC are flexible, and the size of the various arrays can be adjusted to suit any problem. With all arrays set to their maximum, a problem consisting of 1500 branches and 700 nodes requires approximately 50,000 storage locations on the UNIVAC1108. 180K bytes of memory are needed for the IBM370 version.
12. PROGRAMMING LANGUAGES USED - FORTRAN V (UNIVAC1108) and FORTRAN IV (IBM370)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2 (UNIVAC1108), OS/370 (IBM370)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - For large problems, auxiliary data tapes can be used to store input information and results from the last iteration. These data tapes can be used to restart the problem in case of nonconvergence. The General Atomic system routine WARN permits the user to prescribe at run time a time interval parameter which is used as a warning period prior to job termination on the elapsed time job limit. Use of the statement CALL WARN (IWARN) returns a negative value of IWARN until the job enters the specified warning time interval after which a positive value is assigned. This routine is used to initiate writing to tape of restart data for subsequent runs. In the IBM version, subroutine WARN counts the number of iterations taken. If convergence is not achieved in IMAX iterations, the job terminates. The value assigned IMAX currently is 1000.
15. NAME AND ESTABLISHMENT OF AUTHORS -
1108 G. J. Malek
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Detroit Edison

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16. MATERIAL AVAILABLE -

Source decks (1108-1210 cards, 370-784 cards)
Sample problem (90 cards)
Control information (JCL 370-27 cards)
Sample problem output (19 pages)
Reference report

17. CATEGORY - H

KEYWORDS - fluid flow, temperature distribution, pressure, gases, heat transfer, HTGR reactors

18. SPONSOR - AEC Division of Reactor Development and Technology

1. NAME OR DESIGNATION OF PROGRAM - WASP2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600,7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The subroutines for calculating pressure, temperature, and specific volume use cubic and bicubic spline interpolation procedures. Two types of mathematical splines are used. For one independent variable a cubic spline is used and for two independent variables a bicubic spline is applied. Both are as described in reference 2 with modifications that a nonuniform mesh is allowed for the cubic spline and first derivative boundary conditions are permitted for both cubic and bicubic splines. The data points or knots for the splines are obtained from the NASA WASP program (reference 1) which generates very smooth surfaces.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The WASP2 procedures are restricted to be within a pressure range from below atmospheric to near critical for saturation states and for single phase vapor, and to over 10,000 psia for single phase liquid. The temperature range is approximately 40 degrees F to 650 degrees F for the liquid and from saturation temperature to approximately 2200 degrees F for the vapor regions.
6. TYPICAL RUNNING TIME - Computer time to compute specific volume given pressure and enthalpy is 50 microseconds on a CDC7600. Time to compute pressure from internal energy and specific volume is 100 microseconds for vapor and 45 microseconds for liquid on a CDC7600.
7. UNUSUAL FEATURES OF THE PROGRAM - Cubic and bicubic splines provide a fast and accurate method for computing water properties on a large computer running long problems. The approximations also have smooth derivatives which facilitates the modeling of large systems of differential equations.
8. RELATED AND AUXILIARY PROGRAMS - WASP2 replaces an earlier Bettis WASP program developed for use in FLASH2, reference WAPD-TM-839. The source for the stored data points or knots for the spline interpolation routines is the NASA WASP program documented in reference 1.
9. STATUS - Abstract first distributed May 1970.
CDC6600 version of WASP submitted August 1969, replaced by CDC6600,7600 version of WASP2 submitted February 1977.
10. REFERENCES - R. C. Hendricks, I. C. Peller, and A. K. Baron, WASP - A Flexible FORTRAN-IV Computer Code for Calculating Water and Steam Properties, NASA TN D-7391, November 1973.
T. M. Davis and A. L. Kontis, Spline Interpolation for Track-Type Survey Data with Applications to the Computation of Mean Gravity Anomalies, Naval Oceanographic Office Technical Report No. 228, 1970.
W. R. Cadwell, Editor, Reference Manual - Bettis Programming Environment, WAPD-TM-1181, September 1974.
D. A. Spragg, C. S. Caldwell, F. T. Duncckhorst, and G. W. Swartele, WASP2 - A FORTRAN-IV Computer Program for Calculating Water Properties Used in Reactor Safety Analysis (LWBR Development Program), WAPD-TM-1211, June 1976.
G. W. Swartele, BAPL Note - WASP2 Compliance with American Standard FORTRAN, February 1977.
11. MACHINE REQUIREMENTS - The WASP2 procedure requires 200,000 (octal) words of CDC7600 large core memory (LCM) for storing the coefficients for the spline functional fit of the water and steam surfaces.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3 3 (CDC6600), SCOPE 1 1 (CDC7600)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The WASP2 edit program utilizes environmental routines INTTAP, OUTTAP, LINES, and FINISH which are documented in reference 3. These routines can easily be replaced and do not require obtaining the entire programming environment (reference 3). Simple extended core storage routines READEC and WRITEC documented in reference 3 are used for transferring data between large and small core storage.
15. NAME AND ESTABLISHMENT OF AUTHORS -
D. A. Spragg, C. S. Caldwell, F. T. Dunckhorst,
G. W. Swariele, and T. R. Feher
Bellis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (4526 cards)
Sample problem (8 cards)
Sample problem output (29 selected pages, 1 microfiche)
Reference report, WAPD-TM-1211, and BAPL Note
17. CATEGORY - H
KEYWORDS - water, steam, thermodynamics, pressure, temperature, FLASH2 codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GAPL3
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - GAPL3 determines the inelastic, large-deflection behavior of thin plates or axially symmetric shells with pressure loading and deflection restraints
4. METHOD OF SOLUTION - The deformation of the body is described by a set of parameters ζ_i . The strains are found in terms of the ζ_i by geometric relations, and the stresses are found in terms of the strains by material property relations. The principle of virtual work is used to set up simultaneous equations which may be solved for the ζ_i . The solution is iterated until the stresses and strains do not change appreciably
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The thickness of the plate or shell should fall within the limits of thin shell theory
6. TYPICAL RUNNING TIME - A small elastic problem will take less than a minute. A large plastic one can require over 10 minutes
7. UNUSUAL FEATURES OF THE PROGRAM - GAPL3 is quite versatile and may be applied to most thin plate or axially symmetric shell problems. It is particularly appropriate when nonlinear material or geometric effects are important. Among its distinguishing features are -
 - (1) large-deflection theory is used,
 - (2) either deformation theory or incremental theory may be specified,
 - (3) elastic-plastic material properties are used,
 - (4) almost any boundary conditions may be considered,
 - (5) the rigid deflection restraint may take any shape and orientation, and
 - (6) bodies having a variable thickness may be analyzed
8. RELATED AND AUXILIARY PROGRAMS - GAPL3 is an extensive modification of GAPL1 and GAPL2 to permit the solution of a broad class of problems. GAPL3 uses the Bettis Environmental Routines (NESC Abstract 478)
9. STATUS - Abstract first distributed May 1970
CDC6600 version submitted August 1969
10. REFERENCES - A. L. Thurman, GAPL-3, A Computer Program for the Inelastic Large-Deflection Stress Analysis of a Thin Plate or Axially Symmetric Shell with Pressure Loading and Deflection Restraints, WAPD-TM-791, June 1969
C. M. Friedrich, W. H. Gurlinger, A. E. Sumner, Jr., GAPL-1, A Computer Program for the Plastic Stress Analysis of a Horizontal Plate with Pressure Loading Above and Deflection Restraints Below, WAPD-TM-731, January 1970
C. J. Pfeiler, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-666, January 1967
11. MACHINE REQUIREMENTS - Minimum core storage of 100,000 (octal) words, a printer, an on-line punch, and a plotter
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and Assembly language
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
A. L. Thurman
Bettis Atomic Power Laboratory

Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122

16. MATERIAL AVAILABLE - Restricted Distribution

Magnetic Tape Transmittal
Source deck (3416 cards)
Sample problem (28 cards)
Reference report, WAPD-TM-781

17. CATEGORY - 1

KEYWORDS - stresses, plates, shells, deformation, pressure, GAPL1 codes, GAPL2 codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - BE21
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - BE21 solves the few-group discrete ordinates equations in slab geometry. Either homogeneous or inhomogeneous problems can be solved.
4. METHOD OF SOLUTION - Auxiliary variables are introduced that permit the inhomogeneous equations to be solved by direct inversion. The method is stable with respect to roundoff errors. Homogeneous problems are solved by using the same inversion method to evaluate the critical determinant. Criticality is obtained by searching for suitable roots of the critical determinant with inverse interpolation. An exact spatial differencing scheme is included.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The maximum number of ordinates is 60 which may be divided arbitrarily among the groups subject to the restriction that the ordinate schemes be symmetric about, but not include, $\mu=0$ in each group. The corresponding group number limit is 30 with two ordinates per group. Other limitations include -
 - 20 compositions
 - 50 regions
 - 50 source regions
6. TYPICAL RUNNING TIME - Less than one minute is required for a 10 ordinate eigenvalue problem.
7. UNUSUAL FEATURES OF THE PROGRAM - BE21 has an internal library of Gauss-Legendre ordinate schemes that permit either PN or DPN approximation. The homogeneous solution will find any eigenfunction of the system with equal facility.
8. RELATED AND AUXILIARY PROGRAMS - BE21 uses the Bettis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed May 1970
CDC6600 version submitted August 1969
10. REFERENCES - E. Schmidt, BE21 - A Few-group Transport Program in FORTRAN IV, WAPD-TM-781, May 1968.
C. J. Pfaffner, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967.
11. MACHINE REQUIREMENTS - 140,000 (octal) locations of fast memory and 2 scratch tapes.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.1
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
 - E. Schmidt
 - Bettis Atomic Power Laboratory
 - Westinghouse Electric Corporation
 - Box 79
 - West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
 - Magnetic Tape Transmittal
 - Source deck (2185 cards)
 - Sample problem (11 cards)
 - Reference report, WAPD-TM-781

17. CATEGORY - C

KEYWORDS - few-group, criticality, transport theory, slabs, PL method, discrete ordinate method

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SUMOR(M0271)
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Doppler broadening is carried out by a trapezoidal integration over neighboring cross sections weighted by the Solbrig kernel.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Level-level interference is not permitted in fission channels. SUMOR treats s-wave channels only, and potential cross section is approximated as independent of energy.
6. TYPICAL RUNNING TIME - A problem which calculates absorption, fission, scattering, and total cross sections from 5 resonance energies at 50 energies runs approximately 10 seconds.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - SUMOR uses the Bellis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed May 1970
CDC6600 version submitted August 1969
10. REFERENCES - D. R. Harris and C. B. Noll, SUMOR (M0271), A FORTRAN IV Program for the CDC-6600 for Neutron Resonance Cross Sections including Level-level Interference and Exact Doppler Broadening, WAPD-TM-810, July 1969.
D. R. Harris and C. B. Noll, SUMOR, A FORTRAN-IV Program for the Philco-2000 for Neutron Resonance Cross Sections including Level-level Interference and Exact Doppler Broadening, WAPD-TM-518, November 1967.
C. J. Pflafer, CDC-6600 FORTRAN Programming - Bellis Environmental Report, WAPD-TM-868, January 1967.
11. MACHINE REQUIREMENTS - SUMOR requires approximately 135,000 (total) central memory locations. The number of central memory words could be decreased by decreasing the dimensions of the output cross sections. Also, one input and at least three output devices are required.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.1
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
D. R. Harris and C. B. Noll
Bellis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (1540 cards)

Sample problem (21 cards)

Reference reports, WAPD-TM-B10 and WAPD-TM-518

17. CATEGORY - A

KEYWORDS - cross sections, Doppler broadening, multilevel analysis, elastic scattering, capture, fission

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SAS1A
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600, IBM360/75
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
20 axial heat transfer nodes in a fuel pin, in the upper blanket, and in the lower blanket
8 delay groups
60 regions used to describe the core
200 axial segments in the coolant channel
15 radial temperatures in the fuel
6. TYPICAL RUNNING TIME - 5 minutes are required on the IBM360/75
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The basic method of analysis used in the weak explosion module is a modified version of the MARS code.
9. STATUS - Abstract first distributed May 1970
CDC6600 version submitted September 1969
IBM360 version submitted September 1969
10. REFERENCES - A. K. Agrawal, J. C. Carter, G. J. Fischer, T. J. Heames, D. R. MacFarlane, N. A. McNeal, W. T. Sha, C. K. Sanathanan, and C. K. Youngdahl, SAS1A, A Computer Code for the Analysis of Fast Reactor Power and Flow Transients, ANL-7807, August 1969
SAS1A Dictionary
11. MACHINE REQUIREMENTS - 410K bytes on the IBM360/75 (without overlays) and approximately 300K bytes on the IBM360/75 (with overlays)
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE (CDC6600) and OS/360 (IBM360)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - PREA is a function subprogram which gives either the reactivity or power versus time input (depending on the option chosen) for a power transient. This is an arbitrary function which must be specified by the user.
15. NAME AND ESTABLISHMENT OF AUTHOR -
T. J. Heames
Components Technology Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (6600-8668 cards, 360-8590 cards)
Sample problems (6600-198 cards, 360-198 cards)
Reference report and Dictionary

17. CATEGORY - F

KEYWORDS - fast reactors, transients, excursions, heat transfer, reactivity, MARS codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GAMTRI
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The multigroup diffusion theory equations are approximated by 7-point difference equations for the uniform triangular mesh grid. The system of difference equations is solved by an extension of the power method to find the eigenvector (neutron flux) and the eigenvalue (k-effective). Successive line overrelaxation is applied in a special form (exponential overrelaxation) that guarantees the non-negativity of the neutron flux. Coarse mesh rebalancing is used to improve the preasymptotic convergence behavior. A variation of Aitken's method improves the asymptotic behavior, assuming only one error mode.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
10 energy groups
20,000 space mesh points
255 different material regions
6. TYPICAL RUNNING TIME - 5 to 60 minutes are required
7. UNUSUAL FEATURES OF THE PROGRAM -
 - (a) The coarse mesh rebalancing scheme increases the effective solution range.
 - (b) Simultaneous performance of computation and data transfer provide iterations with virtually no delay caused by the use of drum storage.
 - (c) Efficient restart ability and ability to accept a tape flux guess.
8. RELATED AND AUXILIARY PROGRAMS - GAMTRI is a major revision of GAMBLE5 (NESC Abstract 222)
9. STATUS - Abstract first distributed May 1970
UNIVAC1108 version submitted September 1969
10. REFERENCES - J. P. Dorsey and R. Froehlich, GAMTRI, A Program for the Solution of the Multigroup Neutron-diffusion Equations in Triangular Geometry with Arbitrary Group Scattering, for the UNIVAC-1108 Computer, GA-9201, May 12, 1969, and Errata.
11. MACHINE REQUIREMENTS - 65,536 words of core storage, 3 tape units on 1 data channel, 1,572,864 words of drum storage from 1 data channel, and a peripheral printer-punch.
12. PROGRAMMING LANGUAGES USED - FORTRAN IV (90%) and Assembly language (10%)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2, General Atomic Version GAX 23
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - CYTS is the Assembly language routine used for the comprehensive checking and transmitting of data into and out of core storage.
15. NAME AND ESTABLISHMENT OF AUTHORS -
J. P. Dorsey and R. Froehlich
General Atomic Company
P. O. Box 81608
San Diego, California 92138

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (18,639 cards)

Sample problem (150 cards)

Reference report and Errata

17. CATEGORY - C

KEYWORDS - multigroup, diffusion equations, two-dimensional, triangular configuration, neutron flux, power distribution, GAMBLE5 codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SABOR4
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - It is assumed that the structure is a shell of revolution with axisymmetric distributions of thickness and material properties so that when the structural deformations are represented as sums of Fourier circumferential harmonics in theta, the load deflection equations of equilibrium separate into individual harmonics. Then the problem may be solved for each loading harmonic separately and the results summed to obtain the complete solution.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
 - HAL4 maxima -
 - 150 elements
 - 100 tabulated f(theta) points
 - 20 different harmonics allowed for the complete structure
 - MELT4 maxima -
 - 150 elements
 - 72 theta values
 - 25 thickness stations
 - 19 harmonics if the delta-t(s,zeta,theta) option is being used
 - 26 harmonics if the delta-t(s,zeta) option is being used
 - LANCE4 maxima -
 - 150 elements
 - 29 s stations for Simpson integration across an element (this must be an odd number)
 - MAINS4 maxima -
 - 150 elements
 - 151 nodes
 - 29 points for the Simpson's rule integration across an element
 - 0 radius at only one end of an element
 - MAINS4 minima -
 - 2 elements per branch
 - SUMPLOT4 maxima -
 - 150 elements
 - 37 theta values
 - 11 thickness stations
 - 175 elements + number of poles
 - 49 branches
 - 175 points to be plotted for a particular function at one theta-value
 - 175 nodes + branches + internal discontinuities
 - SUMPLOT4 minima -
 - 2 elements per branch or main shell
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -

8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed May 1970
IBM360 version submitted August 1969
10. REFERENCES - E A Witmer, E W Mack, T H H Pian, and B A Berg, An Improved Discrete-element Analysis and Program for the Linear-elastic Static Analysis of Meridionally-Curved, Variable-thickness, Branched Thin Shells of Revolution Subjected to General External Mechanical and Thermal Loads, Part 1, Analysis and Evaluation, SAMSO TR 68-310, Part 1, March 1968
E W Mack, B A Berg, and E A Witmer, An Improved Discrete-element Analysis and Program for the Linear-elastic Static Analysis of Meridionally-Curved, Variable-thickness, Branched Thin Shells of Revolution Subjected to General External Mechanical and Thermal Loads, Part 2, The SABOR 4 Program, SAMSO TR 68-310, Part 2, March 1968
11. MACHINE REQUIREMENTS -
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 A Witmer, E W Mack, T H H Pian,
and B A Berg
Aeroelastic and Structures Research Laboratory
Department of Aeronautics and Astronautics
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (5635 cards)
Sample problem (619 cards)
Reference reports (microfiche only)
17. CATEGORY - I
KEYWORDS - finite element method, mechanical structures, stresses, static loads, shells, matrices
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - TIGIR2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - Information is retrieved on a selective basis. The selection process employed is one which determines the truth value of a request for any given unit record, where a unit record is the information filed for a document, and the request is a Boolean-like expression written in the language used to describe the document
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - One minute of central processor time is required to search about 6000 document records on tape
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed May 1970
CDC6600 version submitted September 1969, replaced by Edition B October 1974
10. REFERENCES - J. L. Copeland, R. J. Cullen, C. H. Hunter, and A. E. Zackrisson, TIGIR, A Document Retrieval Program for the CDC 6600 - User's Reference Manual, KAPL-M-6749(L), July 28, 1969
B. A. Brown, TIGIR, A Document Retrieval Program for the CDC 6600 and TIGSORT/EDITMRG, Two TIGIR Modules to Provide Sort Capability for TIGIR Files, KAPL-M-6749(L) Addendum No. 1 (Rev.), August 1970
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGES USED - FORTRAN and ASCENT
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Some non-standard operations such as buffer assignment at execute time, random file generation and use, and shifting, have made machine language subprograms necessary
15. NAME AND ESTABLISHMENT OF AUTHORS -
Authors J. L. Copeland, R. J. Cullen, C. H. Hunter,
and A. E. Zackrisson

Contact C. J. Schmidt
Building A-1, Room 120
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (14,854 cards)
TIGIR2 system routines (180 cards)
Reference report and Addendum

- 17 CATEGORY - M
KEYWORDS - libraries, maintenance, information retrieval, data processing
- 18 SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FINEL
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The calculation is based on the finite element approach.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
FINEL2 maxima -
2000 nodes
1000 elements
4 types of materials
10 different materials of each type
100 groups
500 forces of any one type (x, y, or slant)
500 boundary conditions of any one type
FINEL3 maxima -
30 nodes per group if the number of dimensions is 2
20 nodes per group if the number of dimensions is 3
100 groups
1000 elements
6. TYPICAL RUNNING TIME - On the CDC6600 with the CHIPPEWA operating system, FINEL2 plastic calculations take between 1.2 and 1.5 minutes per 100 nodes.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - FINPUT is an aid for the preparation of input to the FINELs.
9. STATUS - Abstract first distributed May 1970
CDC6600 version submitted September 1969
10. REFERENCES - W. B. Jordan, FINEL, A Program to Solve Elastic Structures by the Use of Finite Elements, KAPL-M-6582, December 1, 1966
L. A. Grieb, FINEL-2 Input Preparation and Error Checks, KAPL Note, March 13, 1967
L. A. Grieb, FINEL Input Description Attachment, KAPL Note, April 26, 1967
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - CHIPPEWA
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
W. B. Jordan and L. A. Grieb
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301
16. MATERIAL AVAILABLE - Restricted Distribution
Source decks (FINEL 957 cards, FINPUT 211 cards)

Sample problem (FINEL 34 cards)
Reference report and Notes

17. CATEGORY - I

KEYWORDS - two-dimensional, three-dimensional, plates, strains, mechanical structures, stresses, finite element method, elasticity, plasticity, FINPUT codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - NOAH
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The equilibrium state is determined iteratively by an implicit two-pass technique. Three acceleration methods are available - first and second order extrapolation of the source and a jump extrapolation every 13 iterations. Pointwise flux convergence is required. The transient is solved by backwards differencing of time derivatives, and coefficients are evaluated at the preceding time-step. All dependent variables (including temperatures and xenon) are evaluated on the same spatial mesh. Five output procedures are possible.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
6 groups of delayed neutrons
10 regions
500 space points
A new region is required when the feedback free value of any of the parameters is changed from the preceding region value.
6. TYPICAL RUNNING TIME - If NS is the number of space points and NT the number of time-steps (one steady-state iteration is equivalent to one time-step), then the running time is $T = NS \cdot NT / 1500$ seconds. For pointwise convergence to 10^{-6} the equilibrium state is typically obtained in 20 to 80 iterations depending on the choice of acceleration parameters.
7. UNUSUAL FEATURES OF THE PROGRAM - The equilibrium is solved by adding a pseudo time derivative with a relatively small time constant. The approach to equilibrium is rapid because the pseudo time eigenvalue is large. The jump extrapolation technique tends to further increase the rate of approach to equilibrium. Provision for reading in an already calculated equilibrium state (or an arbitrary initial flux and temperature distribution) is included. Restart is possible. Provision is made for additions to the program by the user (by this we mean a number of input locations are not used in the current configuration but are addressable, hence, may be used in user-initiated subroutines without changing the dimension statements).
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed May 1970
CDC6600 version submitted September 1969
10. REFERENCE - G. S. Lellouche, NOAH, A Code for Solving the One Dimensional Space-time Diffusion Equation Accounting for the Effects of Temperature and Xenon Feedback, BNL-50157 (T-153), January 1969.
11. MACHINE REQUIREMENTS - 27K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 2 or 3
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The source deck includes the main program and 20 subroutines. There are two versions of TEMPSS and TEMPTR - TSS1 and

TTR1 for a fuel-clad-coolant model and TSS2 and TTR2 for a fuel-coolant-solid moderator model. There are two versions of STABLE - STB1 does not perform any stabilization while STB2 does. There are eight versions of the perturbation subroutine, PERT - PERT1 for a test of stability under a temperature impulse, PERT2 for oscillation of inlet value of coolant temperature, PERT3 for a step-change in inlet coolant temperature, PERT4 for a ramp-change in inlet coolant temperature, PERT5 for simulation of axial rod bank motion, PERT6 for a step-change in coolant velocity, PERT7 for a ramp-change in coolant velocity, and PERT8 for alteration of the absorption cross section between any two points.

15. NAME AND ESTABLISHMENT OF AUTHOR -

G. S. Lellouche
Brookhaven National Laboratory
Upton, Long Island, New York 11973

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (2599 cards)
Sample problem (75 cards)
Reference report

17. CATEGORY - F

KEYWORDS - one-group theory, one-dimensional, space-time, diffusion equations, temperature feedback, xenon, feedback, delayed neutrons

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - DATATRAN2 RAD1 Geometry Modules
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC6600,7600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - 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-doi 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.
4. **METHOD OF SOLUTION** - The modules constructed for this purpose and their individual functions are:
 RAD1 - converts user-oriented geometry input into a computerized form which can be used by other modules. Specification may be in inches or centimeters.
 PLOT20 - plots the boundaries of a collection of two-dimensional regions. Film, printer, CalComp, and GRAIL output options are available.
 AREA - calculates areas, centroids, and moments of inertia of two-dimensional figures. Calculation of the intersection of lines with a two-dimensional figure is available as an option.
 REPLACE - provides facilities to replace complex contours by parallelograms or rectangles of equivalent areas, to align edges of many regions, and to modify dimensions.
 MASKER - compares two collections (coarse and detail) of two-dimensional geometry to determine the areal intersection of the components.
 MASKED - coalesces and alphabetizes coarse and detail region area data.
 PPLOT - produces an output data set containing all of the basic region names and contour information for a hierarchical region.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Curves are limited to straight-line approximations in most modules and to second-order curves in principal modules. The total geometric complexity is not limited.
 RAD1 - comparison to 0.00001 inch is invoked to determine congruency of points. A maximum of 495 vertices is allowed for any region boundary.
 PLOT20 - regions are limited to 490 vertices.
 MASKER - the coarse geometry is limited to 800 regions.
6. **TYPICAL RUNNING TIME** - For the CDC6600, less than 10 seconds are used to specify a geometry. It takes approximately three minutes to plot a complex geometry and a variable amount of time, usually less than one minute, to calculate properties.
7. **UNUSUAL FEATURES OF THE PROGRAM** -
8. **RELATED AND AUXILIARY PROGRAMS** - DATATRAN2 (NESC Abstract 386) and DATATRAN2 Utility Plotting Modules (NESC Abstract 407)
9. **STATUS** - Abstract first distributed May 1970.
 CDC6600 version of DATATRAN 2-D Geometry Input submitted July 1969, replaced by DATATRAN2 RAD1 Geometry Modules submitted May 1976, processed December 1976, replaced by Edition B submitted January 1978, processed December 1978.
10. **REFERENCES** - R. H. Beam, Jr. and H. J. Kopp, RAD1 Geometry Modules, KAPL-M-7339, June 1974.
 H. J. Kopp, DATATRAN 2 Primer, KAPL-M-7313, August 1973.
 H. J. Kopp, Editor, DATATRAN User's Guide, KAPL-M-7372, (Rev. 1), August 1977.
 H. J. Kopp, W. E. Schilling, D. S. Selengut, R. G. Stieglitz, K. L. Hanawalt and J. J. Urbanik, DATATRAN 2 Implementation, KAPL-M-7386, October 1974.
11. **MACHINE REQUIREMENTS** -
12. **PROGRAMMING LANGUAGES USED** - FORTRAN (90%), COMPASS (5%), DATATRAN2 (5%)

13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - DATATRAN2 with SCOPE 3 1, 3 2, 3 3 or SCOPE 3 4 (CDC6600), SCOPE 1 1 (CDC7600)
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - These modules operate under the DATATRAN2 system. Only changes to subroutine SLOP in module PLOT20 should be required to accommodate local plotting software. The transmittal tape is written for use with the CDC UPDATE utility to create a program library file since this software is only applicable to CDC computers using the DATATRAN2 system. Each subprogram or test case starts with the card reading *DECK followed by the name. Test cases are identified by names with the initial character T. Run decks are described in KAPL-M-7339. Sample problems generate self-explanatory output. This software can only be used with the RUN compiler.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
R. H. Bean and H. J. Kopp*
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301
*Present address-Technology Development Corporation
155 Moffett Park Drive, Building C
Sunnyvale, California 94086
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (254 records*)
Reference report, KAPL-M-7339
* 512-word maximum length
17. **CATEGORY** - L
KEYWORDS - two-dimensional, geometry, computer graphics, data processing, DATATRAN codes, DATATRAN2 codes
18. **SPONSOR** - DOE Division of Naval Reactors

1. NAME OR DESIGNATION OF PROGRAM - DATATRAN2 Utility Plotting Modules
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600,7800
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The modules constructed for this purpose and their individual functions are:
 PLOT1 - designed for the CalComp and report quality output, plots functions of one variable, has histogram capability and logarithmic scaling options.
 PLOT2 - designed for printer, CalComp, electrostatic plotter, and microfilm applications, plots functions of one variable, has logarithmic scaling and multiple y-axis options.
 PLOT3 - plots on visual display units functions of two variables, produces contour, perspective, and stereographic plots for data specified on a regular grid.
 PLOT4 - designed for the CalComp and report quality output, plots functions of two variables, produces contour plots for nonuniform but regular geometry grids.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - There is a limit of approximately 8,000 points per curve for functions of one variable and 18,000 points for functions of two variables.
 PLOT1 - maximum of 15 curves for a given figure.
 PLOT2 - maximum of 15 curves for a given figure using one or more y-axes. Logarithmic scaling is necessarily tied to the flexibility of the output device.
 PLOT3 - the function to be plotted must be continuous.
 PLOT4 - maximum of 40 contour lines on a single plot, 6000 entries per data set.
6. TYPICAL RUNNING TIME - Less than one minute on a CDC6600
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - DATATRAN2 (NESC Abstract 386) and DATATRAN2 RAD1 Geometry Modules (NESC Abstract 406)
9. STATUS - Abstract first distributed May 1970.
 CDC6600 version of DATATRAN Utility Modules submitted July 1969, replaced by DATATRAN2 Utility Plotting Modules submitted May 1976, processed December 1976, replaced by Edition B submitted January 1978, processed December 1978.
10. REFERENCES - H. J. Kopp, R. P. DiStefano, B. L. Hennig, C. N. Hodgins, A. N. Lord, and E. J. Binney, Utility Plotting Modules, KAPL-M-7325, May 1974.
 H. J. Kopp, DATATRAN 2 Primer, KAPL-M-7313, August 1973.
 H. J. Kopp, Editor, DATATRAN User's Guide, KAPL-M-7372, (Rev. 1), August 1977.
 H. J. Kopp, W. E. Schilling, D. S. Selengut, R. G. Stieglitz, K. L. Hanawalt, and J. J. Urbaniak, DATATRAN 2 Implementation, KAPL-M-7386, October 1974.
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGES USED - FORTRAN (80%), COMPASS (15%), DATATRAN2 (5%)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3 1, 3 2, 3 3 or SCOPE 3 4 (CDC6600), SCOPE 1 1 (CDC7600)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - These modules operate under the DATATRAN2 system. Only changes to a single subroutine SLOT which provides an interface to local plotting software should be required. The transmittal tape is written for use with the CDC UPDATE utility to create a program library file since this software is only

applicable to CDC computers using the DATATRAN2 system. Each subprogram or test case starts with the card reading *DECK followed by the name. Test cases are identified by names with the initial character T. Run decks are described in KAPL-M-7325. Sample problems generate self-explanatory graphical output. This software can only be used with the RUN compiler.

16. NAME AND ESTABLISHMENT OF AUTHORS -

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16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (128 records*)
Reference report, KAPL-M-7325
* 512-word maximum length

17. CATEGORY - P

KEYWORDS - programming languages, computer graphics, engineering, DATATRAN codes, DATATRAN2 codes

18. SPONSOR - DOE Division of Naval Reactors

1. NAME OR DESIGNATION OF PROGRAM - TAC2D
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The heat conduction equation is replaced by an equivalent set of linear finite-difference equations. This set of equations is then solved by the Peaceman-Rachford implicit alternating direction method.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
 - (a) The grid line system must be orthogonal in the rectangular, cylindrical, or circular coordinate system. Therefore, the sides of the nodal elements must be orthogonal. The entire problem must be bounded by four grid lines in one of the coordinate systems. Difficulties in treating irregular boundaries can be overcome to some extent through the use of materials having specially chosen properties.
 - (b) All radiation is treated one-dimensionally.
 - (c) There are no provisions for thermal expansion or change of phase. Such special heat transfer situations could be included by extensions of the existing programming.
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
 - (a) The geometrical input is simple.
 - (b) The input of thermal parameters is by FORTRAN V arithmetic statement functions. Many of the calculation variables (time, local temperature, local position) are available for use in these functions.
 - (c) Internal and external flowing coolants may be used.
 - (d) There may be internal and external thermal radiation.
 - (e) There is a wide selection of optional output.
 - (f) There is a special option which may be used for obtaining steady-state results efficiently.
8. RELATED AND AUXILIARY PROGRAMS - TAC3D (NESC Abstract 414), which is three-dimensional and has all the features of TAC2D described in this abstract.
9. STATUS - Abstract first distributed May 1970
UNIVAC1108 version submitted October 1969
10. REFERENCES - J. F. Petersen, TAC2D, A General Purpose Two-dimensional Heat Transfer Computer Code - Users Manual, GA-8868, September 6, 1969.
S. S. Clark and J. F. Petersen, TAC2D, A General Purpose Two-dimensional Heat Transfer Computer Code - Mathematical Formulations and Programmer's Guide, GA-9262, September 1969.
D. W. Peaceman and H. H. Rachford, The Numerical Solution of Parabolic and Elliptic Differential Equations, Society for Industrial and Applied Mathematics, Vol. 3, pp. 28-41, March 1955.
J. F. Petersen, TAC3D, A General Purpose Three-dimensional Heat Transfer Computer Code - User's Manual, GA-9263, September 1969.
S. S. Clark, J. V. Del Bene, and J. F. Petersen, TAC3D, A General Purpose Three-dimensional Heat Transfer Computer Code - Mathematical Formulations and Programmer's Guide, GA-9264, September 1969.

11. MACHINE REQUIREMENTS - 65K UNIVAC1108 or equivalent In addition to input/output, a maximum of four and a minimum of no tapes are required depending upon the code options being used
12. PROGRAMMING LANGUAGE USED - FORTRAN V
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/370
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - In subroutines ERROR2 and STEADY, the calls to MERR cause termination of the problem with error flag setting. Any method of terminating which is applicable to the system being used could be substituted for these two CALL MERR statements.
15. NAME AND ESTABLISHMENT OF AUTHORS -
J. F. Petersen and S. S. Clark
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (6511 cards)
Sample problem (288 cards)
Reference reports, GA-8868 and GA-9262
17. CATEGORY - H
KEYWORDS - heat transfer, two-dimensional, coolants, temperature distribution, TAC3D codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - LARCA
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
25 groups
13 reactions per group
20 zones
36 materials
6. TYPICAL RUNNING TIME - 10 seconds are required
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - Input and output cross sections are in DTF4 (NESC Abstract 209) format. Input fluxes are in the format of zone fluxes punched by DTF4.
9. STATUS - Abstract first distributed May 1970
CDC6600 version submitted October 1969
10. REFERENCES - R. C. Anderson, LARCA, A FORTRAN IV CDC-6600 Program for Calculating Flux-weighted Cross Sections, LA-8373-MS, March 29, 1969, and Addendum, October 1, 1969
11. MACHINE REQUIREMENTS - 63,000 (total) storage
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 -
R. C. Anderson
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87544
16. MATERIAL AVAILABLE -
Source deck (330 cards)
Sample problems (500 cards)
Reference report
17. CATEGORY - N
KEYWORDS - cross sections, averages, data processing, DTF4 codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - TACASI
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Least-squares techniques are used. The solution is by iteration starting with guessed values of the neutron and radiation widths. The multiple scattering calculation employs either infinite slab or right circular cylinder geometry with the beam normal to the face of the cylinder. It is also possible to select stationary nucleus (Doppler-broadened) or moving nucleus (unbroadened) mode in the multiple scattering calculation. Russian roulette and importance sampling techniques are employed to reduce computation time.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - As many as 16 observed quantities may be input and as many as 24 subresonances may be included.
6. TYPICAL RUNNING TIME - A typical problem involving 3 or 4 observed quantities in the stationary target mode can be solved in about 1 minute of computing time if the guesses are reasonably accurate.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - SIGMA and FLUSH are auxiliary codes used to prepare TACASI input. If SIGMA and FLUSH are not used, it will be necessary to convert capture and self-indication area data into capture probabilities as a function of time-of-flight. The code P is used to obtain a printer plot of the experimental data. However, the plot of the calculated time history can still be obtained. If it is desired to process large quantities of data through TACASI, contact the author directly about obtaining these auxiliary codes.
9. STATUS - Abstract first distributed May 1970
UNIVAC1108 version submitted October 1969
10. REFERENCE - F. H. Frohner, TACASI - A FORTRAN IV Code for Least Squares Area Analysis of Neutron Resonance Data, GA-6906, August 4, 1966
TACASI Version 3, GGA Note
S. Friesenhahn, TACASI Options, GGA Note, February 7, 1969
S. Friesenhahn, Code Change, GGA Note, February 25, 1969
P Code Description, GGA Note
11. MACHINE REQUIREMENTS - 65K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
S. Friesenhahn
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (2401 cards)

Sample problem (12 cards)
Reference report and Notes

17. CATEGORY - A
KEYWORDS - least square fit, resonance, Doppler broadening, Breit-Wigner formula, SIGMA codes, FLUSH codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - M0661/M0657/M0626
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - M0661, M0657, and M0626 perform statistical analyses of data based on a least squares polynomial fit
4. METHOD OF SOLUTION - M0661 is based on the constant relation $N=B0$ and simply computes the sample mean, standard deviation, and various other statistics from a given set of data. It also obtains confidence limits for certain parameters based on normal distribution theory.
M0657 uses the straight line $N=B0+B1 \cdot x$ as the model when paired data are given. Estimates of the intercept, $B0$, and the slope, $B1$, are obtained as are various confidence intervals useful in a statistical analysis of the data.
M0626 uses the polynomial of the r -th degree in k variables as its model. It performs a multiple linear regression analysis of the data.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - Less than 1 minute is required
7. UNUSUAL FEATURES OF THE PROGRAM - The data may be transformed by addition of a constant, multiplication by a constant, raising to a power, or use of a logarithmic, exponential or trigonometric transformation prior to the analyses
8. RELATED AND AUXILIARY PROGRAMS - M0661, M0657, and M0626 use the Bettis Environmental Routines (NESC Abstract 478)
9. STATUS - Abstract first distributed December 1970
CDC6600 version submitted October 1968
10. REFERENCES - T. Shimamoto, Three Computer Programs for Polynomial Curve Fitting, WAPD-TM-914, August 1968
C. J. Pfeiler, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967
11. MACHINE REQUIREMENTS - CDC280 plotter for the graphical output
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.1
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
West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source decks (M0626 1514 cards, M0657 1300 cards, M0661 857 cards)
Sample problems (M0626 27 cards, M0657 16 cards, M0661 23 cards)
Reference report, WAPD-TM-914
17. CATEGORY - P
KEYWORDS - statistics, least square fit, data processing
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - MANE1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The equations to be solved are obtained by applying Ohm's law and Kirchhoff's law to the magnetic network. The resulting nonlinear equations are solved by the Newton-Raphson method of iteration. The linearized equations are solved by using Kron's fundamental formula for mesh analysis of an electrical circuit.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The network consists of a number of major rectangles or loops connected to each other in a cyclic fashion. Each large rectangle is subdivided into a number of smaller rectangles. Each side (network branch) has a reluctance but only one branch of each major rectangle has a driving force corresponding to the applied ampere turns in the stator. If there are l loops and r rectangles per loop, then lr linear equations must be solved. A rule-of-thumb limitation is lr less than or equal to 90, although the program is actually limited only by the amount of core storage and the adequacy of Gauss elimination with pivotal condensation.
6. TYPICAL RUNNING TIME - For values of $lr = 24$ the solution is obtained in 5 to 10 seconds.
7. UNUSUAL FEATURES OF THE PROGRAM - Given the magnetization characteristics of the various steels (represented by points on a table), MANE1 finds a point on each curve and calculates the equation of a tangent to the curve instead of a straight line from the calculated point to the origin. Regardless of the complication of the network, the program solves the problem in less than 10 iterations. The program also calculates the total magnetic energy in the entire network.
8. RELATED AND AUXILIARY PROGRAMS - MANE1 is an improved version of M0565 and uses the Bettis Environmental Routines (NESC Abstract 476).
9. STATUS - Abstract first distributed December 1970.
CDC6600 version submitted October 1969, replaced by revised version April 1973.
10. REFERENCES - D. A. Guerdan, O. J. Marlowe, MANE1 - A Digital Computer Program to Solve a Rectangular Magnetic Network, WAPD-TM-790, September 1969.
D. A. Guerdan, M0565, A Program to Solve a Rectangular Magnetic Network for Use on the Philco-2000 Computer, WAPD-TM-557, February 1966.
C. J. Fleiter, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967.
11. MACHINE REQUIREMENTS - For small problems, $lr = 18$, 35,000 (octal) core locations are required. For large problems, $lr = 80$, 154,000 (octal) locations are required.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - FORTRAN integer and real variables are equivalenced. It is assumed that variables are allocated the same number of storage bits independently of this type designation.
15. NAME AND ESTABLISHMENT OF AUTHORS -
D. A. Guerdan and O. J. Marlowe
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation

Box 79
West Mifflin, Pennsylvania 15122

16. MATERIAL AVAILABLE - Restricted Distribution
 - Source deck (870 cards)
 - Sample problem (14 cards)
 - Sample problem output (8 pages)
 - Reference report, WAPD-TM-790
17. CATEGORY - 1
 - KEYWORDS - design, magnetic flux, motors, M0565 codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ALPHA-M
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - ALPHA-M uses an iterative least-squares scheme for closely estimating the weighting factors. In the first iteration, the weighting factors are estimated by using the actual number of counts per channel, leading to a calculated number of counts. In the second, the factors are more closely estimated by using the calculated values from the first iteration. Further iterations lead to the desired degree of accuracy.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
80 isotopes in the library
256 channels in the analyzer
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - ALPHA-M is an improved version of program ALPHA.
9. STATUS - Abstract first distributed December 1970
IBM360 version submitted October 1969, sample problem executed by NESC
10. REFERENCES - E. Schonfeld, ALPHA-M - An Improved Computer Program for Determining Radioisotopes by Least-squares Resolution of the Gamma-ray Spectra, ORNL-3975, September 1966
E. Schonfeld, ALPHA - A Computer Program for the Determination of Radioisotopes by Least-squares Resolution of the Gamma-ray Spectra, ORNL-3810, July 1965
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
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P. O. Box X
Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE -
Source deck (692 cards)
Sample problem (766 cards)
Reference report, ORNL-3975
17. CATEGORY - O
KEYWORDS - gamma radiation, spectra, isotopes, least square fit, background radiation, ALPHA codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - TAC3D
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The heat conduction equation is replaced by an equivalent set of linear finite-difference equations. These are solved by an implicit alternating-direction scheme which requires a regular geometry in that the points at which temperatures are to be calculated must be in regular rows, columns, and planes. As a consequence, TAC3D is primarily suited to solve problems that roughly fit an envelope of either a rectangular parallelepiped or an incomplete right circular cylinder.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
 - (a) The grid plane system must be orthogonal in the rectangular or cylindrical coordinate system. Therefore, the sides of the nodal elements must also be orthogonal. The entire problem must be bounded by 6 grid planes on one of the coordinate systems. Difficulties in treating irregular boundaries can be overcome to some extent through the use of materials having specially chosen properties.
 - (b) All radiation is treated one-dimensionally.
 - (c) There are no provisions for thermal expansion or change of phase. Such special heat transfer situations could be included by extensions of the existing programming.
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
 - (a) The geometrical input is simple.
 - (b) The input of thermal parameters is by FORTRAN V arithmetic statement functions. Many of the calculation variables (time, local temperature, local position, etc.) are available for use in these functions.
 - (c) Internal and external flowing coolants may be used.
 - (d) There may be internal and external thermal radiation.
 - (e) There is a wide selection of optional output.
 - (f) There is a special option which may be used for obtaining steady-state results efficiently.
8. RELATED AND AUXILIARY PROGRAMS - TAC2D (NESC Abstract 408), which is two-dimensional and has all the features of TAC3D, and RAT3D, which TAC3D replaced.
9. STATUS - Abstract first distributed December 1970
UNIVAC1108 version submitted October 1969
10. REFERENCES - J. F. Petersen, TAC3D, A General Purpose Three-dimensional Heat Transfer Computer Code - User's Manual, GA-9263, September 1969.
S. S. Clark, J. V. Del Bene, and J. F. Petersen, TAC3D, A General Purpose Three-dimensional Heat Transfer Computer Code - Mathematical Formulations and Programmer's Guide, GA-9264, September 1969.
J. Douglas, Alternating Direction Methods for Three Space Variables, Numerical Mathematics, Vol. 4, pp. 41-63, 1962.
J. F. Petersen, TAC2D, A General Purpose Two-dimensional Heat Transfer Computer Code - User's Manual, GA-8869, September 1969.

S. S. Clark and J. F. Petersen, TAC2D, A General Purpose Two-dimensional Heat Transfer Computer Code - Mathematical Formulations and Programmer's Guide, GA-9262, September 1969.

11. MACHINE REQUIREMENTS - 65K memory. A maximum of four and a minimum of no tapes are required, depending upon the code options being used.
12. PROGRAMMING LANGUAGE USED - FORTRAN V
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
J. F. Petersen
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (7992 cards)
Sample problem (98 cards)
Reference reports, GA-9263 and GA-9264
17. CATEGORY - H
KEYWORDS - transients, heat transfer, three-dimensional, coolants, x-y-z, r-theta-z, TAC2D codes, RAT3D codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - CEXE/INCEXE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - CEXE solves the three-dimensional xyz time-dependent xenon spatial oscillation problem using a modified one energy group theory and a nodal representation
4. METHOD OF SOLUTION - CEXE solves for the spatial neutron source distribution with coupled Doppler and moderator temperature feedbacks. The time dependence of the iodine and xenon concentrations are based on the assumption of constant power during each time-step interval
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maximum reactor core size representation is restricted to a nodal configuration of 19 x 19 x 19 in the x, y, z directions, respectively
6. TYPICAL RUNNING TIME - A typical problem requires 4 seconds per source iteration for a 1000 node core with no feedbacks and 7.5 seconds per iteration for a 2600 node core with both Doppler and moderator temperature feedback
7. UNUSUAL FEATURES OF THE PROGRAM - CEXE provides a full three-dimensional representation and includes all major feedback mechanisms which are important in xenon oscillation problems. Maximum flexibility has been provided and the code can be used for reactors with bidirectional coolant flow patterns
8. RELATED AND AUXILIARY PROGRAMS - INCEXE prepares tape input required by CEXE
9. STATUS - Abstract first distributed December 1970
IBM360 version submitted October 1969, sample problem executed by NESC
10. REFERENCE - R. Kern, D. C. Wright, W. C. Coppersmith, and Z. R. Rosztoczy, Optimum Spatial Flux Control Project Phase I CEXE, A Three-dimensional Nodal Method for Analysis of Xenon Oscillations and Control, CEND-3932-1-349, May 1969
11. MACHINE REQUIREMENTS - 256K bytes, 6 IBM2314 disk drives, and 3 IBM2400 tape drives
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 -

Author	R. Kern Reactor Theory and Analysis Section
Contact	S. Pacino, Manager Computer Services Section Combustion Engineering, Inc 1000 Prospect Hill Road Windsor, Connecticut 06095
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (CEXE 1432 cards, INCEXE 198 cards)
Sample problems (CEXE 151 cards, INCEXE 26 cards)
Reference report
17. CATEGORY - F

KEYWORDS - three-dimensional, x-y-z, one-group theory, iodine, xenon oscillations, heavy water reactors, Doppler coefficient, INCEXE codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - PARTI
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6500
3. DESCRIPTION OF PROBLEM OR FUNCTION - PARTI is a group collapsing code which determines the optimum discrete representation of a variable for subsequent repetitive calculations .
4. METHOD OF SOLUTION - PARTI uses the results from an initial detailed calculation (such as a slowing-down calculation for an energy-dependent flux application) and reduces the corresponding space and/or energy structure to an optimal few-interval and/or few-group representation in accordance with the minimization of an objective response function. This minimization is attained employing a method of steepest descent in piece-wise constant, non-convex, multi-dimensional phase-space
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - PARTI will optimize the discrete representation of an arbitrary function of one or two independent variables. The present program storage allocation permits up to 80 nodes for each coordinate of a detailed representation and allows collapsing up to 40 nodes for each coordinate of the reduced representation
6. TYPICAL RUNNING TIME - Running times of typical cases have seldom exceeded 10 seconds
7. UNUSUAL FEATURES OF THE PROGRAM - PARTI performs group or mesh collapsing in an optimal sense
8. RELATED AND AUXILIARY PROGRAMS - PARTI may be considered to be an auxiliary program to almost any neutron diffusion theory or neutron transport program
9. STATUS - Abstract first distributed December 1970
CDC6500 version submitted November 1969
10. REFERENCES - A. A. Harms and J. A. Stoddard, PARTI, A Code for Optimal Partitioning of One and Two Variable Piecewise-continuous Functions in Reactor Calculations, TRW 4332 2 69-410, 1969
A. A. Harms and N. J. McCormick, Optimal Neutron Group Structure, Transactions American Nuclear Society, Vol. 11, p. 527, 1968
A. A. Harms and A. L. Babb, Optimal and Non-optimal Neutron Structures, Transactions American Nuclear Society, Vol. 12, p. 143, 1969
A. A. Harms, Variable Phase-space Neutron Transport Analysis, University of Washington Thesis, 1969
11. MACHINE REQUIREMENTS - 32K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - A random number generator with the function name RANF(X) is used
15. NAME AND ESTABLISHMENT OF AUTHORS -
A. A. Harms
Department of Engineering Physics
McMaster University
Hamilton, Ontario, Canada
J. A. Stoddard
TRW Incorporated
TRW Systems Group
One Space Park
Redondo Beach, California 90278

16. MATERIAL AVAILABLE -

Source deck (6500-331 cards)
Sample problem (6500-31 cards)
Reference report, TRW 4332 2 69-410

17. CATEGORY - B

KEYWORDS - group constants, cross sections, optimization

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ATHENA4
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360/75,91
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
100 wave function components
10 interaction components
The reduced matrix elements of the one-body multipole operators may be included automatically in the wave function coefficients. Non-local effects on the wave functions may be included in the local energy approximation.
6. TYPICAL RUNNING TIME - About 2 minutes are required for the sample problem.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - ATHENA4 is a revised and updated version of the original ATHENA code. It can punch the form factors on cards in a format suitable for input to the DWBA code JULIE.
9. STATUS - Abstract first distributed December 1970.
IBM360 version submitted November 1969, sample problem executed by NESC.
10. REFERENCES - F. S. Chwieroth, J. I. Dodson, M. B. Johnson, L. W. Owen, and G. R. Satchler, Form Factors for Inelastic Scattering - The Code ATHENA IV, ORNL-TM-2703, September 5, 1969, and Corrigenda, April 1970.
11. MACHINE REQUIREMENTS -
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 -
F. S. Chwieroth, J. I. Dodson, M. B. Johnson,
L. W. Owen, and G. R. Satchler
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (1926 cards)
Sample problem (11 cards)
Reference report and Corrigenda
17. CATEGORY - A
KEYWORDS - inelastic scattering, potential scattering, nuclear models, ATHENA codes, JULIE codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - CHAINS
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - GE625.635
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The Bateman equations are solved analytically using double-precision arithmetic. Poles are avoided by small alterations of the loss terms. Multigroup fluxes, cross sections, and self-shielding factors entered as input are used to compute the effective specific reaction rates. The atom densities are computed at any specified times.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
50 members in a chain
100 energy groups
100 time values
6. TYPICAL RUNNING TIME - Less than 10 seconds are required on a GE625
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - CHAINS is similar to CRUNCH and ISOCRUNCH.
9. STATUS - Abstract first distributed December 1970
GE625 version submitted December 1969
10. REFERENCE - W. B. Henderson, Program CHAINS (NMP-856), GEMP-490, March 27, 1967
11. MACHINE REQUIREMENTS - 16K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GECOS
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
W. B. Henderson
Nuclear Analysis
Westinghouse PWR Systems Division
P. O. Box 355
Pittsburgh, Pennsylvania 15230
16. MATERIAL AVAILABLE -
Source deck (230 cards)
Binary deck (73 cards)
Sample problem (55 cards)
Reference report
17. CATEGORY - D
KEYWORDS - isotopes, production, decay, reaction kinetics, radioactivity, CRUNCH codes, ISOCRUNCH codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GROUSE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - GE625,635
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Core cross sections in sufficiently fine energy detail to perform numerical Doppler-broadening are generated from single-level Breit-Wigner parameters over the specified energy range. Input parametric flux traverses are computed externally to GROUSE by any appropriate monoenergetic transport approximation, with a trial source in the core for which a correction in GROUSE is subsequently made. The moderator (reflector) and clad (structure) cross sections are supplied as constant scatter and absorption in the monoenergetic flux traverse calculations, but $1/v$ absorption in those regions is allowed in computing the energy dependence of the moderator flux. The spatial flux shape at each energy in the fine energy lattice is synthesized by interpolation in the parametric values using the value of the core absorption and scatter cross sections at those energies. The group reduction uses these fluxes to generate the effective multigroup reaction rates in specified zones in the core. The multigroup effective cross sections are computed to reproduce the effective reaction rates by again using the parametric flux data.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 99 groups
 - 40 core zones
 - 20 parametric values of core absorption cross section
 - 3 parametric values of scattering cross section
 - 25 isotopes
 - 2600 fine energy lattice points

The core can contain a mixture of isotopes if the isotopic composition is not a function of position. If isotopic composition varies, effective cross reactions for each isotope can be carried out on one isotope at a time, using the average non-resonant cross section of all others as part of the background cross section.
6. TYPICAL RUNNING TIME - About 20 minutes are required to process 2600 energies and 40 core zones to obtain multigroup cross sections involving 7 isotopes. Generation of Doppler-broadened isotopic library tape is proportional to the number of isotopes and the number of energies for each isotope. One isotope at 2600 energies can be added in about 4 minutes.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The monoenergetic parametric flux distributions must be calculated and processed externally to GROUSE.
9. STATUS - Abstract first distributed December 1970
GE635 version submitted December 1969
10. REFERENCES - W. B. Henderson, Development and Correlation of a Method for Generating Space-dependent Multigroup Effective Core Cross Sections for 710 Reactor Analysis, GEMP-548, September 25, 1967
W. B. Henderson, User's Data for the GROUSE Code, GEMP Note, December 2, 1969
11. MACHINE REQUIREMENTS - 38K memory, 6 tapes or disk
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GECOS

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Energy lattices are ordered in the analogue of a card sorter. The floating numbers are sorted bit by bit. The sorting algorithms (ORDER and ORDER 1) are therefore machine-dependent and are coded for the GE625,635 machines.
15. NAME AND ESTABLISHMENT OF AUTHOR -
W. B. Henderson
Nuclear Analysis
Westinghouse PWR Systems Division
P. O. Box 355
Pittsburgh, Pennsylvania 15230
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (1814 cards)
Binary deck (563 cards)
Sample problem (955 cards)
Reference report and Note
17. CATEGORY - B
KEYWORDS - cross sections, Breit-Wigner formula, Doppler broadening, flux synthesis, cell calculation, multigroup theory, group constants
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - MICHROD
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - GE625,635
3. DESCRIPTION OF PROBLEM OR FUNCTION - The Vickers pyramid number and the microhardness increment fraction are computed from lilar micrometer eyepiece readings. These readings are made on indents, which have been made by an indenter, in the material being tested
4. METHOD OF SOLUTION - The Vickers pyramid number is a function of the included angle between two opposite faces of the indenter, the load on the indenter, and the diagonal of the indent. The microhardness increment fraction is a relationship between the Vickers pyramid numbers of two specimens, both being tested at the same temperature. If readings from both specimens are not available at the same temperatures, linear interpolation on the given readings is used to obtain readings at the desired temperatures
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
100 temperatures for each specimen
1000 indents, summed over all temperatures, for each specimen
4 readings per indent
6. TYPICAL RUNNING TIME - Less than 3 seconds per case are required
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - MICHROD is written to use a GE635 subroutine PLOP to plot results with a CalComp plotter. This is a program option. The PLOP subroutine for the GE635 is maintained by General Electric Aircraft Engine Group
9. STATUS - Abstract first distributed December 1970
GE635 version submitted December 1969
10. REFERENCE - H. R. Baumgardt and J. L. Kamphouse, Hot Microhardness Program, MICHROD, GEMP-725, December 1, 1969
11. MACHINE REQUIREMENTS - 27K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GEOS
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
Nancy R. Baumgardt
Aircraft Engine Group
General Electric Company
Cincinnati, Ohio 45215
16. MATERIAL AVAILABLE -
Source deck (756 cards)
Binary deck (216 cards)
Sample problem (195 cards)
Reference report
17. CATEGORY - 0
KEYWORDS - radiation effects, temperature, computer graphics, microhardness
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - DOS
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
GE625,635
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The types of dosimeters treated are those in which neutron irradiation of the parent isotope leads to a ground state and a metastable state of the radioactive daughter, or to a ground state only. The Bateman equations are solved directly if the flux is given and iteratively if the activity is given.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maximum of -
100 power cycles
6. TYPICAL RUNNING TIME - 0.25 seconds per dosimeter are required
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1970
GE635 version submitted December 1989
10. REFERENCE - N. R. Baumgardt and W. B. Henderson, Program DOS, NSP-874, A FORTRAN IV Program to Compute the Flux or Specific Activity Associated with a Dosimeter, GEMP-729, December 1969
11. MACHINE REQUIREMENTS - 25K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GEOS III
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
W. B. Henderson
Nuclear Analysis
Westinghouse PWR Systems Division
P. O. Box 355
Pittsburgh, Pennsylvania 15230
Nancy R. Baumgardt
Aircraft Engine Group
General Electric Company
Cincinnati, Ohio 45215
16. MATERIAL AVAILABLE -
Source deck (456 cards)
Binary deck (132 cards)
Sample problem (95 cards)
Reference report
17. CATEGORY - D
KEYWORDS - isotopes, production, decay, dosimeters, daughter products
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GLUB1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The transient is computed as a sequence of quasi-steady states, with fuel and clad temperatures, stresses, and strains being computed at eleven different values of steady-state volume average enthalpy. Linear interpolation then gives these quantities at any other volume average enthalpy. The computations must be done iteratively since all metal properties can be put in as temperature-dependent quantities. Then strains and enthalpy are used to calculate the fuel element core, plenum, and annulus volumes and enthalpies versus time. Finally, this data is used to compute internal pressure, clad stresses, and defect flow. The fuel element is split into two parts, the fuel section and the plenum. The split occurs axially at the top of the fuel. The fuel section contains control volumes for the fuel, core, (if one exists), annulus, and clad. The plenum section has control volumes for the plenum and clad. Heat convection due to water flowing between sections and out of the defect is small and assumed negligible. Stress and strain calculations are done elastically with allowance for interference between the fuel and clad.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - For each metal property, up to 10 values versus temperature can be put in. If power or defect enthalpy is to be input, up to 30 values versus time can be given. Finally, in order to obtain allowable power as a function of defect diameter, up to 10 different diameters can be put in.
6. TYPICAL RUNNING TIME - 5 minutes are required.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - GLUB1 uses the Bettis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed December 1970
CDC6600 version submitted December 1969
10. REFERENCES - F. T. Dunckhorst, L. L. Lynn, W. A. Collman, and J. E. Meyer, GLUB-1 - A FORTRAN IV Digital Computer Program for Water-logged Fuel Element Analysis, WAPD-TM-569, November 1966.
C. J. Pfeifer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967.
11. MACHINE REQUIREMENTS - 60,000 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 - The output conversion and printing routines do not properly print the (phi)min and (phi)max subintervals for the table of J1, mean enthalpy of the fuel.

15. NAME AND ESTABLISHMENT OF AUTHORS -

F T Dunckhorst, L L Lynn, W A Coffman,
and J E Meyer
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122

16. MATERIAL AVAILABLE - Restricted Distribution

Magnetic Tape Transmittal
Source deck (2638 cards)
Sample problem (56 cards)
Reference report, WAPD-TM-569

17. CATEGORY - H

KEYWORDS - fuel elements, transients, deformation, pressure

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - REDUX
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Direct computation is used.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
8 samples
300 count trials per sample
6. TYPICAL RUNNING TIME - 30 seconds are required for the largest samples.
7. UNUSUAL FEATURES OF THE PROGRAM - Bias and error estimates are used for γ and MCC.
8. RELATED AND AUXILIARY PROGRAMS - REDUX uses the Bellis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed December 1970
CDC6600 version submitted January 1970
10. REFERENCES - D. R. Harris and M. Natelson, REDUX, A FORTRAN-IV Program for Calculation of Statistical Parameters from Count Samples Measured in Neutron Fluctuation Experiments, WAPD-TM-811, September 1969
C. J. Plesler, CDC-6600 FORTRAN Programming - Bellis Environmental Report, WAPD-TM-668, January 1967
11. MACHINE REQUIREMENTS - 64,000 (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 AUTHORS -
D. R. Harris and M. Natelson
Bellis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (273 cards)
Sample problem (106 cards)
Reference report, WAPD-TM-811
17. CATEGORY - O
KEYWORDS - data processing, statistics, sampling, reactors, fluctuations
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - PAX03
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - PAX03 performs infinite medium, time-dependent calculations of neutron flux spectra in homogeneous, hydrogenous media. A HARMONY file containing few-group microscopic 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.
4. METHOD OF SOLUTION - Inventories of cells are input in the form of nuclide concentrations in basic nuclear materials and their geometric arrangements and sizes. Individual modules of the program calculate specific properties of the cell which are entered into a general file along with other results for further editing. According to prescribed procedures, the HARMONY file required by PDQ7 is generated from this general file. The parameters required for the P7MG equations are also taken from the general file while the results are entered into a separate file for editing. In cylindrical and spherical geometry the P3, P5, and P7 fast and double-P1 thermal spectra are simplified approximations.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 30 cells calculated in one problem
 - 30 nuclides represented in the fast energy spectrum
 - 50 nuclides used in other parts of the program
 - 4 fast groups with 1 thermal group or 3 fast groups with 2 overlapping thermal groups
 - 3 perturbed parameters in the temperature feedback calculations
 - unlimited number of depletion times
6. TYPICAL RUNNING TIME - About 15 seconds per cell per depletion step are required except for fine detail plate geometry problems which require 90 seconds.
7. UNUSUAL FEATURES OF THE PROGRAM -
 - (a) The cells can be described by concentrations and basic dimensions.
 - (b) Heterogeneous resonance integrals may be calculated from input L-factors for rod geometry and from fine-detailed multigroup calculations for plate geometry.
 - (c) Fast cross sections are obtained from a 57-group XAP library. Both 54- and 57-group problems can be solved.
 - (d) Thermal cross sections and thermal scattering kernels are obtained from a 25-, 38-, or 50-group XAP library.
 - (e) Thermal shielding factors are obtained with a double-P approximation for plates or from a correlation for rods and plates.
 - (f) P1, P2, and P3 or double-P1 spectra are computed thermally and cross section averages are obtained for one-group diffusion, two-overlapping-groups diffusion, P1, double-P1 and P3 models. The averages may be used in HARMONY tablesets or in P7MG.
 - (g) In slab geometry, P1, P3, P5, and P7 approximations are available in the fast multigroups of a P7MG calculation. One-group diffusion, P1, double-P1, and two-overlapping-groups approximations are available for the thermal groups.

8. **RELATED AND AUXILIARY PROGRAMS** - The fast and thermal cross section data are created by the XAP program. The Fink/Pantry data storage and retrieval system is used by PAX03 as are the Bettis Environmental Routines (NESC Abstract 476). HARMONY tabulsets, created by PAX03, are input to PDQ7 (NESC Abstract 275).
9. **STATUS** - Abstract first distributed December 1970.
CDC6600 version of PAX02 submitted January 1970, replaced by CDC6600 version of PAX03 in June 1972.
10. **REFERENCES** - S. M. Nikolich, S. H. Weiss, O. J. Marlowe, B. D. Greenberg, and S. E. Kovscek, PAX03, A Comprehensive CDC-6600 Program to Compute Infinite Medium Multigroup Spectra, HARMONY Input, and One-dimensional P7 Multigroup Solutions, WAPD-TM-888(L), Vols I and II, February 1971.
B. L. Anderson and L. A. Ondis, XAP - A Multigroup Cross Section Library System, WAPD-TM-823(L), February 1971.
C. J. Pfeiffer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967.
H. Bohl, Jr. and O. J. Marlowe, The FINK/PANTRY Data Storage and Retrieval System for a Computer, WAPD-TM-710, Revised, July 1969.
11. **MACHINE REQUIREMENTS** - System disk, dedicated disk area for Bettis file manager, extended core storage (ECS) for auxiliary storage.
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 AUTHORS** -
Authors: S. M. Nikolich, S. H. Weiss, O. J. Marlowe, B. D. Greenberg, and S. E. Kovscek.
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 (2 tapes)
Source decks (PAX03 tape1-19,064 cards, tape 2-13,691 cards, FINK/PANTRY 3224 cards, XAP 853 cards)
Sample problem (PAX03 151 cards)
Reference reports
17. **CATEGORY** - B
KEYWORDS - cross sections, thermal neutrons, neutron spectra, resonance integrals, fission products, HARMONY codes, XAP codes, PDQ7 codes, FINK/PANTRY codes, PAX02 codes.
18. **SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - FARED
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - For each homogeneous block composition, REGA performs a B1 computation for the flux and current in each microgroup and uses these as weighting functions to form microscopic cross section sets for the broad group structure specified by the user. For resonance nuclides, effective resonance capture and fission cross section contributions are computed in the unresolved resonance range in a manner similar to that used in the GANDY code (NESC Abstract 341). A statistical averaging over chi-squared distribution is used but interference scattering is ignored. Averaging over the distribution is performed using the quadrature scheme introduced by Greebler and Hulchins. The STRIP routine in FARED is responsible for the calculation of effective resonance cross sections in the resolved resonance range. A multigroup collision probability procedure is used to compute the average flux in the lump or mixture for each group in an ultrafine group mesh which spans the entire resolved resonance range. The boundary for each ultrafine group is computed by strip as the calculation proceeds down the energy range. The calculation begins at the highest energy peak, all resonance nuclides considered. Note that this procedure accounts for overlap and interference effects. The real and adjoint diffusion equations are solved by a standard fission source iteration procedure. A starting fission source distribution is provided by the user. After each iteration the new fission source distribution is normalized to unity. The depletion equations are solved by a second-order approximation for each of a series of specified minor time-steps. The power distribution is assumed constant during each minor time-step and the fluxes are renormalized at the end of each of these intervals. The flux distributions are then recalculated at the end of the series of minor time-steps. All criticality searches employ the same general algorithm for uniformity in the iterative procedure.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 100 microgroups
 - 30 multigroups
 - 15 downscattering groups
 - 150 mesh points
 - 149 mesh intervals
 - 149 mesh intervals per zone
 - 50 unique nuclides
 - 20 zones
 - 20 blocks
 - 100 zone materials
 - 40 cells
 - 30 nuclides per block
 - 20 zones per block
 - 2 cells per block
 - 30 nuclides in a chain

500 resonance peaks per nuclide
 15 nuclides per cell composition
 30 nuclides per block composition
 7 resonance nuclides per block
 3000 storage locations for bulk material data

6. **TYPICAL RUNNING TIME** - A detailed depletion-fuel management problem for a 1000 MWe LMFR core cycle requires about 20 minutes on a CDC6600
7. **UNUSUAL FEATURES OF THE PROGRAM** - The FARED code is a totally integrated fast reactor design package. It is designed for fast and accurate one-dimensional physics design and survey studies with a strong emphasis on input simplicity. The following are some of the special features of the program -
 - (a) The user is permitted two resonance cells per block to treat, for example, a resonance control material as well as a fuel lump containing resonance nuclides
 - (b) The microscopic cross sections may be recalculated at any time to account for composition changes during depletion
 - (c) Depletion chains are constructed by the user and nuclide lists are expanded to include all nuclides in the chain which are produced during depletion
 - (d) The breeding and conversion ratios are automatically defined by specifying certain nuclides as fissile in the depletion chain
 - (e) Power density searches are available which adjust material compositions to achieve the desired system eigenvalue and specified ratios of maximum (or average) power densities in given search zones
 - (f) Nuclide depletion includes destruction by (n,alpha) and (n,p) reactions and production by (n,2n)
 - (g) The length of a depletion sequence may be determined by the maximum allowable burnup of certain material units, a minimum allowable concentration of certain nuclides, or a minimum eigenvalue
 - (h) A wide variety of edits are available including extensive perturbation edits and the calculation of beta-effective, prompt neutron lifetime and prompt and delayed neutron worths
 - (i) The use of free format input directives allows the user great flexibility in specifying data and constructing sequences of calculations and edits
8. **RELATED AND AUXILIARY PROGRAMS** - RETAP prepares a microgroup library for use by FARED. The library tape generated by this program contains the following seven data files -
 - (1) microgroup energies
 - (2) depletion chain descriptions
 - (3) resolved resonance data
 - (4) unresolved resonance data
 - (5) smooth cross sections and matrices
 - (6) fission spectra
 - (7) depletion, fission product and delayed neutron dataAn update may be performed on an existing library to add or change nuclide data for any file
9. **STATUS** - Abstract first distributed December 1970
 CDC6600 version submitted December 1969, replaced by revised version January 1971
10. **REFERENCE** - D. H. Roy, J. M. Tillford, A. Z. Livolsi, P. N. Colpo, C. D. Carmichael, and J. A. Jacobsen, Fast Breeder Reactor Static Physics Methods Development and Analysis Project, Volume 1 - FARED One-dimensional Fast Reactor Physics Design and Analysis Code, BAW-3867-9, Vol. 1, Rev. 1, December 1970

11. MACHINE REQUIREMENTS - 45,000 (decimal) core storage and 18 tape drives or distinct disk files plus I/O
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 - The two COMPASS machine language routines are described in the reference and are easily convertible to another machine language. Provision is made for varying the number of characters per word in the program. FARED is in overlay structure with three primary overlays and fifteen secondary overlays.
15. NAME AND ESTABLISHMENT OF AUTHORS -
D. H. Roy, J. M. Tillford, and A. Z. Livolsi
Methods Development Section
P. N. Colpo, C. D. Carmichael, and J. A. Jacobsen
Computer Center
Power Generation Division
Nuclear Power Generation Department
Babcock & Wilcox Company
P. O. Box 1260
Lynchburg, Virginia 24505
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal (2 tapes)
Source decks (FARED 16,011 cards, RETAP 4125 cards)
Sample problems (FARED 116 cards, RETAP 18,203 cards)
Sample problem output (FARED-183 selected pages, RETAP library generation-19 selected pages, RETAP edit-172 selected pages)
Reference report
17. CATEGORY - D
KEYWORDS - cross sections, averages, neutron flux, one-dimensional, slabs, cylinders, spheres, criticality searches, depletion, RETAP codes coefficients
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - DOGGY
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
150 columns of input
100 rows per column
6. TYPICAL RUNNING TIME - Running time rarely exceeds 30 seconds per case
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - DOGGY is an updated combination of the two former KAPL form sheet calculation programs, MPD and DOGY.
9. STATUS - Abstract first distributed December 1970
CDC6600 version submitted January 1970
10. REFERENCES - Sally A. Gazda, DOGGY, A FORTRAN-IV Program to Perform Mathematical Form Sheet Calculations, KAPL-M-6590, March 15, 1967
H. H. Rhodes, MPD1 - A Program to Perform Mathematical Form Sheet Calculations, July 8, 1964
J. R. Schmid, DOGY - A Program to Perform Routine Form Sheet Calculations, KAPL-M-EC-34, June 19, 1963
R. J. Cullen, 6600 CalComp Plotter Routines, KAPL Note, July 25, 1966
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and ASCENT
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
Sally A. Gazda
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (2618 cards)
Sample problem (55 cards)
Reference report, KAPL-M-6590, and Note
17. CATEGORY - P
KEYWORDS - data processing, numerical solution, computer graphics, MPD codes, DOGY codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ASPIS
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - ASPIS utilizes a set of linear differential equations, obtained by an expansion of the flux in double range Legendre polynomials. The cross sections are obtained, by interpolation, at specified energy points from a 25-point table. The group cross sections and the slowing-down matrix are then obtained from an infinite medium solution in each of the material regions. The highest energy group is infinitely thin, and the unscattered source strength is computed analytically throughout the shield
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 12 regions
 - 151 spatial mesh points per region
 - 650 total spatial mesh points
 - 10 material compositions
 - 10 MeV maximum energy
 - 251 total energy mesh points
 - 13 energy groups
 - 6 terms in the double range Legendre polynomial expansion of the flux
 - 6 terms in the Legendre polynomial expansion of the scattering kernel
6. TYPICAL RUNNING TIME - 2 minutes are required
7. UNUSUAL FEATURES OF THE PROGRAM - ASPIS will compute the energy, dose, and energy deposition buildup factors for a plane source. For a material composition containing more than one element the energy deposition buildup factor in any one element may be computed
8. RELATED AND AUXILIARY PROGRAMS - ASPIS is a modification of LETO (NESC Abstract 343) adapted for monoenergetic plane gamma ray sources. ASPIS uses the Bellis Environmental Routines (NESC Abstract 476)
9. STATUS - Abstract first distributed December 1970
CDC6600 version submitted February 1970
10. REFERENCES - L. Lois, ASPIS, A Program to Compute Plane Isotropic, Monodirectional and Slant Source Buildup Factors in Laminar Geometry, WAPD-TM-835, April 1969
L. Lois, A Solution of the Slab Transport Problem, WAPD-TM-661, March 1968
C. J. Pfeiffer, CDC-6600 FORTRAN Programming - Bellis Environmental Report, WAPD-TM-666, January 1967
11. MACHINE REQUIREMENTS - 140K (local) memory and 3 tapes for scratch storage
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and ASCENT
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.1
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The term overlay associated with the SCOPE 3.1 operating system determines the amount of program text in central memory of any memory load. The ASPIS program contains a main overlay and 4 primary overlays. Overall program control is vested in the main overlay and the primary overlays are loaded and executed through the use of the overlay routine

15. NAME AND ESTABLISHMENT OF AUTHOR -

L. Lois
 Bellis Atomic Power Laboratory
 Westinghouse Electric Corporation
 Box 79
 West Mifflin, Pennsylvania 15122

16. MATERIAL AVAILABLE - Restricted Distribution

Magnetic Tape Transmittal
 Source deck (3706 cards)
 Sample problem (18 cards)
 Reference report, WAPD-TM-835

17. CATEGORY - J

KEYWORDS - gamma radiation, slabs, cross sections, shielding, dose rates, LETO codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GAZE2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Third-order finite difference equations are used at exterior boundaries and material interfaces with fourth-order differencing at interior points. Criticality searches are performed by repetition of pairs of direct and adjoint flux calculations, each pair followed by a first-order perturbation to derive an estimate of the parameter variation required to achieve the desired system multiplication factor.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM - Optional treatment of the transverse boundary by use of energy- and material-dependent bucklings, leakage cross sections, or ZOOM albedo type boundary conditions.
8. RELATED AND AUXILIARY PROGRAMS - ZOOM
9. STATUS - Abstract first distributed December 1970
UNIVAC1108 version submitted January 1970
10. REFERENCE - S. R. Lenihan, GAZE-2, A One-dimensional, Multigroup, Neutron Diffusion Theory Code for the IBM-7090, GA-3152, August 3, 1962
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGES USED - FORTRAN IV (95%) and
Assembly language (5%)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
S. R. Lenihan
General Atomic Company
P. O. Box 91608
San Diego, California 92138
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (6121 cards)
Sample problem (205 cards)
Reference report
17. CATEGORY - C
KEYWORDS - one-dimensional, multigroup, diffusion, slabs, spheres, cylinders, criticality searches, ZOOM codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SUPERTOG
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The single-level Breit-Wigner formalism is used for calculation of cross sections in the resolved resonance region. Cross sections in the unresolved resonance region are computed by taking averages over suitable Porter-Thomas distributions of the neutron and fission widths. Smooth cross sections are calculated by integration of point-cross-section data given in ENDF/B File 3. Elastic scattering matrices are computed from Legendre coefficients of the scattering angular distribution data. Inelastic scattering and (n,2n) matrices are computed from excitation functions for individual levels and by using a nuclear evaporation model above the region of resolved levels.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
199 groups
4000 data points for each reaction type
30 Legendre coefficients
6. TYPICAL RUNNING TIME - On the IBM360/65 running time varies from 5 to 25 minutes per nuclide and is a function, primarily, of the number of groups, the number of resolved resonances, and the length of the elastic scattering matrix.
7. UNUSUAL FEATURES OF THE PROGRAM - SUPERTOG employs a rather elaborate overlay structure and extensive use of EQUIVALENCE statements to minimize core requirements.
8. RELATED AND AUXILIARY PROGRAMS - Three programs are available which extend the flexibility of SUPERTOG. The SUPERTOG data retrieval program retrieves SUPERTOG output from a card image tape written in the ANISN format. This program will retrieve data from a maximum of four tapes and merge this data onto one tape. The program will then, by input option, edit the data, punch cards in either the ANISN or DTF4 format, or write an unformatted tape for use by ANISN. Another program is available which will merge up to a maximum of four card-image tapes written in the GAM2 update format onto a single tape. This program can also take the one-dimensional arrays from one tape and the two-dimensional arrays from another tape and merge this information onto a single tape. The single tape is input to the SUPERTOG version of the GAM2 update program. The GAM2 update program has been modified to accept output from SUPERTOG on either punched cards or magnetic tape.
9. STATUS - Abstract first distributed December 1970
IBM360 version submitted February 1970, replaced by version 2 January 1971, executed by NESC
10. REFERENCES - R. G. Wright, J. L. Lucius, N. M. Greene, and C. W. Craven, Jr., SUPERTOG A Program to Generate Fine Group Constants and Pn Scattering Matrices from ENDF/B, ORNL-TM-2679, September 1969, and Addendum, 1970.
11. MACHINE REQUIREMENTS - 65K memory, 6 scratch disks, and 1 tape
12. PROGRAMMING LANGUAGE USED - FORTRAN IV (ANSI FORTRAN)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - SUPERTOG is presently used in a two-level overlay structure consisting of seven separate links.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
R. Q. Wright, J. L. Lucius, N. M. Greene,
and C. W. Craven, Jr.
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (Version 1 - 1192 cards, Version 2 - 9863 cards)
Sample problems (Version 1 - 5 cards, Version 2 - 43 cards)
Libraries (Version 1 - 1038 cards, Version 2 - 2231 cards)
Reference report and Addendum
17. **CATEGORY** - B
KEYWORDS - averages, group constants, inelastic scattering, elastic scattering, Breit-Wigner formula, Porter-Thomas distribution, cross sections, GAM1 codes, GAM2 codes, ANISN codes, DOT codes, DTF4 codes, ETOG codes
18. **SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - COBRA41
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600,7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - COBRA41 performs steady-state and transient thermal-hydraulic analysis of rod bundle nuclear fuel elements and cores via the subchannel analysis method
4. METHOD OF SOLUTION - The conservation equations of flow and energy are solved for interconnected subchannel control volumes via conventional finite differencing techniques. The steady-state calculations are solved by implicit finite differencing whereas the transient calculations are performed by either an implicit or explicit finite difference scheme. Internal rod temperatures are calculated by an orthogonal collocation approximation to the heat conduction equation.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Using the COBRA41 code option to store variables on peripheral storage devices eliminates any practical limit as to maximum problem size. However, computer core requirements and code execution time is always a consideration when determining the complexity of the problem to be solved.
6. TYPICAL RUNNING TIME - On a CDC7600 running time is 0.004 seconds per cell-iteration using the implicit solution scheme and 0.00006 seconds per cell-iteration using the explicit scheme. The number of cells is determined as the number of subchannels times the number of axial nodes. The number of iterations required per time-step varies according to convergence criteria and complexity of physics, however, typical values are from 10 to 20 iterations for the implicit scheme and 10 to 50 iterations for the explicit scheme.
7. UNUSUAL FEATURES OF THE PROGRAM - Listed are the improved capabilities of COBRA41 over its predecessor COBRA3C.
 - (a) A new explicit solution scheme to calculate severe transients involving flow reversals, recirculations and expulsion and reentry flows with either a flow or pressure boundary condition specified.
 - (b) Improved storage allocation to reduce central memory requirements, improved running time.
 - (c) Improved fuel rod heat conduction model to calculate interior-rod temperatures with axial conduction and variable thermal conductivity included. Also, each rod may now consist of axially-varying materials.
 - (d) Addition of a set of correlations to calculate the properties of superheated steam and a set of heat transfer correlations covering the complete range of heat transfer from subcooled through boiling.
 - (e) Problem "Dump and Restart" capabilities which allow the solution to be saved for subsequent use either to continue calculations or to be used as an initial guess to a different problem which can result in significant time savings for similar problems.
 - (f) Auxiliary program to redimension COBRA according to user selected input defining problem size and code options desired, thus minimizing core storage requirements.
 - (g) Auxiliary program to generate COBRA input for hexagonal rod-bundle geometry. Input for card groups 4, 7, and 8 can be generated, thus greatly reducing the amount of input required.
 - (h) Line printer plotting capability to plot pressure drop, mass flux, enthalpy and/or crossflow versus axial position for all or a specified number of gaps and channels.
 - (i) A thermally-conducting wall model which can conduct heat between two channels on opposite sides of a wall.

8. **RELATED AND AUXILIARY PROGRAMS** - COBRA41 is an extended version of the COBRA3C computer program. The auxiliary program SPECSET redimensions COBRA41 according to user-specified problem size, and the auxiliary program GEOM calculates COBRA input for data groups 4, 7, and 8 for hexagonal rod bundles.
9. **STATUS** - Abstract first distributed December 1970.
UNIVAC1108 version of COBRA2 submitted December 1970, replaced by COBRA3 in June 1971, replaced by COBRA3C in April 1973, deleted August 1977.
IBM360 version of COBRA2 submitted February 1970, replaced by COBRA3 in September 1971, replaced by COBRA3C in April 1973, deleted August 1977.
CDC8600 version of COBRA3C submitted June 1973, replaced by CDC7600 version of COBRA41 in August 1977.
CDC7600 version of COBRA41 submitted June 1978, replaced by revised Edition B December 1977, replaced by revised Edition C April 1978, replaced by revised Edition D August 1978, sample problems executed by NESC July 1978 on a CDC7600.
10. **REFERENCES** - C. L. Wheeler, C. W. Stewart, R. J. Cane, D. S. Rowe, and A. M. Suley, COBRA-IV-1: An Interim Version of COBRA for Thermal-hydraulic Analysis of Rod Bundle Nuclear Fuel Elements and Cores, BNWL-1962, March 1976.
C. W. Stewart, C. L. Wheeler, R. J. Cane, C. A. McMonagle, J. M. Cuta, and D. S. Trent, COBRA-IV: The Model and the Method, BNWL-2214, July 1977.
C. W. Stewart, C. A. McMonagle, M. J. Thurgood, T. L. George, D. S. Trent, J. M. Cuta, and G. D. Seybold, Core Thermal Model: COBRA-IV Development and Applications, BNWL-2212, January 1977.
COBRA41 NESC No. 432 76000 Tape Contents Description, NESC Note 77-37, Revised August 1, 1978.
D. S. Rowe, COBRA-III-C: A Digital Computer Program for Steady-state and Transient Thermal-hydraulic Analysis of Rod Bundle Nuclear Fuel Elements, BNWL-1695, March 1973.
11. **MACHINE REQUIREMENTS** - 202,000 (total) words and 4 scratch units besides the standard input/output units.
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** -
C. L. Wheeler, C. W. Stewart, J. F. Cane,
D. S. Rowe, and A. M. Suley
Pacific Northwest Laboratories
Batelle
P. O. Box 999
Richland, Washington 99352
* Contact
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (COBRA41-6690 cards)
Sample problems (COBRA41-214 cards, SPECSET-261 cards, GEOM-8 cards)
Auxiliary routines (SPECSET-210 cards, GEOM-622 cards)
Control information (94 cards)
Reference reports, BNWL-1962, BNWL-2212, and BNWL-2214, and ACC Note
17. **CATEGORY** - H
KEYWORDS - blowdown, reactor cores, enthalpy, hydraulics, rod bundles, fluid flow, heat transfer, reactor safety, transients, LMFBR reactors, water reactors, COBRA codes, SPECSET codes, GEOM codes.
18. **SPONSOR** - ERDA Division of Reactor Development and Demonstration
NRC Division of Reactor Safety Research

1. NAME OR DESIGNATION OF PROGRAM - CONTEMPT-LT/026
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The initial conditions of the containment atmosphere are calculated from input values, and the initial temperature distributions through the containment structures are determined from the steady-state solution of the heat conduction equations. A time advancement proceeds as follows. The input water and energy rates are evaluated at the midpoint of a time interval and added to the containment system. Pressure suppression, spray system effects, and fan cooler effects are calculated using conditions at the beginning of a time-step. Leakage and heat losses or gains, extrapolated from the last time-step, are added to the containment system. Containment volume pressure and temperatures are estimated by solving the mass, volume, and energy balance equations. Using these results as boundary conditions, the heat conduction equations describing structure behavior are advanced using an implicit technique. The resulting heat transfer rates are used to correct the previous estimates of the water and energy storage in the containment volume, and the containment conditions are obtained by solving for the second time the containment balance equations. The pressure suppression routines use the conditions at the beginning of a time-step to calculate both the initial expulsion of water from the vents and the flow through the vents. From the calculated flow rates, mass and energy are removed from the dry well and added to the wet well.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 20 pipe elements in normal (unfitted) pressure suppression vent piping
 - 50 flow elements in one segment of the horizontal vent pressure suppression system
 - 10 horizontal vents (or branches) in a segmentCONTEMPT-LT can be used to model all standard boiling-water reactor (BWR) pressure suppression systems including Mark I, Mark II, and Mark III systems, to model pressurized-water reactor (PWR) dry containments, subatmospheric containments, and dual containments with an annular region, and can be used to describe containment responses in experimental systems.
6. TYPICAL RUNNING TIME - On the IBM360/75, approximately 0.021 second per time advancement is required with 90 mesh points for heat structures without pressure suppression. The pressure suppression timing is not easily predicted but two sample problems ranged from 0.3 to 2 seconds per time advancement.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - CONTEMPT-LT/026 is the most recent of a series of computer programs developed to describe the thermal-hydraulic conditions attendant to various postulated transients in the containment of light-water reactor systems. This edition replaces CONTEMPT (NESC Abstract 297), CONTEMPT-CONPS, CONTEMPT-PS, CONTEMPT-LT/022, and CONTEMPT-LT/025 (which contained known errors and was never distributed by the Center).

9. STATUS - Abstract first distributed December 1970
IBM360 version of CONTEMPT-CONPS submitted February 1970, replaced by CONTEMPT-PS April 1971, replaced by CONTEMPT-LT/020 August 1973, replaced by CONTEMPT-LT/022 December 1973, replaced by Edition B July 1974, replaced by CONTEMPT-LT/026 April 1976, revised to Edition B July 1977, sample problem executed by NESC September 1977 on an IBM370/195
10. REFERENCES - L L Wheal, R J Wagner, G F Niederauer, and C F Obenchain, CONTEMPT-LT - A Computer Program for Predicting Containment Pressure-Temperature Response to a Loss-of-Coolant Accident, ANCR-1219, June 1975
K D Richerl, BUFIO, A Subroutine to Permit FORTRAN Access to IOOP, Phillips Petroleum Note, February 1966
A J Smith, Standard Package Description, Calcomp Plotter Subroutines (S0010 0), Appendix D, January 1971
W H Reiling, R C Young, and N H Marshall, UPD - A Program to Update Source Decks, P01751, and Addendum
R J Wagner, STN20, A Subroutine Package to Compute the Thermodynamic Properties of Water, ANCR Note, 1975
NRTS Environmental Subroutine Manual, ANC Document, December 1972
W J Mings, Fan Cooler Containment Model in CONTEMPT-LT/025, SRD-25-76, November 1975
W J Mings, Correction to Uchida Model of CONTEMPT-LT/025 Program, SRD-43-76, December 1976
W J Mings, Version 26 Modifications to the CONTEMPT-LT Program, SRD-83-76, April 1976
11. MACHINE REQUIREMENTS - 430K bytes and a CalComp or SC4060 plotter for graphical output
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and BAL
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 MVT
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The thermodynamic properties of water and steam required by the program are generated by the STN20 program and made available as a library data set. For non-360 users a formatted water properties library and an auxiliary FORTRAN program (READER) to read this library have been provided
15. NAME AND ESTABLISHMENT OF AUTHORS -
L L Wheal and W J Mings
Idaho National Engineering Laboratory
EG&G Idaho, Inc
P O Box 1625
Idaho Falls, Idaho 83401
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (CONTEMPT 9954 cards, NRTS Environmental Subroutines 22,103 cards)
Sample problems (52 cards)
Control information (JCL 110 cards)
Reference reports, Subroutine Descriptions, and SRD Notes
For 360 use
Load modules (CONTEMPT for both 2314 and 3330 disks 476 blocks, ENVIR for both 2314 and 3330 disks 559 blocks)
For non-360 use
Water properties library (1813 cards)
Auxiliary program source deck (READER 35 cards)
17. CATEGORY - G
KEYWORDS - accidents, temperature distribution, pressure, containment, water, thermodynamics, heat transfer, CONTEMPT codes
18. SPONSOR - NRC Division of Systems Safety

1. NAME OR DESIGNATION OF PROGRAM - HEATMESH
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The structure to be studied, represented as a body of revolution, is divided into parts having common material properties and represented as bodies of revolution. Each part is then described as four surfaces of revolution subdivided into nodes which form a mesh. Data for each part are collected, i.e., volume, area, and part number of each node, and node surfaces on the part boundary and inside the part boundary. The distance between the center and the midpoint of each surface of the node is tabulated also.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
Number of subdivisions between 1 and 50 for sides 1 and 3
Number of subdivisions between 1 and 12 for sides 2 and 4
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM - The input data are constructed in the same manner as used in the APT program. Data generated by APT can be used in HEATMESH with only minor changes.
8. RELATED AND AUXILIARY PROGRAMS - The data generated by HEATMESH are used in the difference equations of the HEATFLOW program which solves transient heat transfer problems.
9. STATUS - Abstract first distributed December 1970
CDC6600 version submitted January 1970
10. REFERENCES - V. K. Gabrielson, HEATMESH, A Computer Code for Generating Geometrical Data Required for Studies of Heat Transfer in Axisymmetric Structures, SCL-DR-67-30, September 1967, and Errata, 1970.
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 - All subroutines called which are not included refer to Sandia (Livermore) plot programs and should be easily converted to other systems.
15. NAME AND ESTABLISHMENT OF AUTHOR -
V. K. Gabrielson
Numerical Applications
Division 8321
Sandia Laboratories
Livermore, California 94550
16. MATERIAL AVAILABLE -
Source deck (1036 cards)
Sample problem (36 cards)
Reference report and Errata
17. CATEGORY - N

KEYWORDS - heat transfer, geometry, mechanical structures, mesh generation, APT codes, HEATFLOW codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - BURST1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360/75
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Partial time derivatives for mass velocity, pressure, and enthalpy, obtained from the three conservation laws for mass, momentum, and energy, are approximated with difference equations.
6. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
50 total cylinders and adapters
2000 space-steps in the whole system
5000 time-steps
Only subcooled, frictionless, adiabatic cases can be considered
8. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The BLOT deck is used to plot data stored by BURST1
9. STATUS - Abstract first distributed December 1970
IBM360 version submitted February 1970, sample problem executed by NESC
10. REFERENCES - Ronald P. Rose, George H. Hanson, and Gerald A. Jayne, Hydrodynamics Describing Acoustic Phenomena during Reactor Coolant System Blowdown, IDO-17254, July 1967
Gerald A. Jayne, BURST 1 Program Description (P00410), December 1967
11. MACHINE REQUIREMENTS - 32K 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 -
15. NAME AND ESTABLISHMENT OF AUTHORS -
G. A. Jayne and G. H. Hanson
Idaho Nuclear Corporation
P. O. Box 1645
Idaho Falls, Idaho 83401
R. P. Rose
Westinghouse Astronuclear Laboratory
Westinghouse Electric Corporation
Box 10884
Pittsburgh, Pennsylvania 15236
16. MATERIAL AVAILABLE -
Source decks (BURST1 612 cards, BLOT 240 cards)
Sample problems (BURST1 33 cards, BLOT 29 cards)
Sample problem output (8 pages)
Reference report and Program Description
17. CATEGORY - G

KEYWORDS - cylinders, pressure, one-dimensional, enthalpy, blowdown, hydrodynamics, coolants, BLOT codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ETOM1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - ETOM1 processes basic nuclear information given in the ENDF/B format and produces data decks for use in generation of MUFT4 and MUFT5 libraries
4. METHOD OF SOLUTION - Basically, ETOM1 performs a straightforward group averaging of the various cross sections using the input weight and the microscopic data from the ENDF/B data files. The Breit-Wigner single-level formula is assumed to yield resonance cross sections with reasonable accuracy
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
99 multigroups
250 resolved resonances
6. TYPICAL RUNNING TIME - Execution times for a standard 54-group MUFT problem using ENDF/B data which contain explicit resonance parameters vary from 1 to 2 minutes. When the ENDF/B data for the isotope does not contain explicit resonance parameters, execution times vary from 0.5 to 1 minute
7. UNUSUAL FEATURES OF THE PROGRAM - The general purpose retrieval subroutines enable two tabular functions to be accurately combined (to within some input epsilon) and they also provide for exact (according to the specified interpolation schemes) integration of the functions. Any desired weighting scheme may be used. ETOM1 will accept ENDF/B data from a binary tape or from a BCD card-image tape or just from BCD cards. All data is assumed to be in the standard ENDF/B arrangement. Many of the subroutines used by the program may be useful in other codes connected with the ENDF/B system
8. RELATED AND AUXILIARY PROGRAMS - Storage and retrieval of the ENDF/B microscopic data and combination of two or more tabular arrays into one tabular array with one interpolation scheme is accomplished in large part by the general purpose retrieval subroutines (NESC Abstract 384)
9. STATUS - Abstract first distributed December 1970
CDC6600 version submitted February 1970
10. REFERENCES - R. A. Dannels and D. E. Kusner, ETOM-1 - A FORTRAN Program to Process Data from the ENDF/B File to the MUFT Format, WCAP-3688-1, May 1968
H. C. Honeck, ENDF/B - Specifications for an Evaluated Nuclear Data File for Reactor Applications, BNL-50066, May 1966, Revised July 1967
H. Bohl, Jr., E. M. Gelbard, and G. H. Ryan, MUFT-4 Fast Neutron Spectrum Code for the IBM-704, WAPD-TM-72, 1967
H. Bohl, Jr. and A. P. Hemphill, MUFT-5, A Fast Neutron Spectrum Program for the Philco-2000, WAPD-TM-218, February 1961
J. Faerberbaum, Ed., Description of the ENDF/B Processing Codes CHECKER, CRECT, DAMMET, and Retrieval Subroutines, BNL-13582 (ENDF-110), September 1967, Revised April 1969
11. MACHINE REQUIREMENTS - 43,000 (decimal) locations with 2 tapes (scratch tape and library tape)
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.1
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - ETOM1 is segmented into 6 basic overlays

15. NAME AND ESTABLISHMENT OF AUTHORS -

R. A. Dannels and D. E. Kusner
Nuclear Energy Systems
Westinghouse Electric Corporation
Box 355
Pittsburgh, Pennsylvania 15230

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (7094 cards)
Sample problem (5 cards)
Reference report, WCAP-3688-1

17. CATEGORY - B

KEYWORDS - cross sections, Breit-Wigner formula, group constants, libraries, averages, MUFT codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ETOG1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - ETOG1 performs a straightforward group average of cross sections using an input weighting function and the microscopic data from the ENDF/B files. The Breit-Wigner single-level formula is assumed to yield resolved resonance cross sections with reasonable accuracy. Treatment of unresolved cross sections is similar to that of MC+2 (NESC Abstract 355)
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 99 multigroups
 250 resolved resonances

6. TYPICAL RUNNING TIME -

	ENDF data has resonance parameters	ENDF data has no resonance parameters
MUFT, 54 group	1 minute	0.5 minute
GAM1, 68 group	7 minutes	4 minutes
GAM2, 99 group	15 minutes	8 minutes
ANISN, 99 group	15 minutes	8 minutes

7. UNUSUAL FEATURES OF THE PROGRAM - In the establishment of transfer matrices, analytical results are employed where possible in the normalization of output data. For example, in the generation of the elastic scattering matrix in the energy range in which the scatter is isotropic in the center-of-mass system, results of the numerical integration performed are normalized to values derived analytically.
8. RELATED AND AUXILIARY PROGRAMS - ETOG1 supersedes ETOM1 (NESC Abstract 436) in that (a) more accurate data decks are produced for use in creating MUFT libraries, and (b) additional data decks may be generated for use in creating GAM and ANISN libraries. In the program use is made of the general purpose processor and retrieval subroutines written at Brookhaven for handling ENDF/B data files (NESC Abstract 384)
9. STATUS - Abstract first distributed December 1970
 CDC6600 version submitted January 1970, replaced by later version May 1970
10. REFERENCES - D. E. Kusner 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, and Errata
 H. G. Honeck, ENDF/B Specifications for an Evaluated Nuclear Data File for Reactor Applications, BNL-50066, May 1966, Revised July 1967
 H. Bohl, Jr., E. M. Gelbard, and G. H. Ryan, MUFT-4, Fast Neutron Spectrum Code for the IBM-704, WAPD-TM-72, 1957
 G. D. Joannou and L. S. Dudek, GAM-1, A Consistent P1 Multigroup Code for the Calculation of Fast Neutron Spectra and Multigroup Constants, GA-1850, May 1961
 G. D. Joannou and L. S. Dudek, GAM-11, A B3 Code for Calculation of Slowing Down Spectrum and Associated Multigroup Constants, GA-4265, 1963
 W. W. Engle, Jr., A User's Manual for ANISN, A One-dimensional Discrete Ordinates Code with Anisotropic Scattering, K-1683, March 30, 1967
 D. M. O'Shea, B. J. Toppel and A. L. Rago, MC+2 - A Code to Calculate Multigroup Cross Sections, ANL-7318, June 1967
 J. Felberbaum, (Ed.), Description of the ENDF/B Processing Codes CHECKER, CRECT, DAMMET, and Retrieval Subroutines, BNL-13582 (ENDF-110), September 1967, Revised April 1968

11. MACHINE REQUIREMENTS - 55,000 decimal locations and 4 scratch tapes in addition to the library tape and standard input, output, and punch units
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3 1
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The program consists of 5 overlays
15. NAME AND ESTABLISHMENT OF AUTHORS -
O E Kusner, R A Dannels, and S Kellman
Nuclear Energy Systems
Westinghouse Electric Corporation
Box 355
Pittsburgh, Pennsylvania 15230
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (12,329 cards)
Sample problem (3 cards)
Library (1044 cards)
Reference report, WCAP-3845-1, and Errata
17. CATEGORY - 8
KEYWORDS - cross sections, Breit-Wigner formula, group constants, averages, libraries, ETOM codes, GAM codes, ANISN codes, MUFT codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - BUG2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 regionwide depletion scheme is used. Concentration dependent self-shielding factors may be applied to any nuclide.
4. METHOD OF SOLUTION - Over an arbitrary uniform mesh grid, the system of difference equations for the steady-state solution is solved by an extension of the power method. A form of successive line overrelaxation is used in each group. Coarse mesh rebalancing is used to improve preasymptotic convergence behavior and an exponential extrapolation method is used to improve asymptotic behavior. For depletion, the code decides internally (for each time-step and every nuclide) whether to use either a difference approximation or an analytical solution. A full triangular depletion matrix is allowed.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 10 groups
 - 20,000 space mesh points
 - 255 regions
 - 300 subregions
 - 40 total nuclides
 - 25 heavy nuclides
 - 25 fission products and other burnable nuclides
6. TYPICAL RUNNING TIME - An x-y problem with 4 groups and 7400 mesh points requires 65 minutes to do 8 time-steps. An x-y problem with 9 groups and 7400 mesh points requires 155 minutes for 8 time-steps.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - GAMBLE5 (NESC Abstract 222) is used for the steady-state solutions.
9. STATUS - Abstract first distributed December 1970
UNIVAC1108 version submitted March 1970
10. REFERENCE - J. P. Dorsey, R. Froehlich, and F. Todt, BUG-2/BUGTRI, Two Dimensional Multigroup Burnup Codes for Rectangular and Hexagonal Geometry, GA-8272, August 22, 1969.
11. MACHINE REQUIREMENTS - 65,536 words of core storage, 2 million words of drum storage on one data channel, 3 tape units, and a peripheral printer.
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and Assembly language
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2, GAX23
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
 - J. P. Dorsey, R. Froehlich, and F. Todt
 - General Atomic Company
 - P. O. Box 81608
 - San Diego, California 92138
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (21,874 cards)

Sample problem (155 cards)
Reference report

17. CATEGORY - D

KEYWORDS - two-dimensional, multigroup, diffusion, depletion, x-y, r-z, neutron flux, power distribution, GAMBLE5 codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - BUGTRI
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Over a uniform, triangular-mesh grid, the system of difference equations for the steady-state solution is solved by an extension of the power method. A form of successive line overrelaxation is used in each group. Coarse mesh rebalancing is used to improve preasymptotic convergence behavior and an exponential extrapolation method is used to improve asymptotic convergence behavior. For depletion, the code decides internally (for each time-step and every nuclide) whether to use either a difference approximation or an analytic solution. A full triangular depletion matrix is allowed.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 10 groups
 - 20,000 space mesh points
 - 256 regions
 - 300 subregions
 - 40 total nuclides
 - 25 heavy nuclides
 - 25 fission products and other burnable nuclides
6. TYPICAL RUNNING TIME - Eight time-steps for an x-y problem of 7400 mesh-points could take 65 minutes for 4 groups and 155 minutes for 9 groups.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - GAMTRI (NESC Abstract 401) is used for the steady-state solutions.
9. STATUS - Abstract first distributed December 1970
UNIVAC1108 version submitted March 1970
10. REFERENCE - J. P. Dorsey, R. Froehlich, and F. Todt, BUG-2/BUGTRI, Two Dimensional Multigroup Burnup Codes for Rectangular and Hexagonal Geometry, GA-8272, August 22, 1969.
11. MACHINE REQUIREMENTS - 65,536 words of core storage, 2 million words of drum storage on one data channel, 3 tape units, and a peripheral printer.
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and Assembly language
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2, GAX23
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
 - J. P. Dorsey, R. Froehlich, and F. Todt
 - General Atomic Company
 - P. O. Box 81600
 - San Diego, California 92138
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (22,477 cards)

Sample problem (183 cards)
Reference report

17. CATEGORY - D

KEYWORDS - two-dimensional, multigroup, diffusion, triangular configuration, hexagonal configuration, neutron flux, power distribution, depletion, GAMTRI codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - DYNAM
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Linearized partial differential conservation equations are solved using Laplace transformation of the temporal terms and integration of the spatial variations. DYNAM is written in complex variable notation.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 30 intervals used to describe the power distribution in the nonboiling and boiling regions
 - 29 boiling nodes
 - 7 intervals and corresponding friction multipliers read in per case
 - 14 exit qualities read in per case
 - 40 superheat nodes
 - 10 coefficients read in for the ϕ_{1-2} vs. x -polynomial fit
 - 48 frequencies at which open-loop frequency response is desired
 - 48 frequencies at which signal output is desired
6. TYPICAL RUNNING TIME - A typical problem requires 5 seconds.
7. UNUSUAL FEATURES OF THE PROGRAM - No numerical instabilities are present.
8. RELATED AND AUXILIARY PROGRAMS - STABLE
9. STATUS - Abstract first distributed December 1970
UNIVAC1108 version submitted March 1970
10. REFERENCES - L. E. Efferding, DYNAM, A Digital Computer Program for Study of the Dynamic Stability of Once-Through Boiling Flow with Steam Superheat, GAMO-8656, June 26, 1968
L. E. Efferding, Static and Dynamic Stability of Steam-Water Systems - Part I, Critical Review of the Literature, GA-5555, October 1964
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The test case results will differ from those in the document GAMO-8656 due to modification of the pressure-drop equations.
15. NAME AND ESTABLISHMENT OF AUTHORS -

Abstract	G. Schluster
Program	L. E. Efferding General Atomic Company P. O. Box 81608 San Diego, California 92130
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
 - Source deck (3099 cards)
 - Sample problem (33 cards)
 - Reference report, GAMO-8656

17. CATEGORY - H

KEYWORDS - pressure, variations, steam generators, hydrodynamics, transfer functions, fluid flow, STABLE codes

18. SPONSOR - ,

1. NAME OR DESIGNATION OF PROGRAM - PWCOST
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Costs are calculated using a present-worth levelized approach.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
24 core regions
100 segments
2 fuel particle types
100 reloads before equilibrium is established
100 times for core reload
6. TYPICAL RUNNING TIME - 20 seconds are required.
7. UNUSUAL FEATURES OF THE PROGRAM - PWCOST can be used for evaluating costs of a single fuel segment or for an entire reactor history. There are several accounting procedures available as options including the treatment of pre-irradiation working capital as an add-on to the front-end services cost. The code also calculates the cost of a lease cycle and can evaluate a spent fuel buyback option.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1970.
UNIVAC1108 version submitted March 1970.
10. REFERENCE - D. H. Lee, Jr., PWCOST, A General Purpose Computer Code for the Calculation of Fuel Cycle Costs. GA-9394, June 10, 1968.
11. MACHINE REQUIREMENTS - 65K core and 1 tape
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
D. H. Lee
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (3010 cards)
Sample problem (736 cards)
Reference report
17. CATEGORY - D
KEYWORDS - fuel cycle, economics, nuclear power plants, cost, present worth method, GARGOYLE codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SIMPLE1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Operations available include all standard arithmetic operations, exponentiation, square root, and special functions.
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 1970
CDC6600 version submitted March 1970
10. REFERENCE - Myles F. Barrett, SIMPLE 1, An Algebraic Programming Language for Interactive Time-shared Use, KAPL-M-7109, January 9, 1970
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and ASCENT
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The present implementation of SIMPLE1 is for the CDC *INTERCOM* time-sharing system. The TYPEIT subroutine is used in *INTERCOM* to link the teletype for interactive I/O. The program is self-contained with the possible exception of the free-format data reader. Any available free-format reader capable of converting numerical input to floating-point form could be substituted.
15. NAME AND ESTABLISHMENT OF AUTHOR -
M. F. Barrett
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (681 cards)
Reference report
17. CATEGORY - P
KEYWORDS - programming languages, numerical solution, interactive computing
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - HAA3B
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM370
3. DESCRIPTION OF PROBLEM OR FUNCTION - HAA3B was written to provide an engineering method for calculating heterogeneous aerosol behavior and transport following various hypothetical LMFER 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.
4. METHOD OF SOLUTION - HAA3B employs a time-dependent lognormal distribution when agglomeration is prevalent, then switches to a stirred-settling model. The time-dependent parameters which characterize the lognormal size-distribution function are obtained by numerical integration of three simultaneous differential equations for the zeroth through the second volume moments. The volume moments differential equations were obtained by analytic integration of the appropriate moments of the integro-differential equation. Additional differential equations for the plated, settled, and leaked functions are included in the simultaneous set. A mix of Adams-Moulton, Runge-Kutta, and Gaussian procedures are used to solve the system of simultaneous, first-order differential equations.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 1000 time-steps in lognormal model part
 - 42 discrete radii for leakage distribution calculations
 - 50 leak-rate input values
 - 50 source-rate input valuesApplicability has been verified for moderate concentrations in moderate-sized vessels, and for limited types of sources, only.
6. TYPICAL RUNNING TIME - Approximately 15 seconds are required for execution on a Model 168.
7. UNUSUAL FEATURES OF THE PROGRAM - The program computes plated, settled, suspended, and leaked masses, distribution parameters, and effective radii. It prepares input cards, which describe leaked mass, for use in evaluating aerosol behavior in a second compartment, has a Kiyachio correction calculation, and includes input parameters to characterize effective density and collision efficiency.
8. RELATED AND AUXILIARY PROGRAMS - Leak rates may be obtained from the AI SOFIRE code. Fallout rate data may be used in COMRADEX3 (NESC Abstract 683).
9. STATUS - Abstract first distributed December 1970.
 - IBM360 version of HAA3 submitted February 1970, replaced in April 1977 by IBM370
 - version of HAA3B submitted January 1976, sample problem executed by NESC March 1977 on an IBM370/165
10. REFERENCES - R. S. Hubner, E. U. Vaughn and L. Baumash, HAA-3B User Report, AI-AEC-13038, March 1973.
 - J. M. Otter, Understanding the HAA-3B Input Parameters Used to Characterize the Aerosol Particle Size Distribution, N707-TI-130-041, August 1975
11. MACHINE REQUIREMENTS - A logical unit 5 for input, unit 6 for output, unit 16 for a scratch unit, and a card punch. SC-4020 CRT coding is included as comment cards. Storage allocation is less than 150K bytes.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV (H)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/370 Release 21.6
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHORS -

J. Otter, E. U. Vaughan, L. Baumash, R. Koontz
 Atomic International Division
 Rockwell International
 8900 De Soto Avenue
 Canoga Park, California 91304

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (2119 cards)
 Sample problem (18 cards)
 Reference reports

17. CATEGORY - G

KEYWORDS - aerosols, leaks, particle size, agglomeration, HAA3 codes, SOFIRE codes, COMRADEX codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ROPE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - ROPE is used to calculate roots of polynomials
4. METHOD OF SOLUTION - Three separate methods are employed in finding the roots, the choice of methods being a user option. These methods are Bairstow's method, Lehmer's method, and d'Alembert's method
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - ROPE can find roots of polynomials of order up to 99
6. TYPICAL RUNNING TIME - A rough estimate of running time is 0.001n hours, where n is the order of the polynomial
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1970
CDC6600 version submitted March 1970
10. REFERENCES - J. R. Schmid, R. W. Guillelle, and G. O. Mueller, ROPE, Roots of a Polynomial Evaluation, KAPL-M-6540, April 1, 1966
D. H. Lehmer, A Machine Method for Solving Polynomial Equations, Journal of the Association for Computing Machinery, Vol. 8, No. 2, April 1961
R. F. Jordan and H. W. Moore, POLRTS - Bairstow's Method for Finding Roots in FORTRAN, G. E. Report 64TIP4, February 1964
Zora C. Moller, A Simple Method for Finding the Zeros of Polynomials, Based on d'Alembert's Lemma, LA-3255
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
Nancy R. Mitchell
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General Electric Company
Box 1072
Schenectady, New York 12301
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (705 cards)
Sample problem (5 cards)
Reference report, KAPL-M-6540
17. CATEGORY - P
KEYWORDS - polynomials, equations, solutions
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - LIZARD4
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 dependant 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.
4. METHOD OF SOLUTION - The integration procedure used is a modified Adams-Moulton method commonly referred to as the AMSINT subroutine.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maximum of -
25 nonlinear first-order differential equations
6. TYPICAL RUNNING TIME - Running time is about 150 milliseconds per equation per time interval.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - LIZARD
9. STATUS - Abstract first distributed December 1970
CDC6600 version submitted March 1970
10. REFERENCES - Robert W. Guillelte, Gerhard O. Mueller, and Joseph R. Schmid, LIZARD-IV, A Program to Solve Non-linear, Ordinary Differential Equations, KAPL-M-6548, March 17, 1966
David L. Briggs and Joseph R. Schmid, LIZARD, A Program to Solve Non-linear, Ordinary Differential Equations, KAPL-M-EC-36, October 22, 1963
R. J. Guilan, 6600 CalComp Plotter Routines, KAPL Note, July 25, 1966
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and ASCENT
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
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 (2614 cards)
Sample problem (39 cards)
Reference report, KAPL-M-6548, and Note
17. CATEGORY - P
KEYWORDS - nonlinear problems, differential equations, solutions, initial-value problems, LIZARD codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - MOST
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - A gradient search algorithm is used
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The maximum dimension of the search is 20
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1970
CDC6600 version submitted March 1970
10. REFERENCE - C R Lubitz and G A Shanholt, MOST - A Multidimensional Optimization Scheme, KAPL-M-6174, July 1964
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
C R Lubitz and G A Shanholt
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (437 cards)
Sample problem (6 cards)
Reference report
17. CATEGORY - P
KEYWORDS - optimization, iterative methods, coordinates
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ETOG1 Data for MUFT and GAM Libraries
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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)
4. METHOD OF SOLUTION - The original ENDF/B data tapes 114, 115, and 116 received from the Brookhaven Center were altered. The CRECT program (NESC Abstract 384) was used to make corrections to μ_0 , the average cosine of the scattering angle, χ_1 , the logarithmic energy decrement, and gamma. The anisotropic Grueling-Coerizel parameter Points were inserted into elastic scattering angular distribution tables so that anisotropy did not extend down to thermal energies, and the secondary distribution data for material numbers 1018 and 1021 were changed. The materials for which library data were generated are -

1001 H	1019 Mn55	1037 Au197	1058 Am241
1003 O	1020 Fe	1042 U233FP	1057 Am243
1005 Li6	1021 Ni	1043 U234	1058 Cm244
1006 Li7	1024 Nb	1044 U235	1059 Na23
1007 Be9	1025 Mo	1045 U235FP	1060 W182
1009 Bi10	1026 Xe135	1046 U236	1061 W183
1010 C12	1027 Sm149	1047 U238	1062 W184
1012 N14	1028 Eu151	1048 Np237	1063 W186
1013 C16	1029 Pu153	1050 Pu238	1066 U233SFP
1014 Mg	1030 Gd	1051 Pu239	1067 U233NFP
1015 Al27	1031 Dy164	1052 Pu239FP	1068 U235SFP
1016 Ti	1032 Lu175	1053 Pu240	1069 U235NFP
1017 V51	1033 Lu176	1054 Pu241	1070 Pu239SFP
1018 Cr	1035 Ta181	1055 Pu242	1071 Pu239NFP
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -

Library	No. of groups
GAM1	88
GAM2	88
MUFT4,5	54

A 1/E weighting function joined to the fission spectrum was used. A $1.0 \cdot 10^{-7}$ value was used as the non-resonance potential scattering cross section per absorber atom. For MUFT libraries the 26th group was the lowest group number in the resonance region, the 25th group was the highest in the inelastic region.
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The CRECT code was used to make the necessary alterations to the ENDF/B tapes. The data decks were created for the MUFT4, MUFT5, GAM1, and GAM2 programs.
9. STATUS - Abstract first distributed December 1970
CDC6600 version submitted February 1970
10. REFERENCE - S. Kellman and D. E. Kusner, Description of the Generation of Data Decks by ETOG-1 for Use in Creating MUFT and GAM Libraries, WCAP-3845-2 (ENDF-133), January 1970
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 -

S. Kellman and D. E. Kusner
 PWR Systems Division
 Westinghouse Electric Corporation
 Box 355
 Pittsburgh, Pennsylvania 15230

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal (5 tapes)

MUFT4 (1 tape-7,414 cards)
 MUFT5 (1 tape-10,438 cards)
 GAM1 (1 tape-15,393 cards)
 GAM2 (2 tapes TAPE1-16,938 cards, TAPE2-20,034 cards)
 Reference report
 • variable number of 80-character records per file

17. CATEGORY - Z

KEYWORDS - cross sections, libraries, MUFT4 codes, MUFT5 codes, GAM1 codes, GAM2 codes, ETOG codes, CRECT codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FLASH6/FLASH4
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370, CDC6600,7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The FLASH6 program uses an implicit numerical integration technique to solve the conservation equations of mass and energy for the control volumes and conservation of momentum for the flow paths. Thermodynamic equilibrium is assumed. Pressure in the control volumes is obtained from the equation of state for water. In addition, heat may be added to control volumes by the reactor core model, steam generator models, and plant metal heat capacity models. Fluid properties are generated from stored data.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - In FLASH6 up to 30 pressure-determining nodes and 60 flow paths are available to represent the reactor plant. A maximum of 80 pressure-determining nodes may be used to describe the reactor core detail, with axial sectioning of up to 20 parallel core channels.
In FLASH4 up to 20 pressure-determining nodes and 40 flow paths are available to represent the reactor plant. The plant and core geometry are assumed fixed in time, hence the solution is not applicable after significant dimensional change.
6. TYPICAL RUNNING TIME - FLASH4 running time varies between 0.001 and 100 times real time, depending on the type of the problem.
7. UNUSUAL FEATURES OF THE PROGRAM - FLASH4 can be applied to any water-cooled reactor geometry or plant configuration. It includes acoustic effects for both subcooled and saturated blowdowns. The numerical techniques of FLASH4 result in shorter running time for the long-term solutions of slowly varying transients, e.g. small leaks.
8. RELATED AND AUXILIARY PROGRAMS - Earlier FLASH editions were FLASH and FLASH2 (NESC Abstract 295). FLASH4 uses the environmental routines which were converted for the IBM360 version of PDQ7 (NESC Abstract 275). FLASH6 is an updated version of FLASH5, which was an outgrowth of FLASH4. FLASH6 uses the environmental routines from the Bellis Environmental Library (NESC Abstract 665).
9. STATUS - Abstract first distributed December 1970.
CDC6600 version of FLASH4 submitted January 1970, replaced by CDC7600 version of FLASH6 October 1976.
IBM360 version of FLASH4 submitted August 1974, sample problem executed by NESC October 1974 on an IBM370/195.
10. REFERENCES - J. J. Beyer, W. D. Peterson, D. A. Pralawicz, and G. W. Swartale, FLASH-6: A FORTRAN-IV Computer Program for Reactor Plant Loss-of-Coolant Accident Analysis, WAPD-TM-1249, July 1976.
J. H. Murphy, J. A. Redfield, and V. C. Davis, FLASH-5: A FORTRAN-IV Program for Transient Simulation of a Reactor Plant with a Detailed Core, WAPD-TM-999, May 1973.
T. A. Porsching, J. H. Murphy, J. A. Redfield, and V. C. Davis, FLASH4, A Fully-implicit FORTRAN-IV Program for the Digital Simulation of Transients in a Reactor Plant, WAPD-TM-840, March 1969.

J A Redfield, J H Murphy, V C Davis, FLASH-2, A FORTRAN IV Program for the Digital Simulation of a Multinode Reactor Plant During Loss-of-Coolant, WAPD-TM-666, April 1967

S G Margolis and J A Redfield, FLASH, A Program for Digital Simulation of the Loss-of-Coolant Accident, WAPD-TM-534, May 1966

C J Pleifer, 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

G W Swartels, FLASH6 Compliance with American Standard Fortran, BAPL Note, October 1976

IBM360/370 FLASH4 Reactor Transients Simulation Program Listing, MDC N2267-094, Volumes 1 and 2, July 1974

11. MACHINE REQUIREMENTS - 250K bytes (IBM360), 144K central memory and 200K ECS or LCM memory (CDC6600 or 7600)
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360,370 (IBM360,370), SCOPE 3 3 (CDC6600), SCOPE 1 1 (CDC7600)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - All the FLASH4 subroutines were converted to the IBM360 except the plotting routines. However, all references to the plotting were left intact so that anyone wishing to add this feature will find it less difficult. The majority of the FLASH6 program conforms to ANSI FORTRAN (1966). Exceptions are PRINT and PUNCH statements, DATA statements with implied DO loops, and ENCODE statements. The viscosity routine VISL contains an ENTRY statement. The environmental routine NEXT called to load overlays may have a different number of arguments on each call. The environmental function JPARAM is called with a Hollerith argument.
15. NAME AND ESTABLISHMENT OF AUTHORS -
7600 FLASH6 J J Beyer, W D Peterson, D A Prelewicz,
and G W Swartels
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122

360 FLASH4 C K Herkstroeter and K Geib
McDonnell Douglas Automation Company
Box 516
St Louis, Missouri 63166
Gilbert Associates, Inc
P O Box 1498
525 Lancaster Avenue
Reading, Pennsylvania 19803
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source decks (FLASH6 7600-29,910 cards, FLASH4 360-15,907 cards)
Sample problems (FLASH6 7600-217 cards, FLASH4 360-23 cards)
Sample problem output (FLASH6 37 selected pages, 1 microfiche)
Control information (FLASH4 JCL 360-78 cards)
2914 load module FLASH (FLASH4 360-320 blocks)
Reference reports FLASH6 WAPD-TM-1249 and BAPL Note FLASH4 WAPD-TM-840, WAPD-TM-666, MDC N2267-094
17. CATEGORY - G
KEYWORDS - reactors, transients, accidents, containment, fuels, fluid flow, pressure, coolants, blowdown, reactor safety, FLASH codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - CYGRO3
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600, IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The fuel and clad are divided into a number of concentric rings. Equations for balance of forces and displacements between the rings are used to establish equilibrium. Plastic flow (creep) is treated on an incremental basis. The required sizes of time-steps are calculated internally on the basis of allowed stress and strain increments.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maximum of - 30 rings (fuel plus clad)
6. TYPICAL RUNNING TIME - Each basic time-step takes about 0.01 second per fuel ring (i.e. 0.1 second for 10 rings). The number of time-steps per history input-step varies between 50 and 500.
7. UNUSUAL FEATURES OF THE PROGRAM - Bending moments to hold the fuel rod straight when situated in a power gradient are calculated by a perturbation analysis. Corresponding deflections if allowed to go free are also determined. Axial forces produced by supports can be factored into the calculations. The effect of a central heat producing plug inside the fuel can be calculated. Clad collapse pressures can be specified as a function of time.
8. RELATED AND AUXILIARY PROGRAMS - CYGRO1 and CYGRO2. CYGRO3 uses the Bellis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed December 1970.
CDC6600 version submitted July 1970, replaced by corrected version August 1971.
IBM360,370 preliminary version submitted February 1973, replaced by Edition B March 1975, sample problems executed by NESC April 1975 on IBM370/195.
10. REFERENCES - E. Duncombe and C. M. Friedrich, CYGRO-3 - A Computer Program to Determine Temperatures, Stresses and Deformations in Oxide Fuel Rods (LWR Development Program), WAPD-TM-961, March 1970.
C. J. Pfeifer, CDC-6600 FORTRAN Programming - Bellis Environmental Report, WAPD-TM-668, January 1967.
ACC Programming Note 73-4, August 28, 1972.
Input Description for CYGRO-3 (TVA-Aerojet IBM 360/370 Version), ACC Note 75-36, April 28, 1975.
11. MACHINE REQUIREMENTS - 140,000 (total) words
12. PROGRAMMING LANGUAGES USED - FORTRAN IV (CDC6600), FORTRAN IV and Assembly language (IBM360)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE (CDC6600), OS/360,370 (IBM360,370)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - CYGRO3 calls a subroutine TICK which is not included with the program nor with the Bellis Environmental Routines. Therefore, the user will have to provide his own subroutine TICK. CALL TICK(HRS) is used to obtain elapsed time for the current job. It sets HRS (REAL) to the elapsed charge time in hours.

15. NAME AND ESTABLISHMENT OF AUTHORS -

8600 E. Duncombe and C. M. Friedrich
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 Westinghouse Electric Corporation
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360,370 R. N. Hagen
 EG&G Idaho, Inc.
 P. O. Box 1625
 Idaho Falls, Idaho 83401
 D. C. Bell and T. R. Walker
 Tennessee Valley Authority
 523 Power Building
 Chattanooga, Tennessee 37401

16. MATERIAL AVAILABLE - Restricted Distribution

Magnetic Tape Transmittal
 Source decks (8600-5208 cards, 360-6000 FORTRAN cards and 2299 BAL cards)
 Load module (2314 297 blocks)
 Sample problems (8600-95 cards, 360-483 cards)
 Sample problem output (8600-15 pages, 360-81 selected pages)
 Reference reports and Notes

17. CATEGORY - I

KEYWORDS - stresses, fuel elements, deformation, bubble growth, temperature, pressure, CYGRO codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - KENO2/KENO4
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360, CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 (GECM) 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 k_{eff} 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.
4. METHOD OF SOLUTION - The scattering treatment used in KENO assumes that the differential neutron scattering cross section can be represented by a P1 Legendre polynomial. Absorption of neutrons in KENO is not allowed. Instead, at each collision point of a neutron tracking history the weight of the neutron is reduced by the absorption probability. When the neutron weight has been reduced below a specified point for the region in which the collision occurs, Russian roulette is played to determine if the neutron's history is to be terminated at that point or if the neutron is to survive with an increased weight. Spilling of high-weight neutrons is allowed in order to minimize the variance in k_{eff} for systems with regions of widely varying average weights.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - KENO4 is flexibly dimensioned so that the allowed size of a problem is limited only by the total data storage available. A method for determining the size of a problem is included in reference 9.
6. TYPICAL RUNNING TIME - Typical KENO2 problems run between 2 and 30 minutes on the CDC6600, depending on the number of histories requested, the statistical weighting used, and the presence or absence of reflectors. Running time for the IBM360 version of KENO2 depends on the problem and number of histories. For unmoderated metal arrays approximately 3 minutes are required on an IBM360/65. For a moderated system, approximately 15 to 30 minutes give adequate statistics.
KENO4 running times are highly problem-dependent. A bare 2x2x2 array of highly-enriched cylindrical units was executed on an IBM360/195. A total of 22,500 neutron histories were run in 0.281 minutes for a deviation of 0.52% in k -effective. The corresponding 360/91 time is 0.5 minutes. The same problem was run with a 6-inch paraffin reflector, tracking 18,600 histories for a deviation of 0.69% in k -effective in 2.249 minutes of 360/195 time. The time required to execute a problem depends on the complexity of the geometry, the number of energy groups, and the type of materials in the problem.
7. UNUSUAL FEATURES OF THE PROGRAM - KENO2 (CDC6600) input is extensively checked for consistency and completeness. For the IBM360 version of KENO2 a simplified geometry description is permitted when no surfaces intersect.
KENO4 has a simple geometry input, easily describes arrays of units, allows the description of several units of different size and shape in the same problem, and uses multigroup cross sections. A restart capability is available, enabling the user to run a long problem in several short passes. A search option is available for altering the unit size or the spacing between units in order to achieve a predetermined value of k_{eff} .
8. RELATED AND AUXILIARY PROGRAMS - Related codes include ANJEN, DOT, GECM, and O5R. The 6600 version includes an auxiliary program, named K2TAPE, to read the cross section library data and create a binary file to be read by KENO2.
KENO4, an extension and improvement of KENO, is a module of AMPX at ORNL. KENO4 can read cross sections from an AMPX working format interface library. HANDY is a program to

aid in preparing OSR (generalized geometry) input for KENO4. GEOMCHK reads and checks the geometry input for KENO4. PICTURE aids in preparing correct input data for the general geometry routine GEOM

9. STATUS - Abstract first distributed January 1972
 IBM360 version of KENO submitted May 1970, replaced by second version September 1971, replaced by KENO4 December 1975. sample problems executed by NESC July 1976 on an IBM360/195, card-image libraries and conversion routines added May 1977
 CDC6600 version of KENO2 submitted July 1973, library and auxiliary program added August 1974
 IBM360 version of KENO2 submitted August 1973, revised April 1974, sample problem executed by NESC
10. REFERENCES - G E Whitesides and N F Cross, KENO - A Multigroup Monte Carlo Criticality Program, CTC-5, September 10, 1969
 KENO Data Guide, CTC-5 Errata pp 21-32, September 1971
 Deanne Dickinson, Rocky Flats KENO II Manual, April 1973
 ACC 450 KENO2 CDC6600 Programming Notes, July 1973
 KENO2, ACC No 450 360B, Argonne Code Center Programming Note 74-26, March 6, 1974
 H K Clark, KENO-II Memorandum, DPST-70-449 (revised), August 1, 1973
 KENO2, 450 6500, Tape Description, Argonne Code Center Programming Note 75-21, January 1975
 L M Petrie and N F Cross, KENO IV - An Improved Monte Carlo Criticality Program, ORNL-4938, November 1975
 References for KENO IV Support Codes, ORNL Note, 1975
 G E Whitesides, Adjoint Biasing in Monte Carlo Criticality Calculations, Transactions of the American Nuclear Society, Vol 2, No 1, June 1968
 J R Knight and L M Petrie, 16 and 123 Group Weighting Functions for KENO, ORNL-TM-4660, November 1975
 N M Greene, J L Lucius, W E Ford, III, J E White, R O Wright, and L M Petrie, AMPX - A Modular Code System for Generating Coupled Multigroup Neutron-Gamma Libraries from ENDF/B, ORNL-TM-3706, March 1976
 D C Irving and R M Freestone, Jr, OSR, A General Purpose Monte Carlo Transport Code, ORNL-3622, February 1965
 D C Irving and G W Morrison, PICTURE An Aid in Debugging Input Data, ORNL-TM-2892, May 1970
 G R Handley and J N McLeod, A User's Manual for HANDY (A FORTRAN IV Program for Calculating Numerical Coefficients of the General Second-degree Equation in Three Variables), Y-1515, June 1969
11. MACHINE REQUIREMENTS - The CDC6600 program requires 64K words of fast core, a disk facility or one or more tape units. The IBM360 version of KENO2 requires approximately 150K of core with larger problems requiring more core. The IBM360 version of KENO4 requires 1 to 6 scratch units besides the standard input/output units and a minimum of about 200K core
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and Assembly language (IBM360), FTN FORTRAN with COMPASS subroutine (CDC6600)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 (IBM360) and SCOPE 3.3 (CDC6600)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The enclosed cross section and albedo data are included for the sole purpose of allowing the sample problems to be run for instructional purposes and should not be assumed useful for any other purpose without close examination as to their applicability
 The Assembly language subroutines mentioned in item 12 include TIMFAC, DATIM, ALOCAT, a random number package RANDNUM (entries FLTRN, AZIRN, EXPRN, and GTISO), and a timing subroutine PULL (entries PULL and ITIME). Substitute FORTRAN routines are supplied for all KENO4 Assembly language routines except the random number routine, FLTRN

15. NAME AND ESTABLISHMENT OF AUTHORS -

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- 360 KENO2 H K Clark
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E I duPont de Nemours and Company, Inc
Aiken, South Carolina 29801
- 360 KENO4 L M Petrie and N F Cross
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16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

- Source decks (KENO2 6600-5109 cards, 360-5400 cards, KENO4 360-8485 cards)
Auxiliary program source decks (KENO2 K2TAPE 6600-77 cards, KENO4 HANDY 360-263 cards, PICTURE 360-199 cards, GEOMCHK 360-77 cards, Cross section library processor 360-239 cards, Albedo library processor 360-27 cards, Weight library processor 360-25 cards)
Object deck (KENO2 360-78 cards)
2314 load modules (KENO2 360-312 blocks, KENO4 360-525 blocks)
Sample problem (KENO2 6600-389 cards, 360-569 cards, KENO4 360-342 cards)
Libraries (KENO2 6600-7725 cards, KENO4 360-Cross sections 68 records* and 8263 cards, Albedos 46 records* and 12,365 cards, Weights 8 records* and 1117 cards)
Control information (KENO2 360-43 cards, KENO4 360-84 cards)
Sample problem output (KENO2 6600-58 pages)
Reference reports, Errata, Manual, Notes, and Memorandum appropriate to version
+ 1200-byte maximum length
+ 9000-byte maximum length
28,160-byte maximum length

17. CATEGORY - C

KEYWORDS - multigroup, Monte Carlo method, criticality, adsorption, fission, statistics, three-dimensional, lifetime, reactivity, x-y-z, transport theory, ANISN codes, DOT codes, GEOM codes, OSR codes, K2TAPE codes, HANDY codes, PICTURE codes, GEOMCHK codes

18. SPONSOR - NRC Office of Nuclear Material Safety and Safeguards

1. NAME OR DESIGNATION OF PROGRAM - SAFE-CRACK
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The program uses the finite-element method which reduces the problem to the solution of a system of coupled integral equations. The Cholesky method is used to solve the linear system of equations and the trapezoidal rule is applied for the time integration.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
300 nodes
675 elements
70 time-steps
6. TYPICAL RUNNING TIME - 90 minutes are required for a full-capacity problem.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - SAFE-CREEP (NESC Abstract 300)
9. STATUS - Abstract first distributed January 1972
UNIVAC1108 version submitted May 1970
10. REFERENCES - Y. R. Rashid, Nonlinear Quasi-static Analysis of Two-dimensional Concrete Structures, Part I Theory, Part II Computer Program Manual, GA-9994, March 23, 1970.
R. D. Browne, Properties of Concrete in Reactor Vessels, Conference on Prestressed Concrete Pressure Vessels at Church House, Westminster, S.W. 1, 13-17 March 1967, The Institute of Civil Engineers, London, pp. 131-151, 1968.
NTRAN, I/O Routines for Tape and Drum, Excerpt from UNIVAC 1107 FORTRAN IV Programmers Reference Manual, UP-3569, Rev. 1.
11. MACHINE REQUIREMENTS - 65K memory and 13 tapes
12. PROGRAMMING LANGUAGE USED - FORTRAN V
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - CALL TICKER refers to an 1108 system routine for logging job time used. A substitute routine will be required for use of this program on another machine. SAFE-CRACK calls several plotting routines not included with the program. These routines are proprietary and may be dummied out.
15. NAME AND ESTABLISHMENT OF AUTHOR -
Y. R. Rashid
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (3236 cards)
Sample problem (92 cards)
Reference report, GA-9994, and Excerpt

17. CATEGORY - 1

KEYWORDS - two-dimensional, concretes, creep, mechanical structures, finite element method, elasticity, stresses, solids, SAFE-CREEP codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SHELL5
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - SHELL5 uses the finite-element method to formulate a triangular plate element whose membrane displacement fields are linear polynomial functions and bending displacement field is a cubic polynomial function. The shell surface is approximated by a network of these plate elements of arbitrary orientation. Five degrees of freedom (3 displacements and 2 bending rotations) are obtained at each nodal point. The direct solution of the resulting system of equilibrium equations is obtained by the segment block tridiagonal Gaussian elimination method
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
1000 nodal points
2000 elements
The maximum difference allowed for coupled nodal point indexes is 23
6. TYPICAL RUNNING TIME - Approximately 60 minutes are required for a full-capacity problem
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed January 1972
UNIVAC1108 version submitted May 1970
10. REFERENCES - N Prince, SHELL5 (SHELL-3D, Version 5) - A Computer Program for the Structural Analysis of Arbitrary Three-dimensional Thin Shells - A User's Manual, GA-9952, January 30, 1970
N Prince and Y R Rashid, Structural Analysis of Shell Intersections, Paper I-21, Proceedings Part I, First International Conference of Pressure Vessel Technology, Delft, Holland, October 1969
R W Clough and C P Johnson, A Finite Element Approximation for the Analysis of Thin Shells, International Journal Solid Structures, Vol 4, 1968
NTRAN, I/O Routines for Tape and Drum, Excerpt from UNIVAC 1107 FORTRAN IV Programmer's Reference Manual, UP-3569, Rev 1
11. MACHINE REQUIREMENTS - 65K memory, 5 tapes, 3.5 million word drum area
12. PROGRAMMING LANGUAGE USED - FORTRAN V
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - CALL TICKER refers to an 1108 system routine for logging job time used. A substitute routine will be required for use of this program on another machine. SHELL5 calls several plotting routines not included with the program. These routines are proprietary and may be dummied out
15. NAME AND ESTABLISHMENT OF AUTHOR -
N Prince
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San Diego, California 92138
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (3381 cards)

Sample problem (101 cards)
Reference report, GA-9952, and Excerpt

17. CATEGORY - 1
KEYWORDS - shells, three-dimensional, elasticity, mechanical structures, finite element method
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - RICE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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).
4. METHOD OF SOLUTION - The energy transfer matrix is obtained from a solution of the two-body kinematic equations. The solution incorporates information on anisotropic elastic scattering and inelastic scattering available from ENDF/B. Damage cross sections and primary recoil spectra are obtained by combining the energy transfer matrix with suitable secondary displacement models and neutron flux spectra.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - RICE does not recognize all of the multiplicity of data formats allowed by ENDF/B. It is programmed to accept the most prevalent formats. In addition, the neutron energy distribution is restricted to a 99-group representation and the recoil energies are represented by 200 energy groups.
6. TYPICAL RUNNING TIME - All options for one element require 10 minutes.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - RICE lacks the capability of calculating elastic scattering cross sections from resonance parameters. The code SUPERTOG can be used to produce smooth elastic scattering cross sections for RICE in cases where resonance parameters are included in the ENDF/B data. The multigroup programs GAM-II, ANISN, and XSDRN can be used to produce neutron spectra for use in RICE.
9. STATUS - Abstract first distributed January 1972
IBM360 version submitted May 1970, sample problem executed by NESC
10. REFERENCE - J. D. Jenkins, RICE, A Program to Calculate Primary Recoil Atom Spectra from ENDF/B Data, ORNL-TM-2706, February 1970.
11. MACHINE REQUIREMENTS - 110,000 words of core storage and five I/O devices other than normal input/output.
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 -
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P. O. Box Y
Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (3129 cards)
Sample problem input (99 cards)
Sample problem library (945 cards)
Sample problem output (37 cards)

Sample problem output (23 selected pages)
Reference report

17. CATEGORY - B
KEYWORDS - inelastic scattering, ENDF/B, elastic scattering, spectra, radiation effects,
GAM-II codes, ANISN codes, XSDRN codes, SUPERTOG codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - PHENIX
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Eigenvalues are computed by standard source-iteration techniques, with group rebalancing, successive line overrelaxation, and fission-source overrelaxation used to accelerate convergence. These methods are used in the two-dimensional diffusion theory code ZDB (NESC Abstract 325) and are incorporated in PHENIX. However, several basic differences exist between the ZDB methods and those used in PHENIX. In PHENIX, a sinusoidal initial flux guess can be used in which the code generates the appropriate values for the flux at each mesh point for any combination of reflective and vacuum boundary conditions. Additionally in PHENIX, the line inversion can be performed by rows (radial), columns (axial), or by alternating the direction from one mesh sweep to the next. Based on experiments with different core geometries and different combinations of boundary conditions, the code will determine the best direction by considering the boundary conditions together with the average axial and radial mesh spacing. The concentration search calculation has also been changed to include the simultaneous addition or removal of any combination of materials in any combination of reactor zones. The performance of convergence tests and calculation of new eigenvalues in search problems are based on techniques used in the Los Alamos SN codes DTF4 (NESC Abstract 209) and 2DF (NESC Abstract 173).

Burnup is performed by PHENIX using zone-averaged total fluxes and zone- and group-averaged cross sections as in ZDB. Each input burnup time-step is arbitrarily divided into 10 smaller time-steps and the burnup equation is then solved as a march-out problem using the smaller time-steps. A constant total power constraint is used to adjust the magnitude of the fluxes at the end of each subdivided time-step.

With the fractional batch refueling scheme used in PHENIX, the fuel fraction with the greatest burnup is discharged. This discharge is calculated by actually burning initially clean fuel over its period of residence in the reactor using the appropriate zone-averaged total fluxes and zone-group-averaged cross sections from previous burnup intervals. Refueling is then accomplished by subtracting the discharge-atom density from the homogenized-region atom density and adding the appropriate clean-fuel atom density. The principal advantage of this refueling technique is the requirement to explicitly tag each fuel isotope only once per region.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maximum of -
50 energy groups
Variable dimensioning is used with nearly all subscripted variables stored in a single 27,000 word array
6. TYPICAL RUNNING TIME - A straight keff calculation in r-z geometry with 8 energy groups and 900 mesh points requires 40 seconds. If the same problem is carried out over the complete cycle of the code, for the first burnup interval (clean reactor, sinusoidal flux guess), running time is about 75 seconds. Each subsequent burnup interval requires 80 to 85 seconds for the same calculational sequence. The number of burnup intervals required to reach equilibrium is a direct function of the particular fractional batch refueling scheme. Thus, if the reactor requires 5 burnup intervals to reach equilibrium from the clean configuration, the total running time is between 5 and 6 minutes.
7. UNUSUAL FEATURES OF THE PROGRAM -

8. **RELATED AND AUXILIARY PROGRAMS** - Mesh point and atom density data can be generated by DPC, a two-dimensional data preparation code, and input directly to PHENIX. This is particularly useful in the case of complex problems. Cross sections may be input via either cards or tape.
9. **STATUS** - Abstract first distributed January 1972
CDC6600 version submitted June 1970
10. **REFERENCES** - R. Douglas O'Dell, Thomas J. Hirons, PHENIX, A Two-dimensional Diffusion-Burnup-Refueling Code, LA-4231, April 3, 1970, and Supplement
Thomas J. Hirons and R. Douglas O'Dell, Calculational Modeling Effects on Fast Breeder Fuel-cycle Analysis, LA-4187, April 1969
Thomas J. Hirons and R. Douglas O'Dell, Calculational Models for Fast Reactor Fuel-Cycle Analysis, Nuclear Applications and Technology, Vol. 9, p. 93, July 1970
W. W. Little, Jr. and R. W. Hardie, 2DB User's Manual, BNWL-831, Rev. 1, February 1969
K. D. Lathrop, DTF-IV, A FORTRAN-IV Program for Solving the Multigroup Transport Equation with Anisotropic Scattering, LA-3373, July 15, 1965
W. H. Hannum and B. M. Carmichael, DPC, A Two-dimensional Data Preparation Code, LA-3427-MS, February 3, 1965
B. J. Toppel, A. L. Rago, and D. M. O'Shea, MC+2, A Code to Calculate Multigroup Cross Sections, ANL-7318, June 1967
11. **MACHINE REQUIREMENTS** - 65K memory, 1 random-access storage device (disk), and 2 magnetic tape units. If cross sections are input from cards, only one tape unit is required. The other tape unit is used for flux guesses or dumps (if desired), and to store burnup data needed for the refueling portion of the program.
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** -
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
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16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (3516 cards)
Sample problem (103 cards)
Reference report, LA-4231, and Supplement
17. **CATEGORY** - D
KEYWORDS - two-dimensional, multigroup, diffusion, depletion, fuel cycle, fast reactors, 2DB codes, DTF4 codes, 2DF codes, DPC codes, MC+2 codes
18. **SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - DAC1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Perturbation theory applied to the multigroup neutron transport equations is used to obtain reactivities, effective delayed neutron fractions, and generation times.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The FORTRAN IV programming techniques such as variable dimensioning used in DTF4 (NESC Abstract 209) are retained in DAC1. Consequently, any combination of problem parameters may be used which will fit in the overall available storage. Generally, the problems that fit for DTF4 can also be accommodated by DAC1.
6. TYPICAL RUNNING TIME - Seven-group, S4, eight spatial intervals, fuel density perturbation in spherical JEZEBEL requires 12.5 seconds. The sample problem requires 10 seconds CP (central processor) time and 30 seconds PP (peripheral processor) time on the CDC6600.
7. UNUSUAL FEATURES OF THE PROGRAM - DAC1 will compute worth of any perturbation in the atom densities, microscopic cross sections, or both at any combination of space intervals of the reference reactor. Worths of materials not defined in the reference reactor specifications may be computed. SN angular fluxes or fluxes and currents from diffusion theory calculations may be used in the perturbation calculations.
8. RELATED AND AUXILIARY PROGRAMS - DAC1 makes direct use of fluxes (regular and adjoint) computed by DTF4. The sample problem input contains a regular angular flux deck ANGFR, an adjoint angular flux deck ANGFA, and data input decks DTFIN and DACIN. Normally a deck like DTFIN would be used as input to DTF4 (NESC Abstract 209) to generate ANGFR and ANGFA, however, to provide an independent check of DAC1, ANGFR and ANGFA are furnished as part of the DAC1 sample problem input.
9. STATUS - Abstract first distributed January 1972
CDC6600 version submitted June 1970
10. REFERENCES - B. M. Carmichael, DAC1: A One-dimensional SN Perturbation Code, LA-4342, April 1, 1970.
K. D. Lathrop, DTF-IV, A FORTRAN-IV Program for Solving the Multigroup Transport Equation with Anisotropic Scattering, LA-3373, July 16, 1966.
11. MACHINE REQUIREMENTS - 2 disk or tape files are required if angular fluxes are used.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - DAC1 reads ANGFR and ANGFA from tapes NREG and NADJ, respectively, and reads the combined DTFIN and DACIN from tape NINP. Output is written on tape NOUT. File numbers assigned by DAC1 are NREG=1, NADJ=2, NINP=10, and NOUT=9. These may be reassigned by modifying statements A144 through A147.
15. NAME AND ESTABLISHMENT OF AUTHOR -
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16. MATERIAL AVAILABLE -

Source deck (1229 cards)
 Sample problem (180 cards)
 Reference report, LA-4342

17. CATEGORY - N

KEYWORDS - one-dimensional, perturbation theory, reactivity, multigroup, discrete ordinate method, reaction kinetics, DTF4 codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - DBUFIT1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - An iterative technique is used to find the best least squares fit of the transmutation equations to the measured burnup data. The values of the adjustable least squares parameters at this best least squares fit contain the desired integral cross section information.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The data from as many as 150 samples may be analyzed at one time.
6. TYPICAL RUNNING TIME - Computational time depends upon the number of iterations required to obtain least squares convergence and the number of data points being fitted. On the 1108, a test case with nine data points requires approximately four seconds per iteration. Initial estimates for the fitting parameters are usually good enough so that most problems converge in 25 to 50 iterations. Doubling the number of data points doubles the running time per iteration. The only other significant use of machine time occurs during the generation of plotting information which may require up to thirty seconds per plot.
7. UNUSUAL FEATURES OF THE PROGRAM - DBUFIT1 provides for a simultaneous least squares fit of all transmutation equations in a given chain to the associated burnup data. One standard deviation uncertainty for all of the measured isotopes can be accommodated by the code.
8. RELATED AND AUXILIARY PROGRAMS - DBUFIT1 supercedes the DUBLIK code. Input is read in via the NAMELIST format.
9. STATUS - Abstract first distributed January 1972
UNIVAC1108 version submitted July 1970
10. REFERENCES - R. P. Malsen, DBUFIT-1 A Least Squares Analysis Code for Nuclear Burnup Data, BNWL-1396, May 1970.
B. H. Duane, Maximum Likelihood Nonlinear Correlated Fields (BNW program LIKELY), BNWL-390, September 1967.
Program Changes Required for the U235-U236-U238-Np237 Pu236-Pu238 and the Pu242-Am243-Cm244 Chains, BNWL Note
11. MACHINE REQUIREMENTS - Core memory requirements are 40,000 (octal) locations for instructions and almost 50,000 (octal) locations for data storage. A CalComp plotter is necessary if plotted results are desired.
12. PROGRAMMING LANGUAGE USED - FORTRAN V
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - CSCX Operating System
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Computations are performed in double-precision in order to avoid instabilities due to round-off error by taking advantage of the efficient UNIVAC1108 double-precision hardware. With some decrease in efficiency and reliability, most cases can also be run in the single-precision mode, thereby saving considerable data storage space in the core memory.
15. NAME AND ESTABLISHMENT OF AUTHOR -
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Batelle

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16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (3503 cards)
Sample problem (191 cards)
Reference report, BNWL-1386, and BNWL Note
17. CATEGORY - D
KEYWORDS - least square fit, isotopes, depletion, fuels, radiation effects, DUBLIK codes, LIKELY codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GSSLRN1B
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - GSSLRN1B 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 easily adaptable for analysis of any spectra which can be adequately defined by peaks represented in analytic form.
4. METHOD OF SOLUTION - The code is based upon least-squares fitting techniques utilizing second-order Taylor expansions with regression analysis. Varied tests have been incorporated into the code which rely on measurement variance, regression analysis, and deviation from a least-squares fit in order to effectively resolve multiplets in complex photopeak spectra.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
2048 channels from a multichannel analyzer per case
200 fitted peaks per case
250 channels per interval of fit
10 peaks per interval of fit
49 parameters per interval of fit
These limits are based upon analysis of photopeaks described by symmetric Gaussian analytical form.
6. TYPICAL RUNNING TIME - Two to six seconds per fitted peak are required. A typical problem would contain 30 to 50 peaks and use 2 minutes of UNIVAC1108 time.
7. UNUSUAL FEATURES OF THE PROGRAM - The code uses the fitted measurement variance in its decision analysis to decide if deviations from the fit are supported sufficiently to warrant a recycling attempt with higher groups of Gaussian terms so as to define hidden photopeaks. In the case of recycled multiple fitting, recovery procedures are engaged to supply the user with the last good fit which was obtained. The code has automatic plotting features to display the measured data, the fitted curve, and the root-mean-squared deviation envelope, in addition to displaying each resolved peak.
8. RELATED AND AUXILIARY PROGRAMS - GSSLRN1B uses the NAMELIST input routine.
9. STATUS - Abstract first distributed January 1972
UNIVAC1108 version submitted May 1970
10. REFERENCES - G. D. Seybold, GSSLRN-1 An Automated Least-squares Computer Code for the Analysis of Photopeak Spectra, BNWL-1227, November 1969
B. H. Quane, Maximum Likelihood Nonlinear Correlated Fields (BNW program LIKELY), BNWL-390, September 1967
Argonne Code Center Programming Note 72-16, Description of GSSLRN1B Subroutines Not Included in the ACC457 Program Package, January 1972
11. MACHINE REQUIREMENTS - 65K core, 131,000 (octal) locations of scratch drum, two tapes, CalComp 763 plotter for plotting options.
12. PROGRAMMING LANGUAGES USED - FORTRAN V with Assembler language used for two minor routines.
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - CSCX Operating System
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The program consists of 50 subroutines and uses an overlay structure consisting of a main link and 5 overlay segments.

16. NAME AND ESTABLISHMENT OF AUTHOR -

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 Pacific Northwest Laboratories
 Battelle
 P. O. Box 999
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16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (3865 cards)
 Sample problem (174 cards)
 Reference report, BNWL-1227 and ACC Note 72-16

17. CATEGORY - 0

KEYWORDS - spectra, least square fit, statistics, multi-channel analysers, LIKELY codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - VELVET2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - GE635
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - VELVET2 integrates the coupled equations in the fuel, gap, cladding, and coolant. The gap, cladding, and coolant employ a nodal model which is coupled to an approximate analytic solution in the fuel. The velocity field is calculated from the model of Ibragimov, which considers the effect of the irregular flow geometry on the turbulent structure of the flow. The eddy diffusivity of heat is assumed to be related to the eddy diffusivity of momentum through the correlation of Dwyer, and thus becomes a point function in the coolant channel and describes turbulent heat transfer in both the radial and circumferential directions.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 10 radial divisions in the fuel
 - 5 radial divisions in the clad
 - 10 radial divisions in the coolant between the outer edge of the buffer layer and one-half the pitch
 - 10 circumferential divisions
6. TYPICAL RUNNING TIME - About 5 seconds are required for a typical problem.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - VELVET2 is a second-generation version of the original VELVET work.
9. STATUS - Abstract first distributed January 1972
GE635 version submitted April 1970
10. REFERENCES - D. J. Bender and P. M. Magee, Turbulent Heat Transfer in a Rod Bundle with Liquid Metal Coolant, GEAP-10052, July 1969.
M. Kh. Ibragimov, et al., Calculations of the Tangential Stresses at the Wall of a Channel and the Velocity Distribution in a Turbulent Flow of Liquid, Atomnaya Energiya, Vol. 21, p. 101, 1966.
O. E. Dwyer, Eddy Transport in Liquid-Metal Heat Transfer, American Institute of Chemical Engineers Journal, Vol. 9, p. 261, 1963.
VELVET2 Subroutine Descriptions including -
ISERVE, GE 635 Computer Service Function,
FSUP and FSUPC, FORTRAN Output Suppress Function, and
FSNOW, Save File Code Function.
11. MACHINE REQUIREMENTS - 32K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GECOS
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
 - D. J. Bender and P. M. Magee
 - Breeder Reactor Development Operation
 - General Electric Company
 - Sunnyvale, California 94086

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (3486 cards)
Sample problem (51 cards)
Reference report, GEAP-10052, and Subroutine Descriptions
17. CATEGORY - H
KEYWORDS - heat transfer, fuels, coolants, liquid metals, temperature distribution, VELVET codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - DOT2DB
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - GE635
3. DESCRIPTION OF PROBLEM OR FUNCTION - DOT2DB 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.
4. METHOD OF SOLUTION - DOT2DB has three iteration levels. The innermost iteration level computes the spatial flux distribution within an energy group. Convergence at this level may be accelerated by extrapolation of the scalar flux (and, in the transport theory option, the flux moments) by an input factor. The second iteration level computes the energy spectrum of the flux and the multiplication constant or time absorption eigenvalues. Convergence at this level may be accelerated by extrapolation of the fission source distribution by an input factor. The outermost iteration level searches for the material concentration or zone thickness eigenvalues of the problem.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - Running time varies widely, depending on the problem size and the options chosen. An S6, one-group, 10 x 10 spatial mesh, multiplication-constant iteration problem requires 212 seconds of computer processor time. The same problem in diffusion theory requires 13 seconds.
7. UNUSUAL FEATURES OF THE PROGRAM - Either diffusion theory or transport theory calculations can be performed with a single cross section library and identical input format. The generation of a loosely-converged diffusion solution provides an inexpensive method of generating a good flux guess for the transport theory calculation, reducing over-all computation time considerably. The solution in some energy groups can be computed in transport theory with the remaining groups computed using diffusion theory.
8. RELATED AND AUXILIARY PROGRAMS - DOT2DB is a mating of the diffusion subroutines of the BNWL computer code 2DB (NESC Abstract 325) to the ORNL transport code DOT.
9. STATUS - Abstract first distributed January 1972
GE635 version submitted April 1970
10. REFERENCES - R. Protsik and E. G. Leff, User's Manual for DOT2DB, A Two-dimensional Multigroup Discrete Ordinates Transport/Diffusion Code with Anisotropic Scattering, GEAP-13537, September 1969.
DOT2DB Subroutine Descriptions including -
ZERO, to Provide Zero Result on Division by Zero,
LIMRTN, Time Limit Return Subroutine,
FSNOW, Save File Code Function,
ISERVE, GE 635 Computer Service Function, and
LINK and LLINK Program Overlay Subroutines.
11. MACHINE REQUIREMENTS - 45K memory, 3 to 8 scratch files and a cross-section library file.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GECOS-III.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Three GE695 system subroutines, ISERVE, MYTIM, and LIMRTN, are used to determine within the program the amount of computation time remaining and to recover and wrap up when the computation time limit is met.
15. NAME AND ESTABLISHMENT OF AUTHORS -
R. Protsik and E. G. Lell
Breeder Reactor Development Operation
General Electric Company
Sunnyvale, California 94086
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (5679 cards)
Sample problem (152 cards)
Sample problem output (174 pages)
Reference report and Subroutine Descriptions
17. CATEGORY - C
KEYWORDS - multigroup, discrete ordinate method, diffusion equations, transport theory, two-dimensional, anisotropic scattering, 20B codes, DOT codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - LIFE3
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM370, CDC7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 EROA code for calculating the performance of fast breeder reactor fuel elements under normal operating conditions, including power cycling.
4. METHOD OF SOLUTION - The fuel element is assumed axisymmetric for purposes of the analysis. The thermal and mechanical conditions of the fuel element are calculated incrementally as a function of time. The reactor operating conditions are averaged over each time-step, and the behavior of the fuel element is calculated as a function of the reactor operating history. Thermal calculations are based on the assumption of steady-state radial heat flux in the fuel and cladding. The steady-state axial temperature distribution in the coolant is calculated at the beginning of each time-step based on specified coolant inlet and outlet temperatures, the axial power distribution of the element, and fuel-element dimensions at the end of the previous step. Then the radial temperature distribution is calculated from the local coolant temperature, linear heat rating, cladding-coolant and fuel-cladding heat transfer coefficients, and fuel and cladding thermal conductivity. Once the temperature distribution is calculated for a time-step, the incremental fuel restructuring and fission-gas release, thermal expansion of fuel and cladding, and plenum pressure are calculated. The mechanical analysis is based on generalized plane strain and the method of successive elastic solutions. The plenum pressure, coolant pressure, and axial loads imposed by the core restraint system provide the boundary conditions.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The fuel element is assumed to be axisymmetric with maxima of -
 - 5 equal-length fueled sections
 - 20 cylindrical shells per fueled section
 - 1 plenum sectionThe thermal calculations assume steady-state radial heat flux in fuel and cladding, and steady-state axial temperature distribution in the coolant.
 - For a closed fuel-cladding gap, the interface pressure is calculated under the assumption that the fuel and cladding displacement increments are equal at the interface.
6. TYPICAL RUNNING TIME - To compile and execute the sample problem required 4 minutes on the IBM370/185, 60 CP seconds on the CDC7600.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - LIFE1 and LIFE2 are earlier editions.
9. STATUS - Abstract first distributed January 1972.
 - IBM360 version of LIFE1 submitted August 1970, replaced by IBM370 version of LIFE3 submitted November 1976, sample problem executed by NESC July 1977 on an IBM370/185.
 - CDC7600 version of LIFE3 submitted November 1976, sample problem executed by NESC July 1977 on a CDC7600 via I/O terminal at Brookhaven National Laboratory.

10. REFERENCES - M C Billone, B L Harbourn, V Z Jankus, R B Poeppel, T S Roth, W J Shack, J D Stephen, B Sundquist, F R Taraba, J E Turner, and S Zawadzki, The LIFE-III Fuel-Element Performance Code, ERDA-77-56, July 1977
11. MACHINE REQUIREMENTS - 325K bytes of memory (IBM370/195) and 125,000 (octal) words (CDC7600) with one scratch file and one file for restart information, in addition to the system input and output units
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/370 (IBM370), SCOPE 2.1 (CDC7600)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Logical unit 8 is used for problem input and logical unit 6 for printed output. Logical unit 5 is used as a scratch file and logical unit 15 is used to write or read restart data. IBM users must specify GO FT05F001 with RECFM=VBS. Since LIFE3 has no provision for plotting, specifying NPLOT NE 0 on input card number 3 will have no effect. TLEFT is part of the ANL IBM370 environment. The function 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. The function TLEFT supplied with the package returns TLEFT=10000.0 in the IBM version or TLEFT=100.0*(TIMLIM-(CP seconds used)), where TIMLIM=2000.0 in the CDC version.
15. NAME AND ESTABLISHMENT OF AUTHORS -
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F R Taraba and S Zawadzki
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Box 158
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* Engineering contact
+ Program contact
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source decks (LIFE3 370-5801 cards, 7600-5871 cards, TLEFT 370-10 cards)
Sample problem input (370-33 cards, 7600-33 cards)
Sample problem output (370-36 selected pages, 1 microfiche, 7600-32 selected pages, 1 microfiche)
Control information (JCL 370-72 cards)
Reference report
17. CATEGORY - I
KEYWORDS - fuel elements, fast reactors, steady-state conditions, thermal conductivity, performance, heat transfer, temperature distribution, fuel-cladding interaction, mechanical properties, deformation, pressure, swelling, porosity, creep, cracking, stresses, hot pressing, LIFE codes
18. SPONSOR - ERDA Division of Reactor Development and Demonstration

1. NAME OR DESIGNATION OF PROGRAM - EPOCH
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The slowing-down description is provided by a matrix formulation of group-to-group transfer coefficients. A matrix inversion routine is used to obtain the scalar fluxes and currents using the slowing-in sources from other groups and a fission source.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The maximum number of groups is 2000 and the maximum number of ENDF/B materials is 10 (or 5 in age calculations). The number of center-of-mass elastic scattering moments read from ENDF/B must be less than 7. The resonant cross sections for any material are ignored.
6. TYPICAL RUNNING TIME - 7 minutes are required for 358 groups and 17 minutes for 715 groups.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - EPOCH is an extension of EMP1R and BD03 and includes PREP as a subprogram. EPOCH uses the Bettis Environmental Routines (NESC Abstract 476).
9. STATUS - Abstract first distributed January 1972
CDC6600 version submitted July 1970
10. REFERENCES - J. D. Butler, E. M. Gelbard, E. Schmidt, EPOCH: A Program to Calculate Neutron Ages Using the ENDF/B Library, WAPD-TM-822, Addendum 1, May 1970.
J. D. Butler, E. M. Gelbard, and E. Schmidt, EMP1R, A Program to Solve the Multi-group Slab Transport Problem Using the ENDF/B Library, WAPD-TM-822, March 1969.
H. J. Amster and L. M. Culpepper, The PREP Code for Calculating Group and Angle Transfer Cross Sections of Elastic Scattering for the RDR-5 Transport Code on the NORC Computer, WAPD-TM-117, February 1968.
H. C. Honeck, ENDF/B Specifications for an Evaluated Nuclear Data File for Reactor Applications, BNL-50056, May 1966, Revised July 1967.
C. J. Pfeiffer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967.
11. MACHINE REQUIREMENTS - 140K (octal) memory and 1720K (octal) extended core storage. The amount of extended core storage can be readily reduced for most problems.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.1
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - EPOCH uses several Bettis Environmental Routines, which are not included in the SCOPE 2.0 version.
15. NAME AND ESTABLISHMENT OF AUTHORS -
J. D. Butler, E. M. Gelbard, and E. Schmidt
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
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16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal

Source deck (3192 cards)

Sample problem (8 cards)

Reference reports, WAPD-TM-822 Addendum 1 and WAPD-TM-868

17. CATEGORY - 8

KEYWORDS - neutron age, neutron spectra, slowing-down, water reactors, EMPIR codes, BD03 codes, PREP codes, ROR codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SPAN4

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

3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 (liner) 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

$$s=s_0+s_1(a)\cdot s_2(b)\cdot s_3(c)+s_4(a,b)\cdot s_3(c)+s_5(a,c)\cdot s_2(b)+s_6(b,c) \\ +s_7(a,b,c)$$

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.

4. METHOD OF SOLUTION - All kernels used assume exponential attenuation. By ray tracing, the straight-line distances between points in the source and dose points are found, to be used in calculating the attenuation. Integrals are evaluated by Gauss-Legendre, Gauss-Laguerre, or Lobatto quadrature. Accuracy is dependent on the accuracy of the library data and on the orders of quadrature used. In thermal neutron flux calculations, the dose points must be located within or beyond hydrogenous regions, unless the removal cross sections for the non-hydrogenous case are known.

5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Dynamic storage is used for large blocks of data. However, the following limits are to be observed - maxima of -

- 75 shield units
- 75 composition matrices
- 9 sources and detectors
- 9 field-point lists
- 450 different dynamically-stored arrays. The number of such arrays is $3 \cdot (\text{number of shield units}) + \text{number of composition matrices} + 10 \cdot (\text{number of sources} + \text{number of detectors}) + \text{number of field point lists} + 1$
- 400 different composition numbers
- 200 meshlines in any direction in any shield unit
- 33 embedded geometries in the path of one ray
- 9 combined field-point lists
- 33 integrations in one case
- 15 decay-times lists
- 2000 items in any one data group, except source strengths
- 2000 product of the orders of the three quadrature numbers
- Maximum additions to the library -
- 1016 cross section data entries or 32 new elements
- 1060 composition data entries or 279 compositions
- 190 energy-structure data entries or 18 energy structures
- 350 buildup-factor data entries or 3 new buildup-factor materials

6. TYPICAL RUNNING TIME - A conservative estimate of the computer time required for a run is given by

$$t(\text{sec}) = 25 + (0.00042 \cdot n_g \cdot n_i + 0.1 \cdot (e-1) + 0.02 \cdot n_c) \cdot n_f$$

where n_g is the product of the orders of the quadratures used in integrating over the source volume, n_i is the number of meshlines crossed in ray-tracing from a typical Gauss point to a typical field point, n_f is the number of field points in the run, e is the

number of energy levels in the energy structure, and nc is the number of different compositions

7. **UNUSUAL FEATURES OF THE PROGRAM** - The extreme flexibility of the shield geometry options allows nearly exact representations of very complex reactors, shields, and reactor compartment situations. Complex reactors and other devices are represented by embedding portions of one geometry in another as follows:

A basic geometry (rectangular, cylindrical, or spherical) is defined for the shield configuration, and is used to specify the meshlines in the first-level shield unit. The first-level shield usually encompasses all of the shields and components which are to be represented in the problem. After the first-level shield unit has been specified, new shield units may be defined (using a different geometry than the first-level shield if desired), and portions of these new shield units may be embedded between the meshlines of the first-level shield unit. These new shield units become second-level shields.

The embedding process is telescopic, such that third-level shield units may be defined and embedded in the second-level shield units, and each new level of shield geometry is embedded in the next lower level. The meshlines which are specified in each shield may have variable spacing.

Each cell formed by the meshlines of each shield unit may then be specified to contain either a composition (that is, void, element, compound, or mixture) or a cell-shaped portion of a higher-order shield unit. The highest-order shield unit(s) in a problem will therefore have a composition in every cell.

Multiple sources and detectors are allowed, thus simplifying some types of studies. Nine source and detector geometries may be defined in a SPAN4 problem, and again the geometries may be rectangular, cylindrical, or spherical. Sources and detectors may be located arbitrarily with respect to any shield unit, and the regions of integration (or detectors) over which the flux, dose rate, or energy-absorption rate are calculated may be parts of rectangular solids, parts of cylinders, or parts of spheres.

The energy output or particle emission of each source is described by a general three-dimensional distribution function. The variation of the source distribution function between meshlines may be linear, semi-log, or log-log. The generality of the function requires that the integral be estimated by means of Gauss-Legendre, Gauss-Laguerre, or Lobatto quadratures. A number of auxiliary programs which prepare SPAN4 input files and process SPAN4 output files exist. Isotropic sources are usually assumed. A cosine source option allows the simulation of anisotropic sources.

8. **RELATED AND AUXILIARY PROGRAMS** - SPAN4 is an extension of, and supercedes, SPAN3. SPAN4 uses the Bettis Environmental Routines (NESC Abstract 475).

9. **STATUS** - Abstract first distributed January 1972.
CDC8600 version submitted September 1970, replaced by revised Edition B February 1973.

10. **REFERENCES** - O. J. Wallace, SPAN-4 - A Point-Kernel Computer Program for Shielding, WAPD-TM-809(L)-Issue 2, Vols. I and II, October 1972.

O. J. Wallace, SPAN-4 - A Point-Kernel Computer Program for Shielding, WAPD-TM-809, December 1969.

C. J. Pfeiffer, CDC-8600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967.

W. H. Guiling, N. D. Cook, and P. A. Gillis, SPAN-3 A Shield Design Program for the Philco-2000 Computer, WAPD-TM-235, February 1962.

Control Data 6400/6500/6600 Computer Systems SCOPE 3-1 Reference Manual, Publ. No. 60189400A, February 1968.

11. **MACHINE REQUIREMENTS** - 64K central memory and one system disk. Microfilm is required if the plot options are to be used.
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV and ASCENT.
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 3-1.

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - SPAN4 is structured into distinct parts which are loaded into central memory as required. These parts are referred to as overlays as described in reference 5. Essentially an overlay represents the amount of program text in central memory. With overlay loading, the main overlay is always in memory, and, in addition, a particular primary and one secondary overlay may also be in central memory. SPAN4 contains a main overlay, 7 primary overlays, and 8 secondary overlays. Overall program control is vested in the main overlay and the primary and secondary overlays are loaded and executed through the use of the NEXT subroutine described in reference 3.
15. NAME AND ESTABLISHMENT OF AUTHOR -
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16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal (2 tapes)
Source deck (part 1 11,080 cards, part 2 11,553 cards)
Sample problems (466 cards)
Reference reports, WAPD-TM-809(L), Vols 1 and 2
17. CATEGORY - J
KEYWORDS - dose rates, shielding, design, gamma radiation, neutron flux, point kernels, SPAN3 codes
18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - 3DDT
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - CDC6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - 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 k_{eff} 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.
4. **METHOD OF SOLUTION** - Standard source-iteration techniques are used to compute eigenvalues and flux profiles. Using an initial fission source distribution, new flux profiles in each group are sequentially computed, beginning in the highest energy group in regular problems and in the lowest energy group in adjoint problems. The group fluxes are computed by horizontal (r-theta or x-y) planes, beginning with the plane at the lowermost, axial position. Convergence is accelerated by group rebalancing, successive overrelaxation, and line inversion. Material burnup is computed using zone- and group-averaged cross sections which are recomputed after each time-step. The burnup equation for each material in each zone provides for one decay source, two capture sources, seven fission sources, and losses by decay and absorption.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Since variable dimensioning is used, no simple restrictions can be placed on individual components of the problem. However, a 16-group problem containing 30 x 30 x 30 mesh points and 80 zones can be accommodated on a 65K computer. Upscattering is not treated in 3DDT.
6. **TYPICAL RUNNING TIME** - Execution times are on the order of 0.01 to 0.02 seconds of CP time per mesh-point per energy-group on the CDC6600. A 2-group problem using a 20 x 20 x 20 mesh would require 2.7 to 5.3 minutes of CP time. The low estimate applies to a k_{eff} calculation, and the high estimate applies to an implicit eigenvalue search calculation. Each successive burnup interval requires about one-half of the above times. It is expected that the running time will increase more than linearly with the number of energy groups, especially if the downscattering matrix is relatively full.
7. **UNUSUAL FEATURES OF THE PROGRAM** - Variable dimensioning is used to make maximum use of fast core storage. Both extended core storage (ECS) and disk storage are utilized in 3DDT. Four-dimensional flux arrays are stored on the disk using tape file simulation, three-dimensional flux arrays are stored in ECS using random access, and two-dimensional flux arrays are stored in central memory. Thus, central memory storage requirements are insensitive to the number of energy groups and the number of axial mesh points. Because of the manner in which arrays are stored, very large two-dimensional problems can be run on a 65K computer.
8. **RELATED AND AUXILIARY PROGRAMS** - 3DDT is an extension to three space dimensions of the two-dimensional 2DB code (NESC Abstract 325). The generalized input subroutines used for reading data in the DTF4 code (NESC Abstract 209) are also used in 3DDT.
9. **STATUS** - Abstract first distributed January 1972
CDC6600 version submitted September 1970
10. **REFERENCES** - John C. Vigil, 3DDT: A Three-dimensional Multigroup Diffusion-burnup Program, LA-4386, February 1970.
Random ECS I/O, LASL Note, July 10, 1969.
W. W. Little, Jr. and R. W. Hardie, 2DB User's Manual, BNWL-831, Rev. 1, February 1969.
K. D. Lathrop, DTF-IV, A FORTRAN-IV Program for Solving the Multigroup Transport Equation with Anisotropic Scattering, LA-3373, July 15, 1965.

11. MACHINE REQUIREMENTS - CDC6600 computer with 65K words central memory, 500K ECS, 8,000K disk (four tape files are simulated on the disk), two magnetic tape units, and the usual input/output devices
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 - SDDT uses three LASL ECS system routines - ECRD, to fetch a vector from ECS, ECWR, to store a vector in ECS, and ECFL, to reduce the ECS block storage requirement
15. NAME AND ESTABLISHMENT OF AUTHOR -
John C. Vigil
Los Alamos Scientific Laboratory
P O Box 1663
Los Alamos, New Mexico 87544
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (4406 cards)
Sample problem (76 cards)
Reference report, LA-4396, and Note
17. CATEGORY - D
KEYWORDS - three-dimensional, diffusion equations, transport theory, x-y-z, r-theta-z, reactivity, multigroup, criticality searches, 2DB codes, DTF4 codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - DYN01
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600, IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - DYN01 calculates the distribution of electrons that are emitted from a photomultiplier composed of a series of dynodes
4. METHOD OF SOLUTION - One electron impinging upon a photomultiplier produces an output of many electrons. This output can be described statistically by use of generating functions. The output from each dynode is assumed to have a Polya distribution. The procedure followed is the same as that first described for uniform dynodes by J. R. Prescott of the University of Alberta (reference 2), employing a recursion relationship for the probability distributions
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
4 stages
10,000 electrons for which probabilities will be calculated
6. TYPICAL RUNNING TIME - Running time is highly dependent on the number of electron calculations desired and the convergence criterion specified. A four-stage, 5000 electron problem with a convergence criterion of $1.0E-9$ requires about 10 seconds. Most cases should run in less than 1 minute.
7. UNUSUAL FEATURES OF THE PROGRAM - Application of Prescott's formula to a series of non-uniform dynodes
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed January 1972
CDC6600 version submitted October 1970
IBM360 version submitted November 1971, sample problem executed by NESC
10. REFERENCES - J. E. Edwards and J. F. McCarthy, DYN01 A Program to Compute the Distribution of Secondary Electrons in Photomultipliers, KAPL-M-6575, September 21, 1966
J. R. Prescott, A Statistical Model for Photomultiplier Single-electron Statistics, Nuclear Instruments and Methods, Vol. 39, pp. 173-179, 1966
L. A. Dietz, General Method for Computing the Statistics of Charge Amplification and Photon Detectors Used for Pulse Counting, International Journal of Mass Spectrometry and Ion Physics, Vol. 5, pp. 11-19, 1970
11. MACHINE REQUIREMENTS - About 45,000 words of memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE (CDC6600) and OS/360 (IBM360)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
6600 J. E. Edwards and J. F. McCarthy
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301

360 P. A. Henline
High Energy Physics
Argonne National Laboratory
Argonne, Illinois 60439

16. MATERIAL AVAILABLE - Restricted Distribution
Source decks (6600-157 cards, 360-161 cards)
Sample problems (6600-5 cards, 360-7 cards)
Reference report, KAPL-M-8575
17. CATEGORY - O
KEYWORDS - statistics, photomultipliers, electrons
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - RESEND/ADLER
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600, PDP10
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - RESEND calculations are done in two steps by two separate sections of the program. The first section does the resonance calculation and stores the results on a scratch file. The second section combines the data from the scratch file with background cross sections and prints the results.
ADLER uses the Adler-Adler formalism
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - RESEND expects its input to be a standard mode BCD ENDF file (Version 11/111). Since the output is also a standard mode BCD ENDF file, the program is limited by the six significant figure accuracy inherent in the ENDF formats. (If the cross section has been calculated at two points so close in energy that only their least significant figures differ, that interval is assumed to have converged, even if other convergence criteria may not be satisfied.) In the unresolved range the cross sections have been averaged over a Porter-Thomas distribution. In some regions the calculated resonance cross sections may be negative. In such cases the standard convergence criterion would cause an unnecessarily large number of points to be produced in the region where the cross section becomes zero. For this reason an additional input convergence criterion (AVERR) may be used. If the absolute value of the cross section at both ends of an interval is determined to be less than AVERR then the interval is assumed to have converged. There are no limitations on the total number of points generated. The present ENDF (Version 11/111) formats restrict the total number of points that can be given for a reaction type to 5000.
ADLER can handle resonance data up to a maximum of 10 isotopes with a total number of 500 resonances. The code assumes that the resolved resonance parameters are given for one energy range which is the same for all the isotopes of an element. The mesh points at which the cross sections are calculated can be varied. Since the calculated data are not stored, an increase in the number of mesh points does not conflict with any storage requirement.
6. TYPICAL RUNNING TIME - To produce the U238 (ENDF MAT = 1103) cross sections with a 1 percent accuracy (ERR = 0.01) RESEND generates about 12,000 resonance points and requires about 1 hour on the PDP10. For less complex materials running time is considerably shorter.
ADLER calculations of cross sections of one isotope with 37 resonances and 20 mesh-points between resonances requires 21 seconds without Doppler-broadening and 209 seconds with Doppler-broadening.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - RESEND combines the features of the resonance region codes AVRA3, AVRA4, and SIGMA2. Additional subroutines under development will further enable it to replace ADLER and RAMP1 (NESC Abstract 492).
9. STATUS - Abstract first distributed January 1972.
CDC6600 versions of AVRA3,4, SIGMA2, and ADLER submitted October 1970, replaced by revised version December 1971. AVRA3,4, and SIGMA2 replaced by PDP10 version of RESEND August 1972.
10. REFERENCES - M. R. Bhat, ENDF/B Processing Codes for the Resonance Region, BNL-50286 (ENDF-148), June 1971.

M. K. Drake, Ed., Data Formats and Procedures for the ENDF Neutron Cross Section Library, BNL-50274(T-601) (ENDF-102), Vol. 1, October 1970

Odell Ozer, Program RESEND, BNL-17134, January 1972

D. B. Adler and F. T. Adler, Analysis of Neutron Resonances in Fissile Elements, Programs CODILL, CURVEPLOT and SIGMA, COO-1546-3, September 1966

11. MACHINE REQUIREMENTS - RESEND requires 24K (decimal) core with 2 scratch units, an input unit for the ENDF data, an output unit, a unit for reading in the run parameters (teletype or system input) and a unit for printing run-associated messages (teletype or system output). ADLER requires 37K (octal) memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3 0
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
M. R. Bhat and O. Ozer
National Nuclear Data Center
Brookhaven National Laboratory
Upton, Long Island, New York 11973
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (RESEND 2321 cards, ADLER 892 cards)
Sample problem (ADLER 167 cards)
Reference reports, BNL-50296 and BNL-17134
17. CATEGORY - A
KEYWORDS - averages, scattering, capture, fission, cross sections, multilevel analysis, ENDF/B, Doppler broadening, Breit-Wigner formula, AVRAVE3 codes, AVRAVE4 codes, SIGMA2 codes, RAMP1 codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - APRFX1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The fine-group cross sections are collapsed to a broad-group structure according to a flux spectrum either input by the user or calculated by the code. Fine-group cross sections are averaged to form either macroscopic or microscopic isotope cross sections and any combination of macroscopic mixtures of these cross sections.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - This version of the code uses the DLC-2B library in ANISN-DOT format. Upscattering is not included.
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The program utilizes the 99 group DLC-2B neutron cross section library. This library is derived from the ENDF/B data by use of SUPERTOG (NESC Abstract 431) and is in the ANISN-DOT format. The code functions similarly to ZOT written at Los Alamos Scientific Laboratory.
9. STATUS - Abstract first distributed January 1972
CDC6600 version submitted October 1970
10. REFERENCES - Paul S. Pickard, Neutron Cross Section Collapsing Code APRFX1, AMXRD-BNL(12-70), June 1, 1970
Paul S. Pickard and Donald O. Williams, Calculated Neutron Energy Spectra for the APRF Reactor, AMXRD-BNL(9-70), April 28, 1970
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
Author Paul S. Pickard

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16. MATERIAL AVAILABLE -
Source deck (646 cards)
Reference reports
17. CATEGORY - B

KEYWORDS - cross sections, multigroup, group constants, SUPERTOG codes, ANISN codes, ZOT codes, DOT codes

16. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - HRG3
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - UNIVAC1108, IBM360,370
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - 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.
4. **METHOD OF SOLUTION** - The 68 fine-group fluxes and currents are calculated by one sweep through the group structure, starting from a specified source distribution. The source may be selected from among the eight available on the data tape or may be input. The multigroup model uses a full downscattering matrix, with inelastic, (n,2n), and P0 and P1 components of elastic scattering explicitly included. Macroscopic fine-group parameters are constructed from input nuclide concentrations and microscopic parameters, available on the data tape for more than 200 individual nuclides. There is no restriction, other than availability, on the number of nuclides usable in a case. A special calculation is made in the resonance range for certain nuclides, using an adaptation of the Adler, Hinman, and Nordheim method to obtain an intermediate resonance approximation for both the absorber nuclide and an admixed moderator. The resonance contribution is allocated to the fine-groups in a consistent manner providing self-shielding in both space and energy. Additional self-shielding factors may be read in for any nuclide, if desired. The fine-group fluxes and currents are used as weighting functions in averaging macroscopic and microscopic parameters over the specified broad-group structure. As an option, the neutron age in an infinite medium may be calculated by the moments method.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - The maximum number of broad groups is 33. Broad-group boundaries are adjusted internally to coincide with one of the 68 fine-group boundaries.
6. **TYPICAL RUNNING TIME** - For 10 nuclides, including four with resonance calculation and no punched output, 40 seconds are required for the first case in a run, and 20 seconds for each succeeding case.
7. **UNUSUAL FEATURES OF THE PROGRAM** -
8. **RELATED AND AUXILIARY PROGRAMS** - NUTAPE2 updates and/or prints the HRG3 data tape. BINHOT converts a BCD library to the binary format used by HRG3.
9. **STATUS** - Abstract first distributed January 1972.
UNIVAC1108 version submitted October 1970.
IBM360 version submitted March 1973, sample problem executed by NESC.
10. **REFERENCES** - J. L. Carter, HRG3 - A Code for Calculating the Slowing-down Spectrum in the P1 or B1 Approximations, BNWL-1432, June 1970.
HRG-3 Changes in Conversion to IBM 360/370, TVA Note, 1973.
11. **MACHINE REQUIREMENTS** - 64K memory, normal input, output, program, and punch units, 1 unit for library, 1 to 4 scratch units or their equivalent on drum (UNIVAC1108), 200K memory, standard I/O units, 1 unit for library, and 1 scratch unit (IBM360).
12. **PROGRAMMING LANGUAGE USED** - FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - CSCX (UNIVAC1108), OS/360 (IBM360)
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - A few special features of CSCX are used by the UNIVAC1108. Their functions are described in the reference report BNWL-1432.

15. NAME AND ESTABLISHMENT OF AUTHORS -

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360 G. W. Perry
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Chattanooga, Tennessee 37401

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal (360-2 tapes, 1108-3 tapes)

Source decks (HRG3 1108-2512 cards, 360-2116 cards, NUTAPE2 1108-815 cards, 360-858 cards, BINHDT 1108-278 cards, 360-286 cards)

Sample problems (HRG3 1108-48 cards, 360-21 cards, BINHDT 1108-26 cards, 360-1 card, NUTAPE2 360-3 cards)

Libraries (1108-1417 binary records, 360 and 1108 PART 1 17,635 cards, PART 2 19,530 cards)

Control information (HRG3 360-11 cards, BINHDT 360-16 cards, NUTAPE2 360-14 cards)

Sample problem output (BINHDT-11 pages)

Reference report and TVA Note

17. CATEGORY - B

KEYWORDS - slowing-down, group constants, cross sections, elastic scattering, inelastic scattering, NUTAPE2 codes, BINHDT codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - BUBL1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - BUBL1 is a computer simulation of a fuel region. Within this region, fission gas events are followed via a Monte Carlo technique. Individual bubbles are followed through their time history from nucleation to release from the fuel, with interactions at dislocations and grain boundaries. Specific bubble sizes are determined from either the ideal gas law or the van der Waals equation of state as modified by a local hydrostatic pressure term.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The current version of BUBL1 is restricted to isothermal problems with non-varying hydrostatic pressure and thermal gradient histories.
6. TYPICAL RUNNING TIME - One minute per case is required.
7. UNUSUAL FEATURES OF THE PROGRAM - BUBL1 is a unique analysis tool in that it is the only known program which explicitly describes a fuel region and follows fission gas atoms from nucleation until release from the fuel region occurs. It is the only model available which predicts the phenomena of saturation in gaseous swelling at high temperature and a temperature of maximum swelling, both having been observed experimentally.
8. RELATED AND AUXILIARY PROGRAMS - The long range plan is to integrate the BUBL swelling and gas release model with CYGRO3 (NESC Abstract 449). BUBL1 uses the Bettis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed January 1972
CDC6600 version submitted October 1970
10. REFERENCES - H. R. Warner, BUBL-1 - A Statistical Fuel Swelling and Fission Gas Release Model, WAPD-TM-942, September 1970.
C. J. Plier, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967.
F. A. Nichols, Behavior of Gaseous Fission Products in Oxide Fuel Elements, WAPD-TM-570, October 1966.
E. Duncombe and C. M. Friedrich, CYGRO-3 - A Computer Program to Determine Temperatures, Stresses and Deformation in Oxide Fuel Rods, WAPD-TM-961, March 1970.
11. MACHINE REQUIREMENTS - 65K memory, a printer, and a plotter.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.1
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - BUBL1 uses plotting routines described in reference 2. Function subroutine RANGEN is entered in the BUBL1 program by the real function RANDOM(0), which produces a real random number r such that $0.0 \leq r < 1.0$.
15. NAME AND ESTABLISHMENT OF AUTHOR -
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Westinghouse Electric Corporation

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West Mifflin, Pennsylvania 15122

16. MATERIAL AVAILABLE - Restricted Distribution

Source deck (1366 cards)

Sample problem (12 cards)

Reference report, WAPD-TM-942

17. CATEGORY - 1

KEYWORDS - fuels, swelling, gases, solids, fission products, Monte Carlo method, CYGROS codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - PMS1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - PMS1 corrects experimental fast neutron polarization data for finite geometry and multiple scattering effects, when liquid helium is the polarizer analyzer
4. METHOD OF SOLUTION - The Monte Carlo code simulates the actual geometry of the experiment, traces scattering histories to estimate multiple-scattering asymmetry for an incident neutron beam of arbitrary polarization. The code uses phase shifts to calculate the necessary parameters, the angular distributions $(d\sigma/d\Omega)$, the polarization p and the spin rotation parameter β needed for consistent tracking of polarization effects in successive scattering. The phase shift data are taken from the fitted data of Hoop and Barschall above 1.5 MeV and from Morgan and Walter below 1.5 MeV. The code adjusts the initial input polarization needed to reproduce the measured left-right count ratio for the two detectors
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - No more than five collisions are allowed and liquid helium must be the polarizer analyzer. The total number of energy points for which phase shifts are given must be less than 100
6. TYPICAL RUNNING TIME - About 3 minutes per case are required
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed January 1972
IBM360 version submitted October 1970, replaced by updated version April 1973,
sample problem executed by NESC
10. REFERENCES - G. W. Morrison, T. G. Miller, and F. P. Gibson, PMS1 - A FORTRAN Monte Carlo Code for Correcting Experimental Fast-neutron Polarization Data, CTC-9, December 1969
B. Hoop and H. H. Barschall, Scattering of Neutrons by Alpha-Particles, Nuclear Physics, Vol. 83, p. 65, 1966
11. MACHINE REQUIREMENTS - 32K memory
12. PROGRAMMING LANGUAGES USED - FORTRAN IV(H) and BAL
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
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Oak Ridge, Tennessee 37830
F. P. Gibson and T. G. Miller
U. S. Army Missile Command
Redstone Arsenal, Alabama 35805
16. MATERIAL AVAILABLE -
Source deck (1040 cards)
Sample problem (31 cards)
Sample problem output (6 pages)
Reference report

17. CATEGORY - 0

KEYWORDS - Monte Carlo method, statistics, elastic scattering, polarization, helium

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GRAMP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - GRAMP randomly generates Reich and Moore parameters for multilevel unresolved resonances of fissile isotopes
4. METHOD OF SOLUTION - Parameters are selected randomly from the appropriate distribution functions. Resonance energies are chosen from the Wigner distribution. Partial fission widths and the reduced neutron width are chosen from the Porter-Thomas distribution. The fission width for a given resonance in the Reich and Moore formalism is the sum of a set of partial widths corresponding to the open fission channels.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The maximum number of resonances per spin state is 100. Two compound nucleus spin states are allowed and each spin state may have two open fission channels.
6. TYPICAL RUNNING TIME - Parameters for 1000 resonances are generated in 6 seconds.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - GRAMP output may be punched on cards which serve as input to RECAP-0 (NESC Abstract 671).
9. STATUS - Abstract first distributed January 1972
CDC6600 version submitted November 1970
10. REFERENCES - M. Goldsmith, GRAMP-A Program to Generate Reich and Moore Parameters for Multilevel Unresolved Resonances, WAPD-TM-939, May 1970.
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.1
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - This program uses the Battis Environmental Routines (INTAP, OUTAP and FINISH (NESC Abstract 470)). SETRAN initializes the random number sequence and the RANDOM(0) function provides the next random number from the RANGEN, random number generating routine, which provides real numbers, r , randomly distributed in the range $0 \leq r < 1.0$.
15. NAME AND ESTABLISHMENT OF AUTHOR -
Mark Goldsmith
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Westinghouse Electric Corporation
Box 79
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16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (149 cards)
Sample problem (5 cards)
Reference report
17. CATEGORY - A
KEYWORDS - multilevel analysis, resonance, Reich-Moore formula, Porter-Thomas distribution, fission, compound nuclei, RECAP codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GAPER2D
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - First-order perturbation theory is used with 2DF fluxes and currents replacing the perturbed fluxes. The angular fluxes and scattering cross sections are expanded in spherical harmonics, and truncated at the P1 term
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Scattering anisotropy is limited to the P1 term
6. TYPICAL RUNNING TIME - About 1 minute is required
7. UNUSUAL FEATURES OF THE PROGRAM - Upscattering is allowed
8. RELATED AND AUXILIARY PROGRAMS - 2DF (NESC Abstract 173), a two-dimensional discrete ordinates theory code in x-y or r-z geometry is used to compute and write magnetic tape flux and current data for use by GAPER2D, an extension of GAPER, an earlier transport perturbation program which employed simple synthesis approximations for two- and three-dimensional configurations
9. STATUS - Abstract first distributed January 1972
UNIVAC1108 version submitted December 1970
10. REFERENCES - R. J. Archibald and D. A. Sargis, GAPER-2D: A Two Dimensional Transport Perturbation Theory Program, GA-10103, April 29, 1970
R. Archibald, Input Changes to GAPER-2D (reference GA-10103), Errata, November 13, 1970
11. MACHINE REQUIREMENTS - 65K fast memory, 2 tape units, 4 drum or disk files
12. PROGRAMMING LANGUAGE USED - FORTRAN V
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2 or EXEC8
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Variable dimensioning is used. The microscopic cross section sets are input in GGC4 (NESC Abstract 298) format and mixtures may be stored and altered for use by succeeding problems in a set
15. NAME AND ESTABLISHMENT OF AUTHORS -
R. J. Archibald and D. A. Sargis
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (1187 cards)
Sample problem (823 cards)
Reference report and Errata
17. CATEGORY - N
KEYWORDS - reactivity, perturbation theory, two-dimensional, discrete ordinate method, 2DF codes, GAPER codes, GGC4 codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - CHIC-KIN
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - CHIC-KIN operates by simultaneous solution of the basic one-dimensional conservation equations, using representations which permit the description of both intermediate and fast transients without any change in the model. For water-cooled heterogeneous reactors, the model incorporates all known major feedback mechanisms, and accounts for the details of nonboiling, nucleate-boiling, and film-boiling heat transfer.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Restrictions include -
 - 1 through 20 axial sections
 - 2 through 10 radial sections
 - 2 through 30 mass-velocity or pressure-drop pairs
 - 2 through 30 inlet enthalpy pairs
 - 2 through 30 exit enthalpy pairs
 - 2 through 30 system-pressure pairs
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM - Major features include -
 - (a) calculation of subcooled-boiling (local-boiling) void fractions which are significant contributors to reactor shutdown for a large class of excursions,
 - (b) inclusion of reactivity feedback effects due to moderator density change, moderator temperature change, fuel plate expansion and Doppler broadening,
 - (c) representation of the fluid dynamics by a momentum integral model which allows stagnant initial conditions, flow reversal, and internal channel pressure buildup, and
 - (d) detailed spatial representation of the fuel element (rod or plate) by axial and radial sectionalization.
8. RELATED AND AUXILIARY PROGRAMS - CHIC-KIN utilizes many of the numerical techniques of the CHIC3 program. CHIC-KIN uses the Bellis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed January 1972
CDC6600 version submitted December 1970
10. REFERENCES - J. A. Redfield, CHIC-KIN - A FORTRAN Program for Intermediate and Fast Transients in a Water Moderated Reactor, WAPD-TM-479, January 1965
C. J. Pfeifer, CDC-6600 FORTRAN Programming - Bellis Environmental Report, WAPD-TM-668, January 1967
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.1
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHOR -

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

16. MATERIAL AVAILABLE - Restricted Distribution

Magnetic Tape Transmittal
 Source deck (5054 cards)
 Sample problem (35 cards)
 Sample problem output (20 selected pages)
 Reference report, WAPD-TM-479

17. CATEGORY - H

KEYWORDS - transients, water, heat transfer, feedback, coolants, kinetics, CHIC3 codes, SPERT1 reactors

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - QX1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360/75
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The improved quasistatic method described in reference 1 is used to solve the time-dependent problem. The method consists of factoring the total flux into the product of a space-energy-time dependent shape function and a purely time-dependent amplitude function, normalized so that the most rapidly varying part of the total flux is included in the amplitude function. The two coupled sets of equations which result are solved iteratively. The fuel temperature changes are calculated by a regionwise adiabatic model with the assumption that all power is produced in the fuel. The method was developed specifically for fast reactor safety analysis. The advantages of factorization are greatest for such systems, though the code has been shown to perform adequately on thermal reactor problems.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maximum of
 - 30 energy groups
 - 15 downscaler groups
 - 6 delayed neutron families
 - 20 spatial regions
 - 16 material mixtures per region
 - 150 mesh points
6. TYPICAL RUNNING TIME - A 29-group, 15 downscaler, 51 mesh point rod-drop problem to 30 reactor seconds executes in 10 minutes on the IBM360/75. A 10-group, 6 downscaler, 53 point pulsed reactor problem run to 1 msec reactor time executes in 10 minutes on the IBM360/75. Running time estimates cannot be generalized because of the high degree of dependence on the required accuracy of solution, type of perturbation, and the eigenvalue separation of the space-energy equation.
7. UNUSUAL FEATURES OF THE PROGRAM - The running time can be reduced greatly for problems requiring relatively low accuracy, and the code has been shown to reproduce the results of direct finite-difference codes when convergence is tightened. An automatic time-step selector is provided to optimize the time distribution of shape function recalculations during the transient. A true point kinetics problem can be run using only the initial shape function. A compact problem edit is given in terms of the familiar integral quantities of reactivity, effective delayed-neutron fraction, generation time, etc. Very general problem driving functions and time-step controls may be used. A group-collapsing system is built into the problem preparation module of the code.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed January 1972
 - CDC3600 version submitted by ANL January 1971, revised April 1972, deleted July 1978
 - IBM360/75 version submitted January 1971, replaced by Edition 6 April 1972, sample problem executed by NESC
10. REFERENCES - K. O. Olt and D. A. Meneley, Accuracy of the Quasistatic Treatment of Spatial Reactor Kinetics, Nuclear Science and Engineering, Vol. 36, p. 402, 1969.

D A Meneley, K O Ott, and E S Wiener, Fast Reactor Kinetics - The QX1 Code, ANL-7769, March 1971

D A Meneley, ANL Intra-Laboratory Memorandum, March 1972

11. MACHINE REQUIREMENTS - 450K byte memory, input, output, and punch datasets, a maximum of 2 cross section datasets, and a maximum of 6 scratch datasets
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 IBM360/75 version is overlayed. Edition B of QX1 includes a steady-state restart capability, a more satisfactory iteration procedure for feedback problems, and a simplified dump file facility
15. NAME AND ESTABLISHMENT OF AUTHOR -
D A Meneley-
Applied Physics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
-Present address-Ontario Hydro
Toronto, Ontario, Canada
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (6633 cards)
Sample problem (192 cards)
Library (5609 cards)
Control information (JCL 152 cards)
Sample problem output (37 selected pages)
Reference report, ANL-7769, and ANL Memorandum
17. CATEGORY - F
KEYWORDS - one-dimensional, multigroup, diffusion, fast reactors, kinetics, space-time
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - CRECT/CHECKER/RIGEL/PLOTFB/LISTFC/DICTION/SLAVE3/DAMMET
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600, IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 457) 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.
4. METHOD OF SOLUTION - CRECT accepts a BCD tape in ENDF/B format as input and produces a corrected ENDF/B tape as output. Corrections consist of insertions, deletions and changes specified on input cards.
 In CHECKER most data are submitted to range limit checks. Tabulated data are checked for smoothness in order to detect possible mispunched values. Legendre coefficients are converted to moments and moments are checked to determine if they are physically possible. The Legendre expansion is checked for positivity in the interval $-1 \leq \cos \theta \leq 1$.
 In PLOTFB the specified structure of the library allows data to be subclassified under nuclides, classes of data, and reaction types. The well-defined structure permits the associated information to be accessed by converting material numbers to Hollerith titles, etc. Plots are generated utilizing a plotting package which includes scaling, grid, and normalization routines. Plots can be generated in either linear-log axis or a mixture of both.
 When merging two tapes and converting to a data format other than that of either input tape, DAMMET performs a two-pass operation. The first pass consists of selecting only the data required and converting it to the format of the final tape, with storage of the data on an intermediate tape. Upon completion of the first pass on both tapes, resulting in two intermediate tapes, the second pass merges both intermediate tapes to the final data tape.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - In CRECT correct sequence and material fields of the data tape are assumed. In both CHECKER and CRECT data must be in ENDF/B BCD standard arrangement card image format.
 In CHECKER correct structure of the data tape is assumed and minor anomalies are noted. Common and major irregularities cause termination of execution accompanied by a core dump.
 DICTION can handle only ENDF/B BCD standard arrangement tapes with 1000 or fewer sections.
 In PLOTFB data must be in either the ENDF/B BCD or binary standard arrangement card image format. PLOTFB can extract data only to the material and file level of data within the ENDF library.

In DAMMET a specific reaction cannot be extracted from a tape unless it is within a file or material selected

6. TYPICAL RUNNING TIME -

CDC6600 -

0.007 seconds of CP time is required to process one record of BCD information in CHECKER. Typical CP to PP time ratio for the short form output is 1 to 4, for long form output, 1 to 6.

In CRECT 2 seconds of CP time are required. Typical CP to PP time ratio is 1 to 5.

In DAMMET 3 to 7 minutes of CP time are required to process 13 nuclides. Typical CP to PP time ratio is approximately 3 to 1.

In PLOTFB 4 minutes of CP time and 10 minutes of PP time are required to list and plot 35 materials (approximately 3500 data cards).

In SLAVE3 running time is dependent on the selection of subroutines and processing requirements. Typical CP to PP time ratio is 1 to 3, and an average run is 4 minutes.

IBM360 -

CHECKER requires about 1 minute for each 6000 card images on the input tape.

CRECT requires about 1 minute for each 5000 card images on the input tape.

7. UNUSUAL FEATURES OF THE PROGRAM - In CHECKER there are two output options - (a) long form, which lists each card image as well as the anomalies encountered, and (b) short form, which lists only the anomalies encountered by the program (minimum output option).

8. RELATED AND AUXILIARY PROGRAMS - All eight programs perform an independent operation on ENDF/B data. CRECT may be used to correct errors detected by CHECKER.

9. STATUS - Abstract first distributed January 1972.

CDC6600 versions of all 8 codes submitted December 1970. CRECT replaced by later version August 1972, LISTFC replaced by later version December 1972.

IBM360 versions of CHECKER and CRECT submitted March 1971, sample problem executed by NESC May 1971.

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 September 1970, Revised June 1971.

H. C. Honeck, ENDF/B - Specifications for an Evaluated Nuclear Data File for Reactor Applications, BNL-50088, May 1966, Revised July 1967.

M. K. Drake, Data Format and Procedures for the ENDF Neutron Cross Section Library, BNL-50274, October 1970.

11. MACHINE REQUIREMENTS -

CDC6600 -

For CHECKER 56,300 octal (approximately 24,000 decimal) words of core storage and one tape (or disk) unit.

For CRECT 13,000 octal words of core storage and two data storage units.

For PLOTFB 73,700 octal (about 30,000 decimal) words of core storage and three tape (or disk) units.

For SLAVE3 40,000 octal (approximately 18,000 decimal) words of core storage and one or two tape (or disk) units will be required for a typical job.

For DAMMET 61,000 octal (about 25,000 decimal) words of core storage and a maximum of five tape (or disk) units.

IBM360 -

CHECKER requires 300K bytes for execution.

CRECT requires 150K bytes for execution.

12. PROGRAMMING LANGUAGE USED - FORTRAN IV

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE (CDC6600), OS/360 (IBM360)

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHORS -

6600 Odell Ozer
National Nuclear Data Center
Brookhaven National Laboratory
Upton, Long Island, New York 11973

360 E. M. Pennington
Applied Physics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (CRECT 6600-259 cards, 360-274 cards, CHECKER 6600-3192 cards, 360-3199 cards, RIGEL 6600-2060, LISTFC 6600-3172 cards, DICTION 6600-200 cards, PLOTFB 6600-4015 cards, SLAVE3 6600-2240 cards, OAMMET 6600-1957 cards)
Sample problem (CHECKER 360-8 cards)
Reference report, BNL-50300

17. CATEGORY - M

KEYWORDS - data processing, cross sections, computer graphics, ENDF/B, libraries, maintenance, information retrieval

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - CAGE/BIRD/SPEC
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - CAGE computes the time-energy neutron spectrum in a zero-dimension, multigroup, one- or two-point model according to a frequency collision method. CAGE is also embedded in BIRD. BIRD calculates the time-of-flight dependent correction factor to be applied to neutron time-of-flight spectra in order to correct them for neutron emission time effects and detector efficiency. This is done by computing the neutron time-of-flight spectrum with and without the distortion due to neutron emission, detector efficiency, etc., and computing the ratio of the two spectra for each time channel. SPEC performs the actual data processing job - background evaluation and subtraction, electronic deadtime correction, use of the correction factor computed by BIRD to convert the data from counts per unit of time to neutrons per unit of lethargy, statistical error analysis, grouping and editing.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - A maximum of 35 groups for the multigroup calculation for CAGE and BIRD. Deadtime correction routines of SPEC are designed for TMC 201, 211, and 212 1024-channel analyzers and for an on-line CDC1700. Other maxima include
 - 2000 neutron generations (CAGE)
 - 1100 neutron generations (BIRD)
 - 150 points in the reference fine group spectrum
 - 150 points in the detector efficiency table
 - 100 points in the flight-path transmission table
 - 2000 time channels for the correction-factor computation
6. TYPICAL RUNNING TIME - CAGE requires 3 minutes, BIRD 4 minutes, and SPEC 1 minute for a typical case.
7. UNUSUAL FEATURES OF THE PROGRAM - SPEC reads time-of-flight data from cards or tapes and writes the processed data onto tapes.
8. RELATED AND AUXILIARY PROGRAMS - CAGE and BIRD accept the input cross sections in the GGC format (NESC Abstract 298).
9. STATUS - Abstract first distributed January 1972.
UNIVAC1108 version submitted February 1971, additional material received June 1972.
10. REFERENCES - P. Doulliremont, D. Houston, and J. C. Young, CAGE-BIRD-SPEC, A Package FORTRAN-V System for the Reduction and Analysis of Neutron Time-of-Flight Spectra, GULF-RT-10195, November 18, 1970.
P. Doulliremont, Time-dependent Analysis of Subcritical or Non-multiplying Systems, Nuclear Science and Engineering, Vol. 37, pp. 104-110, 1969.
P. Doulliremont, and J. C. Young, A Multigroup Two-point Kinetic Model for the Time-dependent Analysis of Two-zone Fast Neutron Systems, Nuclear Science and Engineering, Vol. 40, pp. 339-342, 1970.
J. Adir and K. D. Lathrop, Theory and Method Used in the GGC-4 Multigroup Cross Section Code, GA-9021, October 1968.
11. MACHINE REQUIREMENTS - 64K memory and one 100K area of fast drum for CAGE and BIRD. 50K memory, 2 scratch files and, on option, several input/output files for SPEC.
12. PROGRAMMING LANGUAGE USED - FORTRAN V

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC8.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
P. Doullremont, D. H. Houston, and J. C. Young
Gulf Radiation Technology
Gulf Energy and Environmental Systems
P. O. Box 608
San Diego, California 92112
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (CAGE 370 cards, BIRD 505 cards, SPEC 727 cards)
Sample problems (CAGE 310 cards, BIRD 386 cards, SPEC 504 cards)
Sample problems punched output (BIRD 116 cards, SPEC 79 cards)
Sample problems output (CAGE 25 pages, BIRD 6 pages, SPEC 4 pages)
Reference report, GULF-RT-10195
17. CATEGORY - O
KEYWORDS - spectra, data processing, neutrons, statistics, background radiation
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - 3DXT/DEP3
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The neutronics solution is based on modified one-group theory. The material properties are represented by nodal values of the infinite multiplication factor, the migration length, fission cross section, and change in k -infinity due to insertion of a rod. The reflectors are represented by an extrapolated end point. Initial material properties are input and the codes alter the values to account for changes in temperature, xenon concentration, rod location, and depletion.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
3DXT maximum -
100 time-steps
DEP3 maximum -
30 time-steps with 1 to 5 xenon-steps per depletion-step
6. TYPICAL RUNNING TIME - A 3DXT static problem with a 777-node model requires 20 seconds, while a transient problem with criticality search and edit (also 777-node) requires 1 minute per xenon time-step. A DEP3 static problem with a 777-node model requires 20 seconds, while a transient problem with criticality search and edit (also 777-node) requires 3 to 5 minutes per depletion time-step.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The KAPL CalComp plotting routines (KAPLPLOT-NESC Abstract 496) are used.
9. STATUS - Abstract first distributed January 1972
CDC6600 version submitted February 1971
10. REFERENCES - W. M. Stacey, Jr., and D. C. Wade, 3DXT and DEP3 Three-dimensional Spatial Xenon Transient and Depletion Codes, KAPL-3494, June 1970
R. J. Cullen, 6600 CalComp Plotter Routines, Section II, KAPL Note, July 26, 1966
D. C. Wade, One and a Half Group Theory in the DEP3 Nodal Depletion Code, KAPL Note, September 29, 1970
11. MACHINE REQUIREMENTS - 64K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - To conserve central memory, input/output buffers may not exceed 1002 locations each. Subroutine PLTSIZE, called in both DEP3 and 3DXT, is a CalComp routine which arranges the plot output on 30-inch paper. It is called with two floating-point arguments, the width and height of the plot.
15. NAME AND ESTABLISHMENT OF AUTHORS -
W. M. Stacey, Jr. and D. C. Wade
Knolls Atomic Power Laboratory
General Electric Company

Box 1072
Schenectady, New York 12301

16. MATERIAL AVAILABLE - Restricted Distribution

Magnetic Tape Transmittal
Source decks (3DXT 5923 cards, DEP3 6887 cards)
Sample problems (3DXT 101 cards, DEP3 121 cards)
Sample problem output (3DXT 31 selected pages, DEP3 45 pages)
Reference report and KAPL Notes

17. CATEGORY - D

KEYWORDS - three-dimensional, xenon, one-group theory, depletion, criticality searches, feedback, KAPLPLOT codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - BETTIS ENVIRONMENTAL ROUTINES, MODEL 6/3 3, MODEL 7/2 0
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600, 7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
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 - The BETTIS ENVIRONMENTAL ROUTINES and MODEL are used by most of the Bettis programs. However, MODEL includes only file handling and storage allocation facilities
9. STATUS - Abstract first distributed January 1972
CDC6600 Bettis SCOPE 2 version submitted January 1967
CDC6600 Babcock & Wilcox SCOPE 3 1 version submitted February 1970, updated SCOPE 3 3 subroutines added October 1971, deleted May 1979
CDC6600 MODEL SCOPE 3 1 version submitted June 1970, replaced by SCOPE 3 2 version November 1971, deleted May 1979
CDC6600 MODEL SCOPE 3 3 version submitted December 1971
CDC7600 MODEL SCOPE 2 0 version submitted May 1972, replaced by revised edition March 1974
10. REFERENCES - C. J. Pfeiffer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967
R. S. Horeck, L. A. Boelter, and R. W. Morstad, MODEL - Modified Environmental Library, CDC-6600 FORTRAN Programming Guide, CDC Report, September 1971
B. W. Yeatts and L. A. Boelter, MODEL - Modified Environmental Library, Version 6/3 3 Installation Guide, CDC Report, December 1971
L. A. Boelter, MODEL - Modified Environmental Library, CDC-7600 FORTRAN Programming Guide, CDC Report, May 1972
L. A. Boelter, MODEL - Modified Environmental Library, Version 7/2 0 Installation Guide, CDC Report, May 1972
Revised MODEL Routines CDC7000, Combustion Engineering Internal Memorandum, March 1974
11. MACHINE REQUIREMENTS - For the Bettis version 65,356 words of 60-bit core storage (more or less can be used), a system (6603) disk, at least 2 magnetic tapes, at least 4 non-system disks, each on its own channel, and CDC-280 plotting hardware
For the MODEL versions 65,356 words of 60-bit core storage (more can be used), 2 magnetic tapes, and 4 mass storage devices, each on its own channel
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and ASCENT (Bettis), FORTRAN IV and COMPASS (MODEL 6/3 3, MODEL 7/2 0)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 2 0 (Bettis), SCOPE 3 3 (MODEL), SCOPE 2 0 (MODEL 7/2 0)

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The operating systems to be enhanced by MODEL 6/3 3 and MODEL 7/2 0 are CDC6600 SCOPE 3 3 and CDC7600 SCOPE 2 0, respectively. The user must provide a site-configured SCOPE 3 3 or SCOPE 2 0 source code file, in UPDATE program library format. UPDATE is the SCOPE source language library maintenance program, as documented in the SCOPE reference manual. As a result of the installation procedure, a SCOPE 3 3 or SCOPE 2 0 deadstart tape with MODEL routines and a corresponding source file will be produced. The MODEL 6/3 3 FORTRAN-coded routines must be compiled using the RUN compiler or variations thereof, while the MODEL 7/2 0 FORTRAN-coded routines use the FTN compiler. The COMPASS-coded routines must be assembled using the COMPASS 2 0 assembler.

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

Bellis	C. J. Pfeifer Bellis Atomic Power Laboratory Westinghouse Electric Corporation Box 79 West Mifflin, Pennsylvania 15122
B&W	M. L. Dech and R. W. McGraney Control Data Corporation G. R. Poetsch and G. L. Russell Power Generation Division Babcock & Wilcox Company P. O. Box 1260 Lynchburg, Virginia 24505
MODEL	B. W. Yeatts, R. S. Horeck, L. A. Boelter, and R. W. Morstad Control Data Corporation Minneapolis, Minnesota 55440
MODEL 7000 revised	Robert Kirkman Combustion Engineering, Inc. P. O. Box 500 Windsor, Connecticut 06095

16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (Bellis 21,123 cards, MODEL 6/3 3 1022 BCD records, revised MODEL 7/2 0 18,889 cards)
Reference reports

17. **CATEGORY** - P

KEYWORDS - data processing, operation, libraries, maintenance

18. **SPONSOR** - AEC Division of Naval Reactors

1. NAME OR DESIGNATION OF PROGRAM - FREADM1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - GE635
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Time integration of the equations for the dynamics of nuclear kinetics, heat transfer and primary-loop coolant flow may be performed in a coupled mode, or independently. Transient temperature conditions computed for single pins, representative of a number of bundle types, may be used to initiate prescribed accident initiating and/or propagating activities. The user supplies criteria for initiating these activities. Reactivity feedback from the various activities may be computed using models in the code, or input from tables.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - FREADM1 is restricted to accidents which initiate and propagate uniformly within annular or cylindrical coaxial core regions. Heat transfer calculations for up to 12 radial core regions may be performed simultaneously with up to 12 separate bundle types subdivided into 8 or fewer axial sections. Radial heat transfer calculations are done using up to 10 radial fuel nodes, a clad node and a coolant node for each axial section. Loop flow may be treated using a maximum of two independent primary-coolant loops (loops may be of different sizes to simulate more than two loops). Point kinetics with up to six delayed neutron precursor groups is used to compute the transient power level of the core.
6. TYPICAL RUNNING TIME - Running time for FREADM1 is strongly dependent on the options utilized and values supplied for time-step control. 200 kinetics time-steps with Doppler feedback for 12 bundle types and 9 axial sections require about 0.9 minutes of GE635 processor time. 87 coupled kinetics and heat transfer time-steps using 12 bundle types and 9 axial sections require about 4.4 minutes of GE635 processor time. 32 coupled loop flow, kinetics and heat transfer time-steps using 12 bundle types and 9 axial sections require about 5 minutes of GE635 processor time. Computation time per time-step for heat transfer calculations is proportional to $NBT \cdot NAX$ where NBT = number of bundle types and NAX = number of axial sections. Computation time per time-step for an independent loop flow and voiding calculations is about 15 seconds of GE635 processor time.
7. UNUSUAL FEATURES OF THE PROGRAM - FREADM1 is highly flexible both in the complexity of the problem solved and the selection of solution methods. Loop flow, kinetics and heat transfer calculations may be done separately or in a coupled mode. Trigger logic provided in FREADM1 permits the sequence of accident initiating and propagating activities to be determined based on computed local conditions reaching preset levels input by the user. Tables are available which permit a flexible description of the processes for parametric studies. By controlling the time-step size in the kinetics calculation, time-steps for heat transfer and loop flow calculations are performed with time-steps determined by accuracy requirements on these processes only. An integral number of kinetics steps may be taken per heat transfer step. Input to the code is free form with much input optional.
8. RELATED AND AUXILIARY PROGRAMS - FREADM1 will compute the accident through core disassembly. Integration of the nuclear kinetics equations is as performed in FORE2 (NESC Abstract 174).
9. STATUS - Abstract first distributed January 1972
GE635 version submitted March 1971

10. REFERENCES - D. D. Freeman, E. G. Lell, D. J. Bender, and W. G. Meinhardt, The FREADM-1 Code - A Fast Reactor Excursion and Accident Dynamics Model, GEAP-13608, September 1970.
FREADM1 Subroutine Descriptions including -
LINK and LLINK GE System Subroutines,
ISERVE, GE 635 Computer Service Function,
F4TRBK, F4TRAC, F4TRID, FORTRAN I/O Error Processing,
ERRSYS, FORTRAN Compatible Error Subroutine.
E. Y. Morikawa, ERRUNS - Entry in Library Subroutine ERRSYS, GESJ Note, November 11, 1968, and
FSNOW, Save File Code Function.
11. MACHINE REQUIREMENTS - 24K memory with 3 peripheral storage units
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GECOS-III.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
D. D. Freeman, E. G. Lell, D. J. Bender,
and W. G. Meinhardt
Breeder Reactor Development Operation
General Electric Company
Sunnyvale, California 94086
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (10,174 cards)
Sample problem (476 cards)
Sample problem output (40 selected pages)
Reference report and Subroutine Descriptions
17. CATEGORY - G
KEYWORDS - fast reactors, accidents, transients, kinetics, coolants, heat transfer, cylinders, FORE2 codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FUMBLE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - GE635
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Fuel burnup calculations are carried out in each reactor region (e.g., core region 1, core region 2, axial blanket region 1, etc.) using a region-dependent one-group flux, and region and material-dependent one-group capture and fission cross sections which are supplied as input from a separate multigroup diffusion (transport) calculation. Two sets of data from related multigroup calculations may be input to FUMBLE and used as end-point cases for interpolation of the fluxes, volumes and cross sections. Region and material-dependent reactivity worths are used in FUMBLE to calculate the combinations of recycle and make-up materials for reload fuel that satisfy both required reactivity and a specified power distribution in going from one operating interval to another.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Variable-dimensioned arrays are used exclusively within the program, hence the only problem size restriction is dictated by the amount of available computer memory.
6. TYPICAL RUNNING TIME - A detailed problem consisting of 30 reactor regions, 10 operating intervals, 8 fuel materials and requesting all output options requires 2 minutes of central processor time on the GE635 computer.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - FUMBLE and the two-dimensional synthesis diffusion code BISYN (NESC Abstract 287) are linked. Punched cards from a BISYN case give fluxes, volumes, cross sections, and reactivity worths in the FUMBLE format. Punched cards from a FUMBLE case give fuel material concentration in the BISYN format. BISYN output gives fluxes, volumes, cross sections and reactivity worths in the FUMBLE format.
9. STATUS - Abstract first distributed January 1972
GE635 version submitted May 1971
10. REFERENCE - P. Greebler, C. L. Cowan, FUMBLE, An Approach to Fast Power Reactor Fuel Management and Burnup Calculations, GEAP-13599, April 1970, and Errata.
11. MACHINE REQUIREMENTS - Minimum computer memory is 48K on the GE635. Two tapes and one auxiliary which may be required for some cases.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GECOS-III

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Subroutines LLINK and LINK are GE system routines which monitor overlay calls. The LINK subroutine enables the programmer to call program overlays. To load a link and transfer control to it, the required statement is CALL LINK(NAME) where NAME is a Hollerith name designating the name of the link as it appears on the \$LINK control card. To load a link and return to the next sequential statement of the calling routine, the required statement is CALL LLINK(NAME). Individual routines in the overlay may then be referenced.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
P. Greabier and C. L. Cowan
Breeder Reactor Development Operation
General Electric Company
Sunnyvale, California 94086
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source deck (8887 cards)
Sample problem (204 cards)
Sample problem output (30 selected pages)
Reference report and Errata
17. **CATEGORY** - D
KEYWORDS - economics, fuel cycle, depletion, fast reactors, BISYN codes
18. **SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - BUSHL
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The shell of revolution is discretized into a series of frustra with curved meridians. These discrete elements join at nodal circles. Starting with an initial estimate of the buckling load, the prebuckling equilibrium solution for this load is found through a modification of the cylinder option of GAPL3 (NESC Abstract 397). A perturbational displacement field within each element is specified in terms of displacements at the ends $x_i(i)$, and resolved into Fourier components in the circumferential direction. The changes in internal energy and external work produced by the $x_i(i)$ are found as functions of the prebuckling stresses and strains and the $x_i(i)$. Minimizing the total change of potential energy with respect to the $x_i(i)$ leads to a set of equations with the loading parameter as the eigenvalue and the $x_i(i)$ as the unknowns. The inverse power method is used to obtain the required eigenvalue, which is a critical load of the shell. A series of such critical loads is obtained by perturbing the equilibrium state into one particular circumferential harmonic at a time. The buckling load is the minimum of all such critical loads. The solution is iterated until the buckling load corresponds to the load used to find the prebuckling solution.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - BUSHL uses only one Fourier component for the circumferential variations of the buckling displacements restricting its applicability to shells of near cylindrical shape. BUSHL is best-suited for problems where the parameter $(L+2)/R$ is less than 1500 for cylinders. The lower limit for this parameter is governed by the limits of thin shell theory.
6. TYPICAL RUNNING TIME - Usually 3 to 10 minutes are required, depending on problem size and amount of plastic deformation.
7. UNUSUAL FEATURES OF THE PROGRAM - BUSHL is quite versatile and may be applied to most shell-buckling problems where the buckling mode is either lobar or axisymmetric. It is particularly appropriate when nonlinear material properties or large prebuckling deflections are involved. Among its distinguishing features are -
 - (a) large prebuckling deflections are permitted,
 - (b) elastic-plastic-anisotropic material properties are used,
 - (c) almost any end conditions may be considered, and
 - (d) shells with a variable thickness may be analyzed.
8. RELATED AND AUXILIARY PROGRAMS - Modified GAPL3 subroutines are used to obtain the prebuckling equilibrium solution. BUSHL uses the Bellis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed January 1972
CDC6600 version submitted April 1971
10. REFERENCES - A. L. Thurman, BUSHL - A Computer Program for the Inelastic Buckling of Shells of Revolution under External Pressure and Axial Compression, WAPD-TM-890, March 1971.
A. L. Thurman, GAPL-3 - A Computer Program for the Inelastic Large-deflection Stress Analysis of a Thin Plate or Axially Symmetric Shell with Pressure Loading and Deflection Restraints, WAPD-TM-791, June 1969.
C. J. Plesier, CDC-6600 FORTRAN Programming - Bellis Environmental Report, WAPD-TM-668, January 1967.

11. MACHINE REQUIREMENTS - Printer, on-line punch, plotter, and a minimum of 100,000 (octal) words storage
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The buckling of short tubes under hydrostatic pressure has been thoroughly checked out and verified, but shells with curved meridians have not been tested. The axial compression option has not been debugged.
15. NAME AND ESTABLISHMENT OF AUTHOR -
A. L. Thurman
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (4834 cards)
Sample problem (28 cards)
Reference report, WAPD-TM-890
17. CATEGORY - 1
KEYWORDS - shells, pressure, deformation, stresses, finite element method, BAPL3 codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - COMNUC/CASCADE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - In COMNUC Hauser-Feshbach theory as modified by Moldauer is used to determine competition in the decay of the compound nucleus. Physical models for the various reaction types permit the user to input parameters for those models. Direct reaction components may be provided by card input. These cross sections are combined with calculated compound nucleus cross sections to provide a complete self-consistent set of neutron cross sections at each incident neutron energy.
In CASCADE a coupled set of inhomogeneous Volterra equations of the second kind describing the energy dependence of the probability for particle termination of a gamma ray cascade is solved numerically. Branching ratios determined from these probabilities may be used as input to the COMNUC program.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
COMNUC - Only reaction types listed above may be analyzed, but other reactions such as n,p and n,α may be included easily.
CASCADE - Only dipole radiation is permitted in the gamma ray cascades. No discrete channels are permitted - only continuum particle emission.
6. TYPICAL RUNNING TIME - For low incident-neutron energies and few open channels COMNUC running time is about 15 seconds per case on an IBM360/65. Cases of the complexity of the sample cases can take as much as 15 minutes. Approximately 15 minutes are required on an IBM360/65 for a CASCADE case exercising all options and incident neutrons up to 5 MeV in energy.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - CASCADE generates gamma ray cascade branching ratios for input to COMNUC. Output from CASCADE can be used as input for COMNUC when calculating neutron capture cross sections.
9. STATUS - Abstract first distributed January 1972
IBM360 version submitted April 1971
10. REFERENCES - C. L. Dunford, A Unified Model for Analysis of Compound Nucleus Reactions, AI-AEC-12931, July 1970.
C. L. Dunford, Compound Nucleus Reaction Analysis Programs COMNUC and CASCADE, AI-TI-707-130-013, March 1971.
11. MACHINE REQUIREMENTS - 150K bytes
12. PROGRAMMING LANGUAGES USED - FORTRAN IV with one Assembler language subroutine for performing internal I/O
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 C. L. Dunford

Contact Alex Nickols, Code Coordinator
 Atomics International
 P O Box 309
 Canoga Park, California 91304

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
 Source decks (COMNUC-2240 cards, CASCADE-1110 cards)
 Sample problems (COMNUC-210 cards, CASCADE-20 cards)
 Reference reports
17. CATEGORY - A
 KEYWORDS - compound nuclei, cross sections, capture, fission, elastic scattering, inelastic scattering
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - REPP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - The mathematical model in REPP is a right circular cylindrical core containing fuel pins arrayed uniformly in a triangular or square lattice. A minimum of ten and a maximum of 100 axial mesh nodes may be used. The fuel centerline temperature is based on 21 radial nodes in the fuel pin and incorporates a variable thermal conductivity. A flux depression may be delineated in the input which is independent of the radial nodal mesh utilized in the code. The effect of fuel sintering on fuel temperature is optional and when used, the void diameter at the center of the fuel is determined. Nominal and hot-channel thermal and hydraulic conditions are predicted at each nodal location based on an energy and momentum balance. The Keenan and Kayes steam tables, provided in a subroutine, are used to evaluate the coolant properties at each node. The local energy generated and transferred to the coolant is determined from input consisting of the reactor power and a normalized axial power profile. The axial power distribution specified may be independent of the nodal mesh utilized in the code. A Lagrangian interpolation routine is used to expand the input array to be consistent with the nodal mesh used in the code. Integration is performed when required using Simpson's rule. The fuel spacer model uses the A. N. deStordeur technique to predict the pressure drop across spiral wire wrap, honeycomb, lenticular wire, or wire type spacers at the option of the user.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The effect of the restricted coolant flow areas in the corners of encased fuel assemblies on fluid flow (an inherent flow problem especially in two-phase flow) is not calculated. Also the cold wall influence on burnout heat flux is not evaluated. Interchannel mixing and flow distribution present some uncertainty. However, since the sizing technique is based on a theoretical hot channel, these restrictions need not be serious provided sufficient data on fuel performance is known to provide input to the code. Another restriction, the number of nodes capability (10 minimum to 100 maximum axial and 21 fuel pin radial nodes) has not to date seriously affected the accuracy of the results. The code is limited at present to water-cooled reactors, however, replacement of the steam tables with proper property values can extend the use of the code to other coolants. Also the W-2 and W-3 burnout correlations presently used can be replaced to accommodate other burnout correlations.
6. TYPICAL RUNNING TIME - Running time is dependent on the complexity of the problem. If initial conditions are relatively close to the solution, the running time may be as short as 8 to 10 seconds. Otherwise the iterative solution may require 30 seconds. A single pass through the code requires from 2 to 3 seconds.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed January 1972
UNIVAC1108 version submitted June 1971
10. REFERENCE - R. M. Hiatt and C. Bromley, Jr., REPP - A Thermal Hydraulic Design Code for Water-cooled Reactors, BNWL-1013, March 1969
11. MACHINE REQUIREMENTS - 51K addressable core storage

12. PROGRAMMING LANGUAGE USED - FORTRAN V
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - CSCX.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - There are 13 routines in REPP and no overlay links.
15. NAME AND ESTABLISHMENT OF AUTHORS -
R. M. Hiatt and C. Bromley, Jr.
Pacific Northwest Laboratories
Battelle
P. O. Box 999
Richland, Washington 99362
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (2569 cards)
Sample problem (43 cards)
Sample problem output (21 pages)
Reference report
17. CATEGORY - H
KEYWORDS - one-dimensional, heat transfer, pressure, temperature, water, coolants
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FIGS
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - A set of FORTRAN utility subroutines was written to supply the scientific programmer with an easily useable graphics language. The FORTRAN subroutines are grafted onto a basic machine language communication package for the IBM2250 supplied by the IBM Palo Alto Scientific Center
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM - FIGS includes an IBM2250 simulator package for users without the attached display unit. The terminal activity is replaced by hard-copy output for a CI120 or SC4020 and card input
8. RELATED AND AUXILIARY PROGRAMS - The subroutines for the SC4020 and CI120 hard copy device may be obtained from the Systems Maintenance Administrator, Executive Offices, North American Rockwell Corporation, El Segundo, California
9. STATUS - Abstract first distributed January 1972
IBM360 version submitted April 1971
10. REFERENCE - C. L. Dunford and Stanley Schwartz, FIGS, FORTRAN Interactive Graphics Support for an IBM 2250 Display Console, AI-TI-707-130-012, January 1971
11. MACHINE REQUIREMENTS - IBM360 computer with an attached IBM2250 display unit
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and BAL
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 C. L. Dunford

Contact Alex Nickols, Code Coordinator
Atomics International
P. O. Box 309
Canoga Park, California 91304
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (2324 cards)
Reference report
17. CATEGORY - P
KEYWORDS - data processing, computer graphics, interactive computing
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GASPAN
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - GASPAN analyzes output pulses from a lithium-drifted germanium semiconductor detector to define complex gamma-ray spectra of routine crud and filtrate samples
4. METHOD OF SOLUTION - The code accepts 1024 channels of data and recognizes photopeaks, doublets, Compton edges, backscatter peaks, and spurious peaks. Doublets are resolved and other false photopeaks are eliminated. The energy of significant peaks is determined and further analysis can be done on option. This includes identification of component nuclides, calculation of emission rates, correcting for decay, aliquot, and volume
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - GASPAN must be aligned with the particular detector system it uses. It will accept data for up to 1024 channels
6. TYPICAL RUNNING TIME - 8 seconds per sample are required
7. UNUSUAL FEATURES OF THE PROGRAM - Plotting of spectra can be done on option
8. RELATED AND AUXILIARY PROGRAMS - GASPAN was preceded by AUGAR
9. STATUS - Abstract first distributed January 1972
CDC6600 version submitted April 1971
10. REFERENCES - J. D. Michne, GASPAN, An Advanced Code for the Analysis of High Resolution Gamma-ray Spectra, KAPL-M-7179, (unpublished)
R. J. Cullen, 6600 CalComp Plotter Routines, KAPL Note, July 25, 1966
C. Hodgins, KAPL System Subroutines, KAPL Note, September 1969
11. MACHINE REQUIREMENTS - CDC6600 and CalComp plotter
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 requires a nuclide reference library, and uses the KAPLPLOT (NESC Abstract 496) CalComp plotter routines
15. NAME AND ESTABLISHMENT OF AUTHOR -
J. D. Michne
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (1473 cards)
Reference report and Notes
17. CATEGORY - 0
KEYWORDS - gamma radiation, spectra, data processing, AUGAR codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ANCON
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600, IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - In ANCON the system of coupled first-order differential equations is solved by a method based on continuous analytic continuation (references 2 and 3). The basic procedure consists of expanding all the dependent variables except reactivity in Taylor series, with a truncation error criterion, over successive intervals on the time axis. Variations of the basic procedure are used to increase the efficiency of the method in special situations. Automatic switching from the basic procedure to one of its variations (and vice-versa) may occur during the course of a transient. The method yields an analytic criterion for the magnitude of the time-step at any point in the transient.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The code is currently restricted to a maximum of six delayed neutron groups and a maximum of 56 lumps. Larger problems can be accommodated on a 65K computer by increasing the dimensions of a few subscripted variables. Also, the code is currently restricted to a constant external neutron source. Because there are no provisions for describing transport delays, only the open-loop response of a reactor can be computed with ANCON.
6. TYPICAL RUNNING TIME - Running time is highly problem-dependent, depending on such factors as the number of equations in the system, the feedback and heat balance options used, the time at which the transient is terminated, and whether the transient is slow or fast. Most problems that have been run with ANCON required 1 to 10 minutes on the CDC6600.
7. UNUSUAL FEATURES OF THE PROGRAM - The most important characteristic of the computational method is that it yields an analytic criterion for the magnitude of the time-step. This criterion is such that the time-step automatically expands or contracts, depending on the behavior of the dependent variables within each interval. The use of this criterion guarantees that the accumulated fractional error in each dependent variable is always less than $N \cdot E$, where N is the number of time-steps and E is an input truncation error parameter. Also, the code is structured in a form such that reactivity, heat balance, and source options other than those presently available can be incorporated with a minimum of code modification.
8. RELATED AND AUXILIARY PROGRAMS - The ANCON output is printed but not plotted because plotting codes are frequently system-dependent. However, the output is saved on logical unit TAPE1, which may be either a tape unit or a disk file. From TAPE1, the user can make plots with his own plotting routines.
9. STATUS - Abstract first distributed January 1972
CDC6600 version submitted May 1971
IBM360 version submitted December 1971, sample problem executed by NESC
10. REFERENCES - J. C. Vigil, ANCON User's Manual, LA-4616, May 1971
J. C. Vigil, Solution of the Nonlinear Reactor Kinetics Equations by Continuous Analytic Continuation, LA-3518, May 1, 1966
J. C. Vigil, Solution of the Reactor Kinetics Equations by Analytic Continuation, Nuclear Science and Engineering, Vol. 29, pp. 392-401, 1967
11. MACHINE REQUIREMENTS - ANCON requires 32K decimal words of central memory, one peripheral storage device, and the usual I/O devices (card reader, printer, and card punch). Standard system-library functions and a CLOCK routine are used. The CLOCK routine is not essential.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.2 (CDC6600) and OS/360 (IBM360).

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHORS -

6600 John C. Vigil
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87554

360 P. Henline
National Energy Software Center
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (6600-2148 cards, 360-2190 cards)
Sample problems (6600-36 cards, 360-39 cards)
Reference report, LA-4616

17. CATEGORY - E

KEYWORDS - reactor kinetics, delayed neutrons, reactivity, temperature feedback

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - STEAM-67
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - For the usual case, where pressure and/or temperature are known, the viscosity, specific volume, enthalpy or entropy may be calculated in either the liquid or vapor regions. In the vapor region, quality may be calculated as a function of pressure and entropy or enthalpy.
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 January 1972
IBM360 version submitted June 1970, replaced by revised Edition B January 1974,
replaced by revised Edition C July 1975
10. REFERENCES - R J Spitznas, STEAM-67 Tables, Baltimore Gas and Electric Note, May 18, 1970
C A Meyer, et al., Thermodynamic and Transport Properties of Steam, Comprising Tables and Charts For Steam and Water, New York, 1967
R B McClintock and G J Silvestri, Some Improved Steam Property Calculation Procedures, Transactions of the ASME, Vol 92, pp 123-134, April 1970
R B McClintock and G J Silvestri, Formulations and Iterative Procedures for the Calculation of Properties of Steam, ASME Publication (H-17), 1968
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV(G)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Due to precision requirements, all subprograms are written in double-precision. However, arguments are transmitted to and from calling programs in standard precision. Because of this interface between standard and double-precision, the user is cautioned to adhere strictly to the listed calls and parameters and not to use any other available entry points. An error-handling routine is included as part of the package. It will document nonconvergence or arguments out of acceptable range, listing the calling routine and its arguments.
15. NAME AND ESTABLISHMENT OF AUTHOR -
Raymond J Spitznas
Baltimore Gas and Electric Company
Gas and Electric Building
P O Box 1476
Baltimore, Maryland 21203
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (2409 cards)
Reference note, Tables and Charts, and ASME Transactions preprint

17. CATEGORY - H

KEYWORDS - thermodynamics, water, pressure, temperature, liquids, vapors

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - NOISY1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - An analytical expression for the specified quantities for the desired range of input parameters is evaluated. One-group diffusion theory is used with an arbitrary number of delayed neutron groups. The solutions are expansions in Helmholtz modes resulting in a six-dimensional series. Input is reduced through use of an input array generator.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maximum of 50 terms per dimension in the six-dimensional series. The limit is thus 50^{+6} or about 16-billion terms. This is large enough so that the limit is really budgetary. Automatic convergence checking limits the maximum number of terms to approximately 300,000.
6. TYPICAL RUNNING TIME - For auto-spectral density, approximately 10 seconds per point are required, for cross-spectral density, approximately 30 seconds per point.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - Two UNIVAC1108 auxiliary programs are used to generate CalComp graphs of output. SEARCH/DESTROY processes data elements generated by the program generating data for a CalComp graph drawing routine, SNOOPY.
9. STATUS - Abstract first distributed January 1972
UNIVAC1108 version submitted May 1971
IBM7090 version submitted by BNW May 1971, dated July 1978
10. REFERENCE - J. R. Sheff, User's Manual for NOISY1 - A Program for Calculation of Space Dependent Spectral Densities in Cubical Reactors, BNWL-1260, September 1970.
11. MACHINE REQUIREMENTS - 52K words memory
12. PROGRAMMING LANGUAGE USED - FORTRAN V
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - CSCX or EXEC2
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
James R. Sheff
James R. Sheff Company
2211 Camas Avenue
Richland, Washington 99352
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (NOISY1 8712 cards, SNOOPY 859 cards, SEARCH/ DESTROY 493 cards)
Sample problem (NOISY1 337 cards)
Reference report
17. CATEGORY - F

KEYWORDS - correlations, spectral density, space dependence, reactor noise, SNOOPY codes, SEARCH/DESTROY codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - TRIFIDO
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 $(k-\beta)/L$ and reactivity by means of the Gareis-Russell method, and reactivities using the Gozani and Sjostrand methods.
4. METHOD OF SOLUTION - A least-squares weighted fit is used for the decay constant and extrapolated population calculation. Iteration is used for the Gareis-Russell method.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The code is presently restricted to 256 experimental data points (for example, those provided by a TMC multichannel analyser). This is adequate for most pulsed neutron measurements. The restriction can be easily overcome if necessary by changing a dimension card. Minor parameter adjustments are needed determined by experimental conditions.
6. TYPICAL RUNNING TIME - This time depends mainly on the number of cases processed in one run. On an IBM360/85 times are about 2.54 seconds for 1 case, 4.78 seconds for 4 cases, and 12.3 seconds for 10 cases.
7. UNUSUAL FEATURES OF THE PROGRAM - The code calculates several pairs of decay constants and extrapolated population of the fundamental prompt neutron mode varying the starting analysis channel (initial time). Since the code selects as fundamental prompt mode values those which provide the best agreement between fitted and experimental values, it can proceed directly to calculate $(k-\beta)/L$ and reactivity values. Thus all these kinetic parameters are obtained in just one computer run. In order to provide a visual check, the code plots a graph of the experimental data, corrected by noise and deadtime effects, and fitted values.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed January 1972
IBM360 version submitted June 1971, sample problem executed by NESC
10. REFERENCES - F. D'Filippo and N. Pieroni, TRIFIDO, Code for Calculating Kinetics Parameters in Pulsed Neutron Experiments, CNEA-Re44, August 1970.
Edward Gareis and John L. Russell, Jr., Theory of Pulsed Neutron Source Measurements, Nuclear Science and Engineering, Vol. 16, pp. 263-270, 1963.
T. Gozani, The Theory of the Modified Pulsed Source Technique, EIR-Bericht No. 79, April 1965.
N. G. Sjostrand, Measurements on a Subcritical Reactor Using a Pulsed Neutron Source, Arkiv for Fysik, Vol. 11, pp. 233-246, 1957.
11. MACHINE REQUIREMENTS - 11K words of 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 AUTHORS -
F. D'Filippo and N. Pieroni
Comision Nacional de Energia Atomica
Departamento de Reactores

Ada. del Libertador 8250
Buenos Aires, Argentina

16. MATERIAL AVAILABLE -

Source deck (428 cards)
Sample problem (8 cards)
Reference report, CNEA-Re44

17. CATEGORY - E

KEYWORDS - kinetics, least square fit, prompt neutrons, pulsed neutron techniques

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - MOD5
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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} .
4. METHOD OF SOLUTION - The code is based on a discrete Markov slowing-down model developed by the author. The energy range of interest in the slowing-down region is divided into an arbitrary number of states and a Markov matrix is constructed which defines the probabilities for transition from one state to another in some finite time interval. The neutron density (defined as a vector over the state structure) is evolved in time by repetitive multiplication of the density vector into the transition matrix. Currently cross sections are derived from the 26-group Russian set. Capture, fission, and leakage events are accounted for in three absorbing states.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 5 isotopes
 - 71 real energy states
 - 201 virtual energy states
 - 26 broad groups for input cross sections
 - 400 time-steps
 - 21 time moments
 - 10 groups from which inelastic scattering can take place
 The program has been modified to handle up to 701 virtual energy states and 201 real states.
6. TYPICAL RUNNING TIME - On the IBM360/67 the running time in seconds is given approximately by the formula $t = 0.004 n \cdot n_v + 10$ where n is the number of real states and n_v is the number of virtual states.
7. UNUSUAL FEATURES OF THE PROGRAM -
 - (a) Elastic scattering transition probabilities are calculated with a new stochastic algorithm, reference 1.
 - (b) The state structure can be calculated by the code to provide optimal (most accurate) treatment of elastic scattering.
 - (c) Calculation times may be greatly reduced by allowing the transition matrix to follow the neutron distribution. This traveling array technique may also allow a much finer state structure for a given core capacity.
 - (d) A unique transition matrix generating technique provides transition matrices that are consistent, accurate, and stable regardless of energy range or time-step width.
8. RELATED AND AUXILIARY PROGRAMS - SLOAD arranges the cross section library in proper format and loads it on the appropriate direct access device.
9. STATUS - Abstract first distributed January 1972.
IBM360 version submitted June 1971, sample problem executed by NESC.

10. REFERENCES - T. J. Williamson and R. W. Albrecht, A Direct Stochastic Model for Neutron Moderation, Nuclear Science and Engineering, Vol. 37, pp. 41-58, 1969.
T. J. Williamson and R. W. Albrecht, Calculations of Neutron Time-Energy Distributions in Heavy Moderators, Nuclear Science and Engineering, Vol. 42, pp. 89-111, 1970.
L. P. Abagyan, et al., Group Constants for Nuclear Reactor Calculations, Consultants Bureau, 1964.
T. J. Williamson, MOD5 User's Manual, NPS-61WN71061A, 1971.
11. MACHINE REQUIREMENTS - 175K bytes memory, normal input, output, program, and punch units, 8 cylinders of IBM2314 or equivalent direct-access storage
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - IBM360 CP-CMS.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
T. J. Williamson
Physics Department, Code 61WN
Naval Postgraduate School
Monterey, California 93940
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (MOD5 2600 cards, SLOAD 103 cards)
Sample problems (MOD5 23 cards, SLOAD 1992 cards)
Reference report, NPS-61WN71061A including the two NS and E reprints
17. CATEGORY - E
KEYWORDS - multigroup, slowing-down, spectra, time dependence, stochastic processes, scattering, SLOAD codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - RAMP1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 II data format. Cross sections may be Doppler-broadened if so desired.
4. METHOD OF SOLUTION - The Reich-Moore approximation as described in reference 2 is used.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The program assumes that the resolved resonance parameters are given for a single energy range for all isotopes and can handle resonance data up to a maximum of 10 different isotopes with a total of 500 resonances over all isotope energy ranges and L values and an L value not exceeding 5. The mesh points at which the cross sections are calculated can be varied. Since the calculated data are not stored, an increase in the number of mesh points does not conflict with any storage requirements.
6. TYPICAL RUNNING TIME - Calculations of 4 isotopes involving a total of 294 s- and p-wave resonances take 11 seconds of central processor time per 100 energy points on the CDC6600.
7. UNUSUAL FEATURES OF THE PROGRAM - The Doppler broadening is done using numerical methods and can handle p-wave resonances and resonances corresponding to higher partial waves.
8. RELATED AND AUXILIARY PROGRAMS - Other ENDF/B Version II processing codes for the resonance region are SIGLOT (NESC Abstract 377) and AVRAGE3 and 4, SIGMA2, and ADLER (NESC Abstract 465).
9. STATUS - Abstract first distributed January 1972.
CDC6600 version submitted June 1971, replaced by revised edition December 1971.
10. REFERENCES - M. R. Bhat, ENDF/B Processing Codes for the Resonance Region, BNL-50296 (ENDF-148), June 1971.
C. W. Reich and M. S. Moore, Multilevel Formula for the Fission Process, Physical Review, Vol. 111, pp. 929-933, 1958.
11. MACHINE REQUIREMENTS - 40K (octal) memory.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV.
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.0.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
M. R. Bhat
National Nuclear Data Center
Brookhaven National Laboratory
Upton, Long Island, New York 11973
16. MATERIAL AVAILABLE -
Source deck (1127 cards)
Sample problem (22 cards)
Reference report, BNL-50296
17. CATEGORY - A
KEYWORDS - scattering, capture, fission, cross sections, Doppler broadening, Reich-Moore formula, resonance, ENDF/B

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - TROUT
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - GE635, UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - TROUT is a file maintenance program which allows the user to alter, merge, delete, overlay or create multigroup cross section files in MUG format.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Up to four file tapes may be mounted and merged into a single file tape. A file tape may not have more than 30 files.
6. TYPICAL RUNNING TIME - A 4-group cross section file is generated from card input in about 10 seconds. The optional print capabilities of the program can greatly increase the run time.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - TROUT uses the GE NPOST-RWSBT input/output routines. A FORTRAN version of these is included with the UNIVAC1108 package. TROUT also does tape handling as required by SYN (NESC Abstract 495).
9. STATUS - Abstract first distributed January 1972.
UNIVAC1108 version submitted August 1969.
GE635 version submitted June 1971.
10. REFERENCES - R. A. Davis, W. A. Duncan, M. D. Kelley, TROUT, A System of File Tape Maintenance Routines, APED-4738.
GE Nuclear Energy Division System Routines, ACC Collection, October 1971.
11. MACHINE REQUIREMENTS - 25K of fast memory, 6 tape drives, and 4000 words of peripheral storage (GE635)
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GEOS III (GE635) and EXEC2 (UNIVAC1108).
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Computer must have the ability to use READ after WRITE instructions. Machine-dependent calls make use of this ability to transfer data directly from memory to any peripheral device and hence, shorten the required run time.
15. NAME AND ESTABLISHMENT OF AUTHORS -
R. A. Davis, W. A. Duncan, and M. D. Kelley
Nuclear Energy Division
General Electric Company
175 Curtner Avenue
San Jose, California 95125
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (635-2482 cards, TROUT 1108-1908 cards)
Sample problem (635-167 cards, 1108-414 cards)
Auxiliary routines (NPOST Assembly 1108-799 cards, NPOST FORTRAN 1108-600 cards)
Reference report
17. CATEGORY - M
KEYWORDS - libraries, information retrieval, multigroup, cross sections, maintenance, SYN codes

1. NAME OR DESIGNATION OF PROGRAM - ADEP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6400
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The alternating direction explicit method or exponentially-transformed alternating direction explicit method is used. One set of fuel and coolant temperatures determined from the average power generation is used for each region with the region cross sections adjusted according to these temperatures. External adjustment of regional cross sections during the transient can be accomplished by specifying a linear rate for change over a time interval.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Variable dimensioning permits flexibility in the number of energy groups, number of delayed precursors, number of regions, and number of mesh points. Problems are initiated from equilibrium conditions. Zero flux boundary conditions apply at all surfaces.
6. TYPICAL RUNNING TIME - On a CDC6400 the range can be from 1 minute to an hour depending on the problem. The sample problem takes 3 minutes.
7. UNUSUAL FEATURES OF THE PROGRAM - A steady-state subroutine can be used to calculate consistent initial conditions or adjoint fluxes. This subroutine can also be used to determine the point kinetics parameters ρ , β , and λ for a given configuration. Problems can be restarted from tape. Time-step size can be varied but no automatic time-step size assignment is included in the program.
8. RELATED AND AUXILIARY PROGRAMS - The ADEP1 and ADEP2 codes are superseded by this version.
9. STATUS - Abstract first distributed January 1972
CDC6400 version submitted August 1971
10. REFERENCES - R. S. Denning, ADEP, One- and Two-dimensional Few-group Kinetics Code, BMI-1911, July 1971.
11. MACHINE REQUIREMENTS - 40,000 (octal) memory needed to load the basic program.
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 - Variably-dimensioned arrays are stored at the end of blank common and addresses are transferred through the arguments of subroutines. The computer must be instructed not to reduce the field length after loading.
15. NAME AND ESTABLISHMENT OF AUTHOR -
R. S. Denning
Columbus Laboratories
Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (1743 cards)
Sample problem (42 cards)
Reference report

17. CATEGORY - F

KEYWORDS - one-dimensional, two-dimensional, few-group, diffusion, delayed neutron precursors, feedback, space-time, reactor kinetics, excursions, ADEP1 codes, ADEP2 codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SYN

2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - GE636

3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.

4. METHOD OF SOLUTION - The BISYN approach is to run one or two initial one-dimensional flux solutions in the dimension specified by the user. From the initial solution(s), group and region dependent bucklings are calculated for up to five one-dimensional flux and adjoint solutions in the orthogonal dimension. These solutions are then normalized to become shape functions. Each shape function is then used to calculate flux and adjoint weighted cross sections averaged over the full span of that shape function for every region(s) in which it is to be used. Thus, region-dependent cross sections are obtained which vary only in the dimension selected for the initial solution(s). A final solution is then performed in this dimension, using the collapsed cross sections, to generate a group and mesh dependant set of fluxes and adjoints plus an eigenvalue. The shape functions are then combined with the final solution to synthesize a two-dimensional set of real and adjoint fluxes. Extensive edit routines are available to calculate the power distribution, neutron balance, etc. as is a perturbation routine which will calculate $\delta k/k$ by region, subregion, or by mesh point.

BICYCL converts the two-dimensional output data from BISYN to one-dimensional input data. Each burnable region is assigned to a fuel type with the necessary condition that all regions within a fuel type have the same initial isotopics. BICYCL then uses the integrated form of the general time-dependent differential equation $dn/dt = \text{rate of production} - \text{rate of destruction}$. This form of the equation is used in the solution of the combined thorium-uranium chain plus four independent fission product aggregates (excluding xenon and samarium which are treated separately) for each fuel type. The program then performs the necessary search options (burnup-makeup-recycle) to obtain a requested reactivity (the reactivity calculations are done by perturbation theory). Once the reactivity is satisfied (a cycle) it then proceeds to calculate an estimate of the isotopics for the next cycle. When the cycle has the isotopics within a given epsilon of the previous cycle then the problem is considered to be at equilibrium. Interior to a cycle the fuel may be shuffled in a pre-determined manner.

5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -

BISYN and BICYCL maxima -

- 8 regions in either dimension
- 74 intervals in either dimension (75 nodes)
- 16 lethargy groups
- 8 downscatter groups
- 120 different isotopes
- 40 isotopes per composition
- 64 compositions
- 2 initial solutions
- 5 shape functions
- homogenization of regions for shape functions

BICYCL maxima -

- 40 fuel types
- 20 time-steps
- 5 shuffling sequences per fuel type
- 26 isotopes in burner chain

6. **TYPICAL RUNNING TIME** - A BISYN problem with 6 radial regions, 5 axial regions, 2 initial solutions, 4 shape function solutions, average edit control plus a BICYCL problem with 20 fuel types, 29 regions, recycle search option, and minimum edit control uses approximately 8 minutes of GE635 processor time
7. **UNUSUAL FEATURES OF THE PROGRAM** - BISYN may calculate shape functions in non-multiplying regions (blankets, reflectors) using a leakage source from the shape function of an adjacent region, or may be set up simply by copying a previous shape function with the fluxes in lethargy groups $x+1$ to $imax$ set equal to the flux in group x . The program has the option of checking for negative total removal cross sections by group(s) and region(s) plus noting where they occur. The user has the option of zeroing out the buckling or the removal cross section before the flux solution is run. If no action was taken on encountering negative removal cross sections and the flux becomes negative then the user has the option of a) terminating the problem, b) setting to zero those buckling values corresponding to those groups and regions for which the flux was negative, or c) setting to zero those removal cross sections corresponding to those groups and regions for which the flux was negative.
BICYCL uses multigroup perturbation theory for calculating reactivity ignoring all matrix terms. The program, on option, may recycle fuel from any one fuel type to any other fuel type.
8. **RELATED AND AUXILIARY PROGRAMS** - RAPFU (NESC Abstract 372), FUMBLE (NESC Abstract 480), TROUT (NESC Abstract 493), and the NPOST-RWSBT system of input/output routines
9. **STATUS** - Abstract first distributed January 1972
GE635 version submitted May 1971
10. **REFERENCES** - P. Graebler, et al., BISYN - A Two-dimensional Synthesis Program, GEAP-4822, July 15, 1965, and Supplement 1, December 1968
M. D. Kelley and T. R. Jones, BISYN-PERT - A Two-dimensional Perturbation Module for the BISYN System, GEAP-10048, April 1969
P. C. Vaughan, et al., BICYCL - A Computer Code for Two-dimensional Analysis of Equilibrium Fuel Cycles, GEAP-13556, December 1969
M. D. Kelley, SYN - Operational Aspects of the Combined BISYN, PERT, and BICYCL Synthesis Codes, GEAP-13572, December 1970
GE Nuclear Energy Division System Routines, ACC Collection, October 1971
11. **MACHINE REQUIREMENTS** - 51K of fast memory, 2 tape drives and 821,760 words of peripheral storage
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV and GMAP
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - GEOS III
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Each of the segments, BISYN and BICYCL, is divided into links (or core loads) with each link composed of a driver routine and its subordinate routines. The main BISYN routine has been relegated to subroutine status to conform to the link (overlay) structure
15. **NAME AND ESTABLISHMENT OF AUTHOR** -
M. D. Kelley
Breeder Reactor Development Operation
General Electric Company
Sunnyvale, California 94086
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal (2 tapes)
Source deck (37,250 cards)
Sample problems (101 cards)
Reference reports
17. **CATEGORY** - D

KEYWORDS - two-dimensional, multigroup, diffusion, x-y, r-2, synthesis, depletion, perturbation theory, RAPFJ codes, FUMBLE codes, TROUT codes

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM -** KAPLPLOT
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -**
CDC6600
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** 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.

XCYPLOT and YCYPLOT cause alphabetic information to be written parallel to the direction of the abscissa axis, XCYPLOT, or the ordinate axis, YCYPLOT.

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.
4. **METHOD OF SOLUTION -**
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Plotter resolution is 0.005 inches. This means the plotter can move to within 0.0025 inches of any specified point on the paper. Therefore, it is of no value to guarantee more than 3 decimal digits of accuracy in numbers which are to be plotted. The range of pen motion is limited. The pen may be moved only within a rectangle whose dimensions are 11 inches by 11 inches. These dimensions may be changed by calling PLTSIZE. On calling any of the drawing subroutines, if an attempt is made to move the pen outside the rectangle of allowable pen motion, the attempt will fail. The absolute plotting coordinates of points within the rectangle are from 0.0 to 11.0 in both directions (unless the maximum values are changed by calling PLTSIZE). If a negative x or y coordinate is given, zero will be used instead of the given value. If a coordinate which exceeds the allowable bound is given, the allowable bound will be used.
6. **TYPICAL RUNNING TIME -** The time used in plotting is proportional to the amount of pen motion which is done, whether or not the pen is actually drawing. The speed at which the pen is moved about the paper is proportional to the length of the move. To draw a 10-inch long line in one motion takes from 0.55 to 0.77 seconds, depending on the angle of the line. To draw the same 10-inch line in 0.01 inch increments would take 2.04 to 2.86 seconds. The difference in computer time is comparable.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -** This package is a part of the KAPL computer environment and is used by many applications problems, e.g. GASPAN (NESC Abstract 485), 3OXT/OEP3 (NESC Abstract 477).
9. **STATUS -** Abstract first distributed January 1972
CDC6600 version submitted August 1971
10. **REFERENCES -** KAPL Internal CalComp Subroutines, KAPL Document, March 31, 1971

11. MACHINE REQUIREMENTS - GRUN, LINLG, and LOGLN each require 2000 octal locations
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and ASCENT
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
J. Brooking
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (3267 cards)
Reference report
17. CATEGORY - P
KEYWORDS - data processing, libraries, computer graphics
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - REL01
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - REL01 computes the failure probability for a single failure mode. Two options are available: option 1 calculates the interaction of two normally-distributed variables and option 2 calculates the interaction of two truncated normally-distributed variables.
4. METHOD OF SOLUTION - The failure probability is calculated by means of a simplified Monte Carlo technique which randomly selects a value of the applied stress value and calculates the probability that the strength is smaller than the stress. The density of the failure distribution and the average failure probability are calculated for n such calculations.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The number of random selections of the applied stress is restricted to 2000.
6. TYPICAL RUNNING TIME - Less than 1 minute is required.
7. UNUSUAL FEATURES OF THE PROGRAM - REL01 calculates the interference of two truncated normal-distribution functions.
8. RELATED AND AUXILIARY PROGRAMS - REL01 uses the Bettis Environmental Routines (NESC Abstract 476).
9. STATUS - Abstract first distributed January 1972
CDC6600 version submitted September 1971
10. REFERENCES - D. R. Rauth, C. M. Smith, E. C. Strothers, REL01 - A Reliability Program for a Single Failure Mode, WAPD-TM-1009, May 1971.
C. J. Pfeifer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967.
J. D. Church and B. Harris, The Estimation of Reliability from Stress-strength Relationships, Technometrics, Vol. 12, pp. 49-54, 1970.
Z. Govindarajulu, Distribution-free Confidence Bounds for $P(X \text{ less than } Y)$, Annals of the Institute of Statistical Mathematics, Vol. 20, pp. 229-238, 1968.
D. B. Owen, K. J. Craswell, and D. L. Hanson, Nonparametric Upper Confidence Bounds for $PR(Y \text{ less than } X)$ and Confidence Limits for $P(Y \text{ less than } X)$ when X and Y are Normal, Journal of the American Statistical Association, Vol. 59, pp. 906-924, 1964.
11. MACHINE REQUIREMENTS - 110K (local) and standard I/O units.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.1
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
D. R. Rauth, C. M. Smith, and E. C. Strothers
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
Pittsburgh, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (460 cards)
Sample problem (5 cards)
Reference report, WAPD-TM-1009

17. **CATEGORY** - P
KEYWORDS - Monte Carlo method, statistics, stresses, failures
18. **SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - CONCEPT5/CONCEPT3
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370, UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - CONCEPT is based on the premise that any central station power plant involves approximately the same major cost components regardless of location or date of initial operation. The program has detailed cost models for each plant type at a reference condition. Through use of size, time, and location-dependent cost adjustments, a reference cost model is modified to produce a specific capital cost estimate.
CONCEPT is supported by two auxiliary programs--CONTAC, which generates and maintains the cost-model data file COMO, and CONLAM, which generates and maintains the equipment, labor, and materials historical cost data file LAMA.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - CONCEPT3 accepts power levels of 500 to 2000 MW(e), while CONCEPT5 accepts levels of 500 to 1500 MW(e). The auxiliary program CONLAM is limited to 30 time periods of cost history for 23 locations without program alterations.
6. TYPICAL RUNNING TIME - A single CONCEPT3 or CONCEPT5 cost estimate is generated in less than 1 minute.
7. UNUSUAL FEATURES OF THE PROGRAM - CONCEPT utilizes execution-time NAMELIST variations of stored constants, printer plotting cash flow curves, and numerous output and solution options.
8. RELATED AND AUXILIARY PROGRAMS - CONCEPT requires the use of CONLAM to generate a user file of labor and materials cost history and CONTAC to generate a user file of cost models to support CONCEPT.
9. STATUS - Abstract first distributed January 1972.
IBM360 version of CONCEPT submitted September 1971, replaced by CONCEPT2 March 1973, replaced by CONCEPT3 March 1974, replaced by CONCEPT4 April 1976, replaced by Edition B February 1977, replaced by Edition C May 1978, replaced May 1979 by CONCEPT5 version submitted February 1979, sample problem executed by NESC April 1979 on an IBM370/185.
10. REFERENCES - H. I. Bowers, R. C. DeLozier, L. D. Reynolds, and B. E. Srite, CONCEPT - Computerized Conceptual Cost Estimates for Steam-Electric Power Plants - Phase II User's Manual, ORNL-4809, April 1973, as amended by CONCEPT User's Memoranda 1-4, April-June 1973.
CONCEPT III Supplemental User's Instructions, ORNL Note, March 25, 1974.
R. J. Barnard, CONCEPT User's Memo #6, March 27, 1974.
R. J. Barnard, CONCEPT User's Memo #8, April 30, 1974.
H. I. Bowers, CONCEPT User's Memo #9, October 28, 1974.
C. R. Hudson, II, CONCEPT-5 User's Manual, ORNL-5470, January 1979.

11. MACHINE REQUIREMENTS - 150K bytes, one scratch disk or tape, two support tapes, and the standard I/O units are needed for CONCEPT3, less than 270K bytes, four scratch files, two support files, and the standard I/O units for CONCEPT5
12. PROGRAMMING LANGUAGES USED - FORTRAN IV (H) (98%) and Assembly language (2%) (IBM360), FORTRAN IV (UNIVAC1108)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 (IBM360) and EXEC8 (UNIVAC1108)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The CONCEPT5 main program and the CONTAC5 auxiliary program use a local BAL subroutine called IDAY. The routine is used to obtain the date of the run. The ORNL routine is included in the package but should be replaced with the equivalent subroutine in the local environment.
15. NAME AND ESTABLISHMENT OF AUTHORS -
360 CONCEPT5 C R Hudson, II and H I Bowers
Oak Ridge National Laboratory
P O Box Y
Oak Ridge, Tennessee 37830
R C DeLozier and R J Barnard
Computer Sciences Division
Union Carbide Corporation, Nuclear Division
P O Box P
Oak Ridge, Tennessee 37830

1108 CONCEPT3 J E Gralleau and T J Zielinski
General Atomic Company
P O Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (CONCEPT3 1108-1872 cards, CONCEPT5 360-2448 cards, IDAY 360-63 cards)
Sample problems (CONCEPT3 1108-8 cards, CONLAM3 1108-3359 cards, CONTAC3 1108 42 files-737 cards each, CONCEPT5 360-304 cards, CONLAM5 360-3474 cards, CONTAC5 360 48 files with a total of 24,384 cards)
Control information (CONCEPT3 1108-47 cards)
Auxiliary programs (CONLAM3 1108-499 cards, CONTAC3 1108-647 cards, CONLAM5 360-499 cards, CONTAC5 360-579 cards)
Sample problem output (CONCEPT3 1108-79 selected pages)
Reference reports, Supplemental User's Instructions, and User's Memos, appropriate to version
17. CATEGORY - D
KEYWORDS - economics, power plants, PWR reactors, BWR reactors, HTGR reactors, CONCEPT codes, CONLAM codes, CONTAC codes
18. SPONSOR - DOE Energy Technology,
Office of Nuclear Energy Programs
NRC Division of Site Safety and Environmental Analysis

1. NAME OR DESIGNATION OF PROGRAM - MIRAB/MIRAP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC8400
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - A system of first-order differential equations having nonconstant coefficients was set up from the various mass flux and mass balance definitions which were written for the system. The numerous rate coefficient values needed for each term in these equations are computed in various subroutines of the main program. Those coefficients which depend only on temperature are computed in one set of subroutines while those which depend on both temperature and iodine concentration are computed in another subroutine. Physical property data required in these computations are calculated in yet another subroutine. The method is designed to use containment temperature data generated from a separate thermal analysis of the system. The rate and duration of iodine injection to the vessel and the relative proportions of each form are preselected by the user. The rate is restricted to a linear function of time. The program specifically models three volumes which are equivalent to a BWR drywell, wetwell, and refueling building. Natural deposition of iodine is assumed to occur by a natural convection mechanism, and deposition on both dry and condensing surfaces is considered. Iodine removal by sprays incorporates hydrolysis effects and also takes into account the influence of a distribution of drop sizes, drop coalescence, liquid-phase mass transfer resistance, and recycling of used liquid. Removal of particulate iodine considers the mechanisms of gravitational settling, diffusio-phoresis, and impaction or interception by spray drops. Separate efficiencies are used for the removal of the different iodine forms by filter units but these efficiencies must be supplied by the user. Well-mixed conditions are assumed to prevail in the large gas and liquid volumes in the system. For BWR reactors all leakage from drywell and wetwell regions is assumed to enter the refueling building, and escape from this building occurs via a filtered exhaust system.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - MIRAB will only accept temperature data from cards and is limited to the three iodine forms noted above. MIRAP is restricted to a single volume containment vessel and to the three iodine forms noted above.
6. TYPICAL RUNNING TIME - MIRAB requires approximately 30 seconds per 100 time-steps calculated. MIRAP requires approximately 15 seconds per 100 time-steps calculated.
7. UNUSUAL FEATURES OF THE PROGRAM - Both codes use a generalized approach to the iodine removal problem, i.e., they treat several processes occurring simultaneously instead of each one individually.
8. RELATED AND AUXILIARY PROGRAMS - MIRAB needs temperature data generated from a separate thermal analysis program. MIRAP was designed to accept thermal data as generated by an early version of the CONTEMP computer program (NESC Abstract 433).
9. STATUS - Abstract first distributed October 1972.
CDC8400 versions submitted November 1971, replaced by Edition B October 1975.
10. REFERENCES - R. L. Ritzman, MIRA-Methods for Iodine-Removal Analysis in Reactor Containment Systems, BMI-1915, August 1971.

11. MACHINE REQUIREMENTS - Each code uses 42K (octal) memory, card reader, line printer, and one tape.
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 IRKG subroutine is an initialization routine which computes initial derivatives and supplies starting data to RKG. RKG is the integration routine which utilizes the fourth-order Runge-Kutta-Gill method to supply the main program with the concentrations and their derivatives at all subsequent time increments. BILIN1 is a subroutine for linear interpolation from a table of spray drop unsaturation fractions as a function of their Sherwood number and the dimensionless time. BILIN1 was included in the package with Edition B.
15. NAME AND ESTABLISHMENT OF AUTHOR -
Robert L. Ritzman
Columbus Laboratories
Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (MIRAB 1025 cards, MIRAP 992 cards)
Sample problems (MIRAB 149 cards, MIRAP 591 cards)
Auxiliary program (BILIN1 64 cards)
Reference report
17. CATEGORY - G
KEYWORDS - fission products, iodine, containment, accidents, reactor safety, PWR reactors, BWR reactors, CONTEMPT-PS codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FRCL2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6400
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Analytical solutions to the conventional problem of one-dimensional diffusion from a sphere are used. For the preaccident release component uniform conditions are assumed over the period of reactor operation. Parabolic radial temperature profiles for the fuel pellets are computed and used to define five radial temperature zones for each core segment. From this the corresponding set of dimensionless release parameters are calculated for insertion in the analytical solution. For the accident release component the change in temperature versus time is considered by incrementally modifying the dimensionless release parameters for each of the core segments.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The calculation is limited to maxima of 12 fission product species, 10 radial core regions, and 11 axial core regions. Also, four separate sets of fission product diffusion parameter values must be supplied for different temperature ranges or assumed atmospheric conditions.
6. TYPICAL RUNNING TIME - Approximately 2 seconds per fission product species per accident time-step are required.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed October 1972
CDC6400 version submitted November 1971
10. REFERENCES - R. L. Ritzman and D. L. Morrison, FRCL2-A Computer Code for Calculating Fission-Product Release in Reactor Accident Analyses, BMI-1913, August 1971
11. MACHINE REQUIREMENTS - 62K (octal) memory, card reader, line printer
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 -
15. NAME AND ESTABLISHMENT OF AUTHORS -
Robert L. Ritzman
Columbus Laboratories
Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201
16. MATERIAL AVAILABLE -
Source deck (293 cards)
Sample problem (58 cards)
Reference report

17. CATEGORY - G
KEYWORDS - fission products, fuel elements, accidents
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ENDRUN2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - GE635
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Resolved resonance parameters are evaluated according to the Doppler-broadened Breit-Wigner, single-level line shape equations. Resonance contributions are averaged over each fine group with an extrapolated Romberg integration scheme. Unresolved resonance calculations employ an averaging over the chi-squared statistical distribution of resonance parameters. Self-shielding is accomplished by weighting with a $1/(\sigma(t) + \sigma(o))$ flux, where $\sigma(o)$ is an input value representing the total other-material cross section. Provisions are made for the overlap of resolved and unresolved resonance sequences and smooth data. Separate inelastic, elastic, and n,2n matrices are calculated.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - ENDRUN may be used on any ENDF/B material with fewer than 9 isotopes. A case may include up to 100 coarse groups and 30 fine groups per coarse group. Maximum transfer matrix size is 70×50 . Up to 5 $\sigma(o)$ values and 9 temperatures may be provided as input data for self-shielding.
6. TYPICAL RUNNING TIME - A simple 29-group case for any material without resonance data is processed in only a few seconds on the GE635. A similar case for U238 with all self-shielding options may run over an hour.
7. UNUSUAL FEATURES OF THE PROGRAM - ENDRUN is designed to allow maximum user flexibility in creating a multigroup file or testing data, e.g. several ENDF/B reactions may be combined in a single output cross section, any type of data or single cross section may be processed separately, input may come from cards, BCD or binary tape, or compressed binary tape, and matrices may be output separately or combined.
8. RELATED AND AUXILIARY PROGRAMS - ENDRUN2 is a descendant of the ENDRUN1 code of April 1970 and retains most of the major subroutines from the earlier code. It uses several of the ENDF/B retrieval subroutines in processing the ENDF/B data file and also the QUICKW table look-up routine from MC-2. A generalized data file tape (GMUB) may be created for direct use by the TDOWN code (NESC Abstract 505).
9. STATUS - Abstract first distributed October 1972
GE635 version submitted October 1971
10. REFERENCES - B. A. Hutchins, C. L. Cowan, M. D. Kelley, J. E. Turner, ENDRUN-11, A Computer Code to Generate a Generalized Multigroup Data File from ENDF/B, GEAP-13704 (ENDF-145), March 1971.
I. I. Bondarenko, Group Constants for Nuclear Reactor Calculations, Consultants Bureau, New York, 1964.
H. C. Honeck, ENDF/B Specifications for an Evaluated Nuclear Data File for Reactor Applications, BNL-50066, May 1966, Revised July 1967.
DRAW, GESV Note, January 15, 1969.
REREAD, CONVRT Subroutine Description, GESV Note, September 11, 1967.
11. MACHINE REQUIREMENTS - The code requires 52K memory, including a 10K overlap with loading routines. Up to 5 tapes and 7 auxiliary units (disks in the authors' environment) may be required, but the number of tapes may be reduced by use of permanent disk files with the card reader as the input unit.

12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV except for use of RWSBT and NPOST in the GE compressed binary input and output routines. FORTRAN versions of these routines are available, also.
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - GECOS III
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - Primary changes to convert this program to another machine would be in the input and output routines, auxiliary unit assignments, and the plotting routines which are particularly machine dependent.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
B. A. Hutchins, C. L. Cowan, M. D. Kelley,
and J. E. Turner
Nuclear Energy Division
General Electric Company
310 Deguigne Drive
Sunnyvale, California 94086
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (ENDRUN2 12,142 cards, QUICKW 276 cards, auxiliary routines 503 cards)
Sample problem (ENDRUN2 215 cards)
Control information (ENDRUN2 412 cards, QUICKW 26 cards)
Sample problem output (38 pages)
Reference report, GEAP-13704, and Notes
17. **CATEGORY** - B
KEYWORDS - multigroup, cross sections, Breit-Wigner formula, Doppler broadening, elastic scattering, inelastic scattering, fission, capture, ENDF/B, LMFBR reactors, ENDRUN1 codes, TDOWN codes
18. **SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - EDITOR
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360, CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - EDITOR processes materials, files (in the ENDF/B sense) or sections (reaction types) according to input instructions
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - A maximum of 50 materials may be handled in one batch, where a batch is a group of associated input instructions. A maximum of 5 files per material and 15 sections per file may be requested in each batch. Files 1 to 5, 7, 12 to 15, and 23 will be processed by the program. Other files will be ignored
6. TYPICAL RUNNING TIME - The sample problem compiles and executes on the IBM360 in less than 3 minutes
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed October 1972
IBM360 version submitted September 1971, replaced by Edition B February 1973,
sample problem executed by NESC April 1973
CDC6600 version submitted February 1973
10. REFERENCES - C. L. Thompson, J. R. Stockton, L. M. Petrie, R. Q. Wright, S. K. Penny, EDITOR, A Processing Code For ENDF/B Format Data, ORNL-TM-3288 (ENDF-142), February 1971
11. MACHINE REQUIREMENTS - Approximately 300K bytes of core
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 (IBM360), SCOPE (CDC6600)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - EDITOR may be used to append materials to an existing tape, if the original tape is not blocked
15. NAME AND ESTABLISHMENT OF AUTHORS -
C. L. Thompson, J. R. Stockton, L. M. Petrie,
R. Q. Wright, and S. K. Penny
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (360-3044 cards, 6600-3057 cards)
Sample problems (360-4 cards, 6600-5 cards)
Control information (JCL 360-12 cards)
Libraries (360-430 cards, 6600-430 cards)
Sample problem output (360-26 selected pages, 6600-27 selected pages)
Reference report
17. CATEGORY - M
KEYWORDS - data processing, cross sections, libraries, ENDF/B, maintenance, information retrieval
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - DUZ2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - A cyclic Chebyshev semi-iterative method is used. A symmetric nonnegative definite matrix which relates displacement components is derived by the finite element method. The elastic displacement solution is obtained using cyclic Chebyshev with simultaneous iterations. Plastic problems are solved by the initial strain method, whereby plastic strains are treated as thermal strains in an outer iteration, and the elastic solution constitutes an inner iteration. Stresses and other edit quantities are then calculated from elastic displacements and plastic strains.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The program provides for up to 99 regions, to describe material properties and boundary conditions. There may be up to 5000 points in a rectangular array, with at most 250 mesh rows or columns. Because of the initial strain method, plastic strains should not be significantly larger than elastic strains.
6. TYPICAL RUNNING TIME - Over a two-month period, successful user runs were observed to average 282 seconds, ranging from 37 to 1786 seconds. Most long jobs are not run all at once, but in 500-second shots with force-offs and restarts.
7. UNUSUAL FEATURES OF THE PROGRAM - The program treats nonhomogeneous material properties which are temperature dependent. Temperature profiles may be obtained from HOT2 which uses an identical rectangular mesh-point grid and region overlay. Boundary displacements and stresses may be linear functions of r and z . Inelastic stress-strain relations may be input as piecewise linear curves or power fits. Several edit quantities including stress intensity, generalized stress, and principal stresses, can be plotted in contour or perspective, or printed.
8. RELATED AND AUXILIARY PROGRAMS - Temperature files from HOT2 (NESC Abstract 286) can be read. Displacement files can be requested for restarting DUZ2 or for use with other programs. A file of stresses and strains can also be requested for use with other programs. DUZ2 uses the Bettis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed October 1972
CDC6600 version submitted October 1971
10. REFERENCES - C. M. Friedrich, W. H. Gurlinger, L. A. Hageman, C. Jeffrey, W. D. Peterson, DUZ-2: A Program for Solving Axisymmetric and Plane Elastic-Plastic Problems on the CDC-6600, WAPD-TM-926, September 1970.
C. J. Pfeiffer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967.
W. D. Peterson and J. Spanier, HOT2 - A Two-dimensional Transient Heat Conduction Program for the CDC-6600, WAPD-TM-669, June 1967.
11. MACHINE REQUIREMENTS - The program was written for a CDC6600 with a central memory size of at least 64K, reader, printer, a system disk and 4 non-system disks each on its own channel. The program makes optional use of extended core storage and CDC-280 microfilm output.
12. PROGRAMMING LANGUAGES USED - Although the program is written primarily in FORTRAN IV, certain inner loop routines were optimized using COMPASS. Also, the program calls on COMPASS routines which are a part of the Bettis computing environment.
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3 1

14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The program is organized for overlay loading under the SCOPE 3.1 system. There is a main overlay, or root, which resides in central memory at all times, and fourteen primary overlays and three secondary overlays. The root contains many of the FCHIP routines, including NEXT, which loads each overlay as needed. The two secondaries contain mutually exclusive routines for the input primary-INPF for card input and IFM for file input. The root declares a blank common array of length one. If there are m words from the start of blank common to the field length, and n words of text in whatever primary and secondary are executing, the storage space actually available totals m-n words. The root contains these parameters in the labeled common block /SIZE/M,N. All available blank common space is allocated by FTB, which also handles all temporary disk or extended core files.
Eight subroutines are missing and may be handled in the following ways. Calls to subroutines PEEP, UNPEEP, MESSAGE, and NEXTIN are not necessary and may be eliminated. Subroutine REMARK writes a message in the day file or on the operator console. This subroutine can be replaced with a dummy subroutine. Subroutine SHIFT is described in WAPD-TM-668 on page 68. Subroutines WRITEC and READC will not be called if sufficient storage and disk space is provided and they may remain as unsatisfied externals.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
W. D. Peterson and C. Jeffrey
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
16. **MATERIAL AVAILABLE** - Restricted Distribution
Magnetic Tape Transmittal (2 tapes)
Source decks (part 1-12,808 cards, part 2-12,823 cards)
Sample problem (72 cards)
Reference report, WAPD-TM-926
17. **CATEGORY** - I
KEYWORDS - stresses, two-dimensional, finite element method, deformation, HOT2 codes, BETTIS ENVIRONMENTAL ROUTINES codes
18. **SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - THRES2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600, IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - A statistical model with empirically determined parameters is employed. Binding energies, if calculated by the program, are calculated from an empirical mass formula due to Hillman (BNL-846). Since direct reaction effects can be important the calculations are normalized to compensate partly for deficiencies in the model. The empirical model is similar to previous (n,2n) work but is extended to include charged particle emission.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maximum of -
19 reaction types
6. TYPICAL RUNNING TIME - Approximately 30 seconds per nuclide are required on a CDC6600 for the calculation of 19 reactions in the energy range 0 to 20 MeV in 0.5 MeV steps. Approximately 1 minute per nuclide is required for fission spectrum averages of the 19 reaction cross sections.
7. UNUSUAL FEATURES OF THE PROGRAM - Fitting parameters and binding energies are supplied by the program but may optionally be specified as input by the user. Output in the ENDF format is available. Uncertainties are estimated.
8. RELATED AND AUXILIARY PROGRAMS - THRES2 replaces the earlier THRESH program.
9. STATUS - Abstract first distributed October 1972.
CDC6600 version of THRESH submitted October 1971, replaced by CDC6600 version of THRES2 June 1976, sample problem executed by NESC June 1976 on a CDC6600, revised to Edition B June 1977.
IBM360 version of THRES2 submitted January 1977, sample problem executed by NESC June 1977 on an IBM370/195.
10. REFERENCES - S. Pearlstein, Neutron-Induced Reactions in Medium Mass Nuclei, Journal of Nuclear Energy, Vol. 27, pp. 81-89, 1973.
S. Pearlstein, Analysis of (n,2n) Cross Sections for Medium and Heavy Mass Nuclei, Nuclear Science and Engineering, Vol. 23, pp. 238-250, 1965.
S. Pearlstein, Neutron Cross Sections and Their Uncertainties Obtained from Nuclear Systematics, NBS Special Publication 425, pp. 332-334, 1975.
S. Pearlstein, Program THRES2, NNCSC Report, December 1975.
11. MACHINE REQUIREMENTS - The program uses 13K (decimal) on the CDC6600.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE (CDC6600), OS/360 (IBM360)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - A PDP10 version of THRES2 has been prepared and used at BNL also.
15. NAME AND ESTABLISHMENT OF AUTHORS -
8600 S. Pearlstein
National Nuclear Data Center
Brookhaven National Laboratory
Upton, Long Island, New York 11973

360 L. Garcia de Viedma
NEA Data Bank
B. P. No. 9
91190 Gif-sur-Yvette, France

16. MATERIAL AVAILABLE -

Source deck (6600-1246 cards, 360-1246 cards)
Sample problems (6600-11 cards, 360-11 cards)
Reference reports, BNL-15271 and NNCSC Report

17. CATEGORY - A

KEYWORDS - cross sections, fission spectra, neutrons, THRESH codes

18. SPONSOR - ERDA Division of Physical Research

1. **NAME OR DESIGNATION OF PROGRAM** - TDOWN
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - GE635
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - 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.
4. **METHOD OF SOLUTION** - TDOWN uses the rapid cross section adjustment procedure and a generalized file. For each material, the file contains the groupwise values of infinitely-dilute cross sections, resonance self-shielding factors which are tabulated for temperatures and a range of $\sigma(0)$ - the material composition parameter, and scattering matrices. Self-shielding of a cross section is accomplished by computing $\sigma(0)$ and using interpolation routines to determine the self-shielding factor for the $\sigma(0)$ and input temperature. Self-shielding is an iterative procedure with the convergence criteria specified in the input. Spectral adjustments to the elastic removal are carried out directly if the flux sets are input. Zero- or one-dimensional flux solutions may be specified to generate the flux sets. The flux solutions are iterated until spectral adjustments converge to the criteria specified by the user.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Most of the restrictions on TDOWN are due to the limitations of the linked codes. Some of these limitations are - a generalized file has a maximum of 100 energy groups, and up to 120 material cross section sets may be generated.
6. **TYPICAL RUNNING TIME** - Problems with all the flux spectra input use a maximum of a few minutes on the GE635. A 29-energy-group problem generating 100 materials in 15 compositions with the flux spectra computed by two one-dimensional flux solutions, 9 iterations each, required 18 minutes of processor time.
7. **UNUSUAL FEATURES OF THE PROGRAM** - TDOWN gives the user flexibility in determining the detail a particular output cross section file will have with respect to composition and spatial effects. Output cross sections sets from the compositions are not automatic. Each set is selected from particular compositions and then the user can apply any spectral set to correct the elastic removal. If the problem requires flux solutions and consequently regional descriptions, compositions may be defined outside of the regions.
8. **RELATED AND AUXILIARY PROGRAMS** - Data for the generalized file GMUG are generated by the ENDRUN2 program (NESC Abstract 501).
9. **STATUS** - Abstract first distributed October 1972
GE635 version submitted October 1971
10. **REFERENCES** - C. L. Cowan, B. A. Hutchins, J. E. Turner, TDOWN - A Code to Generate Composition and Spatially Dependent Cross Sections, GEAP-13740, August 1971.
I. I. Bondarenko, Group Constants for Nuclear Reactor Calculations, Consultants Bureau, New York, 1964.
B. A. Hutchins, C. L. Cowan, M. D. Kelley, and J. E. Turner, ENDRUN-II, A Computer Code to Generate a Generalized Multigroup Data File from ENDF/B, GEAP-13704, March 1971.
C. T. Ehlers, CASERR, A FORTRAN Compatible Subroutine, GESV Note, November 26, 1967.
FXOPT Subroutine Description, GESV Note, November 6, 1972.
11. **MACHINE REQUIREMENTS** - The code requires 32K memory on a GE635, including a 10K overlap with the loading routines. In addition to the usual input/output units, 3 tape handlers and 6 files on a peripheral device (disk at the authors' installation) are used.

12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GECOS III
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Primary changes to convert this program to another machine would be the input/output routines and peripheral unit assignments
15. NAME AND ESTABLISHMENT OF AUTHORS -
C L Cowan, B A Hutchins, J E Turner
Nuclear Energy Division
General Electric Company
310 DeGuigne Drive
Sunnyvale, California 94086
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (TDOWN 10,751 cards, PUNT 1704 cards, auxiliary routines 693 cards)
Sample problems (TDOWN 19 cards, PUNT 11 cards)
Control cards (TDOWN 405 cards, PUNT 119 cards)
Sample problem output (21 pages)
Reference report, GEAP-13740, and Notes
17. CATEGORY - B
KEYWORDS - multigroup, cross sections, self-shielding, neutron spectra, elastic scattering, ENDRUN codes, PUNT codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - JP1XR
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - JP1XR 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.
4. METHOD OF SOLUTION - The program is based on the coupled-channels formalism of Tamura and the collective model of the nucleus. The interaction to which the incident particle is subjected is described by the generalized optical model potential which includes spin-orbit and Coulomb interactions and has a Saxon-Woods radial dependence.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maximum of -
100 angles for which the differential quantities (cross section and polarization) are to be computed.
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - JP1XR is based on the program JUPITOR1 (NESC Abstract 308).
9. STATUS - Abstract first distributed October 1972
CDC6600 version submitted October 1971
10. REFERENCES - C. J. Slavik, JP1XR, A Computer Program for Nuclear Coupled-channel Calculations, KAPL-M-7079(L), February 1971
T. Tamura, Computer Program JUPITOR-1 for Coupled-channel Calculations, ORNL-4152, August 1967
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
C. J. Slavik
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (3159 cards)
Sample problem (59 cards)
Reference report, KAPL-M-7079(L)
17. CATEGORY - A
KEYWORDS - scattering, cross sections, optical models, coupled channel theory, JUPITOR1 codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - PHASER
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - These quantities are computed from the neutron scattering phase shifts. PHASER can also compute these quantities from the complex elements of the scattering matrix. The phase shifts may be complex to allow for open inelastic scattering channels. Hauser-Feshbach theory is used to compute the compound nuclear cross sections and moments.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maximum of -
15 states to be considered in the Hauser-Feshbach calculation
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed October 1972
CDC6600 version submitted October 1971
10. REFERENCE - C. J. Slavik, PHASER, A FORTRAN Program to Compute Neutron Cross Sections, Polarizations, and Legendre Moments from Phase Shifts, ADA-TP-12(L), March 30, 1971
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 -
C. J. Slavik
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (505 cards)
Sample problem (4 cards)
Reference report
17. CATEGORY - A
KEYWORDS - elastic scattering, inelastic scattering, cross sections, Hauser-Feshbach theory
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - MUCHA1/MUCHA2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6400
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - In MUCHA1 an explicit, finite-difference technique is used to solve the conservation equations describing the fluid behavior in the parallel core channels. Fluid thermodynamic properties are determined from property tables using an explicit, finite-difference technique. In MUCHA2 an explicit finite-difference technique is used to solve the conservation equations describing the fluid behavior in parallel core channels and plena. Fluid thermodynamic properties are determined from property tables incorporated in the code. Heat conduction in the fuel rod is determined using an explicit, finite-difference technique.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - In MUCHA1 the two fuel rods can be represented by up to a total of 15 radial nodes. Each fuel rod and its associated flow channel may be represented by up to 12 axial segments. MUCHA2 applies the same restrictions to each pair of equivalent fuel rods.
6. TYPICAL RUNNING TIME - MUCHA1 running time varies between 200 to 300 times real time, using 2-foot axial segments in each flow channel. Doubling the number of axial segments will increase the running time by approximately a factor of 4. MUCHA2 running time varies between 200 to 400 times real time, using 2-foot axial segments in each flow channel. Doubling the number of axial segments will increase the running time by approximately a factor of 4.
7. UNUSUAL FEATURES OF THE PROGRAM - With MUCHA1 the thermal and hydraulic behavior of any two fuel rods and their associated flow channels can be predicted during all phases of a loss-of-coolant accident. MUCHA2 provides a detailed description of the core and plenum thermal-hydraulic behavior during all phases of a loss-of-coolant accident, including the emergency core coolant injection phase.
8. RELATED AND AUXILIARY PROGRAMS - MUCHA1 requires as input time-dependent plenum fluid conditions determined by MUCHA2 or a system-oriented code.
9. STATUS - Abstract first distributed October 1972
CDC6400 version submitted November 1971
10. REFERENCES - R. A. Cudnik, ECCSA and MUCHA - Computer Codes for the Analysis of Emergency Core Cooling Systems, BMI-1916, September 1971
Battelle 6400 Programming Bulletin, No. 11, UNILIN, March 21, 1967
Battelle 6400 Programming Bulletin, No. 12, BILIN1, March 24, 1967
11. MACHINE REQUIREMENTS - MUCHA1 requires 120K (octal) memory and one tape for restart capability. MUCHA2 requires 120K (octal) memory, one tape for restart capability, and one tape for storing plenum boundary conditions.
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 - MUCHA1 and MUCHA2 require the use of CDC8400 FORTRAN function subprograms UNILIN and BILIN1. UNILIN performs linear interpolation from a table of values of y versus x. BILIN1 performs linear interpolation from a table of values of z versus x and y. MUCHA1 calls UNILIN from HTCHG and MUCHA2 calls it from HTCHG, FLUID, and PLENA. MUCHA1 calls BILIN1 from PHISQ and MUCHA2 also calls it from PHISQ.
15. NAME AND ESTABLISHMENT OF AUTHORS -
Ronald A. Cudnik
Columbus Laboratories
Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (MUCHA1-1722 cards, MUCHA2-3067 cards)
Sample problems (MUCHA1-436 cards, MUCHA2-69 cards)
Block data and auxiliary routines (2111 cards)
Reference report and Bulletins
17. CATEGORY - G
KEYWORDS - reactor safety, heat transfer, accidents, coolants, thermodynamics, water
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ETOT2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - ETOT2 performs a straightforward 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 formula is assumed to yield resolved resonance cross sections with reasonable accuracy
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - In addition to the restrictions on the ENDF/B data itself, ETOT2 has the following restrictions -
 Maximum number of groups or points = 309
 Maximum number of resolved resonances = 500
6. TYPICAL RUNNING TIME - About 5 seconds per isotope are required on the CDC7600. The time is dependent on the number of resonance parameters
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The program uses the general purpose processor and retrieval subroutines written at NNDC, Brookhaven for handling ENDF/B data files (reference 4). The program is related to ETOM1 (NESC Abstract 436) which generates epithermal cross sections
9. STATUS - Abstract first distributed October 1972
 CDC7600 version received January 1972
10. REFERENCES - Charles L. Beard and Robert 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
 Henry C. Honeck, ENDF/B Specifications for an Evaluated Nuclear Data File for Reactor Applications, BNL-50088 (ENDF-102), May 1966, revised by S. Pearlstein July 1967
 M. K. Drake, Data Formats and Procedures for the ENDF Neutron Cross Section Library, BNL-50274 (ENDF-102 Vol. 1), October 1970
 Odell S. Ozer, Description of the ENDF/B Processing Codes and Retrieval Subroutines, BNL-50300 (ENDF-110), September 1967, Revised April 1969, September 1970, and June 1971
11. MACHINE REQUIREMENTS - The code requires 50K (decimal) memory on the CDC7600, uses 1 scratch tape, 1 library tape, and the standard input/output and punch units
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - CDC7600 SCOPE 1.7
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The program consists of 6 overlays
15. NAME AND ESTABLISHMENT OF AUTHORS -
 C. L. Beard and R. A. Dannels
 Nuclear Energy Systems
 Westinghouse Electric Corporation
 Box 355
 Pittsburgh, Pennsylvania 15230
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
 Source deck (5714 cards)

Sample problem (5 cards)
Reference report, WCAP-7363

17. CATEGORY - B
KEYWORDS - ENDF/B, cross sections, libraries, KATE codes, THERMOS codes, TEMPEST codes,
LASER codes, ETOM1 codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - VIM1/VIM1X
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC7600, IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The Monte Carlo method is used with neutrons started from an initial source distribution in space, angle, and energy with a statistical weight of unity. They are followed from collision to collision until capture, escape from the system, or fission occurs. The spatial coordinate where fission occurs, along with the number of neutrons produced at each point, provide the basis for determining the source distribution for the next generation. VIM1 regards this set of weighted source points as a distribution function from which the source neutron starting points are selected each with initial statistical weight of unity. The inelastic scattering model includes both the evaporation model and a discrete excitation level approach. Absorption weighting of variable amount is optionally permitted.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - VIM1 is restricted to critical assemblies of the plate drawer type, and the energy range must be between 10 MeV and 10 eV.
 - 7600 maxima -
 - 13 materials
 - 36 rows in the critical assembly matrix
 - 36 columns in the critical assembly matrix
 - 360 maxima -
 - 250,000 histories per problem
 - 1,000 histories per batch
 - 6 drawer types
 - 50 rows in the matrix
 - 51 columns
 - 13 isotopes in problem
 - 150 zones
 - 27 groups for edits
 - 30 energy bands for stratified sampling of source neutron energies
 - 9 central fission ratios computed
6. TYPICAL RUNNING TIME - Approximately 1 second per 1200 collisions is required on the CDC7600. The IBM360/75 executes the sample problem in 2 minutes.
7. UNUSUAL FEATURES OF THE PROGRAM -
 - Use of cross section probability tables in the unresolved resonance range,
 - use of point cross section data in lieu of multigroup constants, and
 - use of cumulative distribution functions of the center-of-mass scattering angle to describe angular distributions instead of Legendre coefficients.
8. RELATED AND AUXILIARY PROGRAMS - A cross section library tape generator is included in the program package.
9. STATUS - Abstract first distributed October 1972
 CDC7600 version submitted November 1971
 IBM360 version submitted January 1972, revised February 1973, sample problem executed by NESC

10. **REFERENCES** - L. B. Levitt, R. C. Lewis, VIM1, A Non-multigroup Monte Carlo Code for Analysis of Fast Critical Assemblies, AI-AEC-12951, May 15, 1970
Input Description for VIM1 - 7600, Atomics International Memorandum, November 1971
F. L. Fillmore, User's Manual for the VIM-IX Monte Carlo Code, ANL ZPR-TM-121, September 20, 1972
VIM1 360 Version Tape Contents Description, ACC Programming Note 73-19, March 1973
Parameter Card for LIBREAD, ACC Programming Note 73-20, April 5, 1973
11. **MACHINE REQUIREMENTS** - 65K (decimal) fast central memory, 80K ECS, and 1 magnetic tape unit are required on the CDC7600. 650K bytes and 2 tape units are required on the IBM360.
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV (7600) and FORTRAN IV and BAL (360)
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 1.1 (CDC7600) and OS/360 (IBM360)
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - VIM presently uses a cross section library based on ENDF/B II data including coding to use probability tables in the unresolved resonance region. An ENDF/B III library for use with VIM has been prepared and VIM is being updated to accommodate it.
The 360 routine TLEFT is part of the ANL 360 environment. It returns to a calling program the difference, in hundredths of a second, between the time estimate on the job card and the total elapsed CPU + voluntary wait time. The function is called with one dummy argument. The value returned is in single precision, floating-point binary. The value of the dummy argument remains unchanged.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
L. B. Levitt and R. C. Lewis
Atomics International
P. O. Box 308
Canoga Park, California 91304
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (VIM1 7600-2025 cards, VIM1X 360-3111 cards, LIBREAD 360-278 cards)
Load module VIM MODLIB (360-188 blocks)
Sample problems (7600-385 cards, 360-272 cards)
Libraries (14 files)
Control information (JCL 360-32 cards)
Sample problem output (7600-24 pages)
Reference reports, Input Description Memorandum, and ACC Programming Notes
17. **CATEGORY** - C
KEYWORDS - Monte Carlo method, fast reactors, criticality, ZPR-3 reactors, ZPPR reactors, ZEBRA reactors
18. **SPONSOR** -

1. **NAME OR DESIGNATION OF PROGRAM - VENUS**
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360/75**
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** VENUS computes the power, energy release and space-time (r-z geometry) history of the temperature, pressure, density and material motion of an LMFR during a disassembly excursion. Reactivity feedback due to Doppler broadening and motion of the reactor material is taken into account.
4. **METHOD OF SOLUTION -** The power and energy release are calculated using the point kinetics formulation of Kaganov with up to six delayed neutron groups (see reference 2). The reactivity is a combination of an input driving function and feedback effects due to Doppler broadening and material motion. An adiabatic model is used to calculate the temperature increase throughout the reactor, based on an initial temperature distribution and power profile provided as input. These temperatures are, in turn, converted to fuel pressures via an energy dependent or energy-density dependent equation of state (EOS). In non-fueled regions, pressures are calculated by a simple compression model. The code is structured such that the user can readily add a new EOS, if the EOS in the program is not applicable or suitable to the user's requirements. The material motion that results from the pressure buildup is calculated by a direct finite-difference solution of a set of two-dimensional (r-z) hydrodynamics equations. This is done in Lagrangian coordinates using a modified version of Kolsky's method. The reactivity change associated with this motion is calculated by first-order perturbation theory. The displacements are also used to adjust the fuel densities as required for the density dependent equation of state. An automatic time-step-size selection scheme is provided to control the numerical accuracy of the calculations.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** VENUS is written so that the dimensions of the storage arrays can be readily changed to accommodate a broad range of problem sizes. In the base version, the total number of mesh points is restricted such that $(nr+3) \cdot (nz+3)$ is less than 700, where nr and nz are the total number of mesh intervals in the r and z directions, respectively. The total number of spatial regions used in the mockup must be no greater than 20. The program requires about 375K bytes of core storage with these restrictions. If the available storage is increased these restrictions can be relaxed accordingly.
6. **TYPICAL RUNNING TIME -** Typical problems require from 3 to 15 minutes of IBM360/75 CPU time, with some cases taking up to 30 minutes. Rather mild excursions in reactors that have little initial void space usually require the longer running times.
7. **UNUSUAL FEATURES OF THE PROGRAM -** VENUS has the following two distinct advantages over Bethe-Tait type analyses -
 - (a) Because conservation of mass and momentum are explicitly taken into account in the VENUS program the assumption that the pressure can be calculated by ignoring any change in density during an excursion used in Bethe-Tait type analyses is no longer needed. Since the density is computed explicitly as a function of time, an energy-density-dependent equation-of-state can be employed readily.
 - (b) The use of Lagrangian coordinates in the VENUS program provides detailed information on the motion of the reactor material during an excursion. This information is essential to the basic understanding of the mechanism of an accident and to the assessment of possible damage to the surrounding structures.
8. **RELATED AND AUXILIARY PROGRAMS -** Two auxiliary graphical output programs are included with the program. One is designed for use with the IBM2280, while the other is for the SC4060.
9. **STATUS -** Abstract first distributed October 1972
IBM360 version submitted November 1971

10. REFERENCES - W. T. Sha and T. H. Hughes, VENUS--A Two-dimensional Coupled Neutronics-Hydrodynamics Computer Program for Fast Reactor Power Excursions, ANL-7701, October 1970
J. J. Kaganove, Numerical Solution of the One-group Space-independent Reactor Kinetics Equation for Neutron Density given the Excess Reactivity, ANL-6132, 1960
H. G. Kolisky, A Method for the Numerical Solution of Transient Hydrodynamics Shock Problems in Two Space Dimensions, LA-1867, 1955
J. F. Jackson, R. B. Nicholson, and W. T. Sha, Numerical Stability Problems in the VENUS Disassembly Code, Proceedings of the ANS Topical Meeting on New Developments in Reactor Mathematics and Applications, March 29-31, 1971
H. A. Bethe and J. H. Tait, An Estimate of the Order of Magnitude of the Explosion when the Core of a Fast Reactor Collapses, RHM, Vol. 58, p. 113, Atomic Energy Research Establishment, 1956
N. Hirakawa, MARS, Two-dimensional Excursion Code, APDA-198, 1962
R. B. Nicholson, Methods for Determining the Energy Release in Hypothetical Reactor Meltdown Accidents, APDA-150, 1962
E. P. Hicks and D. C. Manzie, A Computer Code for Calculation of Fast Reactor Maximum Accident, TRG Report 1268(D), 1968
Graphic Programming Services for IBM 2280 and 2282 Film Units, File No. 5360-30, IBM Form C27-6927-1, February 1967
G. D. Brown, C. H. Bush and R. A. Berman, The Integrated Graphics System for the SC-4060, 1. User's Manual, RM-5560-PR, 1968
11. MACHINE REQUIREMENTS - 400K bytes when storing the data in double precision. If the code was converted for use on a computer with a longer word size than the IBM360, it should be possible to use single precision storage. One peripheral storage device is needed if the graphical output option is used.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV(H)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
W. T. Sha
Materials Science Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (VENUS 3107 cards, plotting 192 cards, microfilm 416 cards)
Sample problem (VENUS 226 cards)
Control information (JCL 19 cards)
Reference report, ANL-7701
17. CATEGORY - F
KEYWORDS - fast reactors, feedback, two-dimensional, r-z, hydrodynamics, temperature, pressure, LMFBR reactors, excursions
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - THETA1B
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360/75
3. DESCRIPTION OF PROBLEM OR FUNCTION - THETA1B computes the thermal response characteristics of a nuclear fuel rod subjected to a loss-of-coolant accident environment
4. METHOD OF SOLUTION - THETA1B solves the two-dimensional diffusion equation for a single fuel rod and the one-dimensional conservation of energy equation for the associated fluid channel. The two solutions are linked at the fuel rod-fluid interface by the boundary conditions of surface temperature and heat flux. The energy equations in the fuel rod and fluid channel are solved by several numerical differencing techniques. Normally the fuel rod equation is solved explicitly and the fluid equation is solved by the method of characteristics. The heat transfer model considers forced convection in subcooled liquid and superheated vapor, nucleate boiling, forced convection vaporization, transition boiling, and stable film boiling
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Small time-steps are used, resulting in long running times
6. TYPICAL RUNNING TIME - Approximately 30 minutes are required for a 30-second transient
7. UNUSUAL FEATURES OF THE PROGRAM - Various options are available for heat transfer correlations in the different heat transfer regions. The code may also be used to model electrically-heated test elements used in out-of-pile decompression experiments
8. RELATED AND AUXILIARY PROGRAMS - CINDA3G (reference 2) is used to solve the conduction equation
9. STATUS - Abstract first distributed October 1972
IBM360 version submitted December 1971, sample problem executed by NESC
10. REFERENCES - C. J. Heccevar and T. W. Wineinger, THETA1B, A Computer Code for Nuclear Reactor Core Thermal Analysis, IN-1445, February 1971
J. D. Gaski, Chrysler Improved Numerical Differencing Analyzer for Third Generation Computers, Chrysler Corporation Technical Note TN-AP-87-287, October 1967
ACC Programming Note 72-23, THETA1B Transmittal Tape, April 1972
11. MACHINE REQUIREMENTS - 400K bytes of core memory 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 AUTHORS -
C. J. Heccevar and T. W. Wineinger
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (THETA-3325 cards, CINDA1-9741 cards, CINDA2-7307 cards)
Sample problem (700 cards)
Load modules (THETA-1887 records, CINDA1-1221 records, CINDA2-4261 records)
Sample problem output (24 pages)
Reference report, IN-1445, and ACC Note 72-23
17. CATEGORY - G

KEYWORDS - thermal reactors, coolants, accidents, fluid flow, fuel elements, LOCA, water reactors, heat transfer

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FORSIM
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Partial differential equations are converted to coupled ordinary differential equations by suitable discretization formulas. Integration is done by variable order, variable step-size error controlled algorithms.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maximum of - 1000 ordinary differential equations.
6. TYPICAL RUNNING TIME - The time required depends on the equation system being solved.
7. UNUSUAL FEATURES OF THE PROGRAM - Partial differential equations and boundary conditions are discretized automatically. The statement of a partial differential equation in the user subroutine is analogous to the mathematical function.
Edition B of FORSIM contains options for the integration of stiff systems of ordinary differential equations and automated procedures for solving most classes of partial differential equations as well.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed October 1972.
CDC6600 version submitted January 1972, replaced by Edition B February 1975, sample problem executed by NESC January 1976 on CDC7600 via remote terminal to Brookhaven National Laboratory.
10. REFERENCES - M. B. Carver, FORSIM: A FORTRAN Package for the Automated Solution of Coupled Partial and/or Ordinary Differential Equation Systems, AECL-4844, November 1974.
11. MACHINE REQUIREMENTS - 160,000 (octal) memory and 6 disk files, including input and output.
12. PROGRAMMING LANGUAGE USED - FORTRAN Extended.
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.4.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The user writes in FORTRAN and has full command of all FORTRAN facilities. Any number of subroutines may be written to describe the equations.
The CalComp plot option (p. 25 of reference) may not be invoked because it requires local AECL software. A dummy routine is included with the source to satisfy the loader. However, the printer plot option does operate.
15. NAME AND ESTABLISHMENT OF AUTHOR -
M. B. Carver
Mathematics and Computation Branch
Chalk River Nuclear Laboratories
Atomic Energy of Canada Limited
Chalk River, Ontario, Canada
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (4249 cards)
Sample problem (UPDATE routine 53 cards, data 9 cards)
Control information (42 cards)

Sample problem output (6 pages)
Reference report, AECL-4844

17. CATEGORY - P

KEYWORDS - partial differential equations, ordinary differential equations, integrals

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GENED ENVIRONMENTAL ROUTINES

2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - GE635

3. DESCRIPTION OF PROBLEM OR FUNCTION - 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

FSHOW 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 IB 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

LOCFA 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, POSWOS, 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

PLOTFC 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, SBITF, SBITS, RWD, RWDLO, and MOVEBT.

VAMPIR 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.

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 December 1972
GE635 version submitted November 1972

10. REFERENCES - BITA (A FORTRAN-Compatible Subroutine), GESJ Note
CASE (A FORTRAN-Compatible Subroutine), GESJ Note, November 17, 1971
CASERR (A FORTRAN-Compatible Subroutine), GESJ Note, November 28, 1967
DRAW, GESJ Note, November 10, 1971
ERRSYS (FORTRAN-Compatible Subroutine), GESJ Note
F4TRBK, F4TRAC, F4TRID, GESJ Note
FLEXO, Console Typewriter Output Subroutine, GESJ Note
A E Scadden, FLTBCD (A FORTRAN-Compatible Subroutine), GESJ Note, February
19, 1969
Nels J Anderson, Jr., IDFTAP Function Subprogram Write-up, GESJ Note
ISERVE, GE-635 Computer Service Function, GESJ Note
ISUP and ISUPC, GESJ Note
W Cattaneo, LIMRTN, GESJ Note, January 18, 1968
Nels J Anderson, Jr., LISTFORM, GESJ Note S6T002, September 15, 1967
LOCF4, GESJ Note
NBCDFX (A FORTRAN-Compatible Function), GESJ Note
NFXBCD (A FORTRAN-Compatible Function), GESJ Note
M A Gumucio, NIPS, Alphanumeric Input Processing Subroutine, GESJ Note
L M Cirolli, GE-635 NPOST, GESJ Note, July 13, 1967
R E Ware, NSORT, Sort Routine for FORTRAN Programs, GESJ Note, July 1967
PLOTRO, GESJ Note, November 29, 1971
PRNTHD (A FORTRAN-Compatible Subroutine), GESJ Note, October 6, 1967
REREAD, CONVRT, GESJ Note, September 11, 1967
Nels J Anderson, Jr., RWSBT - Binary File Input-Output Subroutine, GESJ Note
VAMPIR, GESJ Note, November 28, 1971
ZERO (A FORTRAN-Compatible Subroutine), GESJ Note, February 18, 1971
Excerpts from GE-600 Line FORTRAN IV Reference Manual, CPB-1006G, September
1964, Rev March 1969, Rev July 1969

11. MACHINE REQUIREMENTS -

12. PROGRAMMING LANGUAGES USED - FORTRAN IV and GMAP

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GECOS.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
Contact F. A. Wassem
Nuclear Energy Division
General Electric Company
175 Curtner Avenue
San Jose, California 95114
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (1407 cards)
Reference notes and Excerpts
17. CATEGORY - P
KEYWORDS - data processing, operating systems, libraries, computer graphics
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - PTAC11
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360/75
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - PTAC11 is a two pass assembler. A user defined symbol table is created during pass one. The binary code and listing is produced during pass two
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The number of user defined symbols is limited to 800. The standard DEC mnemonics are used with two exceptions. The alternate mnemonics for BCC (branch if carry clear) and BCS (branch if carry set) are not used. The mnemonic for break trap is called BPT
6. TYPICAL RUNNING TIME - Less than 2 minutes is required for 4096 PDP-11 source statements
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed October 1972
IBM360 version submitted January 1972, sample problem executed by NESC
10. REFERENCES - E W Killian, A Program to Assemble Code for the PDP-11 (PTAC-11), P02050, January 1972
C W Richardson and E W Killian, Techniques of Program Preparation for Small Computers, DECUS Fall Meeting, 1968
11. MACHINE REQUIREMENTS - 100K bytes memory, usual I/O units and one tape unit
12. PROGRAMMING LANGUAGE USED - PL/I
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - PTAC11 supplies the user with four different forms of output - a printed listing, a printed symbol table, a printed cross reference listing, and a binary tape in the format read by the PDP-11 absolute loader
15. NAME AND ESTABLISHMENT OF AUTHOR -
E W Killian
EG&G Idaho, Inc
P O Box 1625
Idaho Falls, Idaho 83401
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (1817 cards)
Sample problem (14 cards)
Reference document, P02050
17. CATEGORY - P
KEYWORDS - PDP computers, programming languages, assembler
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - HEATINGS

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

3. DESCRIPTION OF PROBLEM OR FUNCTION - HEATINGS 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.

4. METHOD OF SOLUTION - The point successive overrelaxation iterative method and a modification of the "Aitken delta+2 extrapolation process" are used to solve the finite difference equations which approximate the partial differential equations for a steady-state problem.

The transient problem may be solved using any one of several finite difference schemes. These include an implicit technique which can range from Crank-Nicolson to the classical implicit procedure, an explicit method which is stable for a time-step of any size, and the classical explicit procedure which involves the first forward time difference. The solution of the system of equations arising from the implicit technique is accomplished by point successive overrelaxation iteration, and includes procedures to estimate the optimum acceleration parameter. The time-step size for implicit transient calculations may be varied as a function of the maximum temperature change at a node.

5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -

- 3700 lattice points per 1 megabyte of core
- 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
- 25 analytical functions
- 5 materials with change-of-phase capabilities
- 20 nodes in special temperature table
- 25 points per tabular function
- 25 tabular functions
- 100 printout lines
- 2000 surface-to-surface connectors

Transient problems involving materials with change-of-phase capabilities cannot be solved using the implicit technique with this version of HEATINGS.

6. TYPICAL RUNNING TIME - Estimates for the CPU time (in seconds) required for problems run on the IBM360/91 for steady-state and explicit transient calculations are given by

$$\text{CPU(SS)} = (1.0 \cdot 10^{-(4)}) \cdot (\text{No. of Nodes}) \cdot (\text{No. of Iterations})$$

$$\text{CPU(T)} = (5.0 \cdot 10^{-(5)}) \cdot (\text{No. of Nodes}) \cdot (\text{No. of Time-Steps})$$

It is emphasized that these equations are merely estimates, and the actual CPU time may be considerably different from the estimate depending on the options which are used. For the implicit transient algorithm, the amount of CPU time per time-step will be much larger than that for one of the explicit techniques since the code must do a lot more computation. However, one should be able to use a time-step much larger than would be required in the explicit technique, especially for later times in the transient. Frequently, the implicit algorithm is more than an order of magnitude faster than the explicit algorithm in solving a problem. Temperature-dependent thermal properties and/or boundary conditions can

increase the running time by up to an order of magnitude depending on how many nodes are associated with the temperature-dependent parameters

7. UNUSUAL FEATURES OF THE PROGRAM -

8. RELATED AND AUXILIARY PROGRAMS - HEATING5 is the latest edition of the HEATING program originally developed by Liguori and Stephenson from Fowler and Volk's generalized heat conduction code, GHT. HEATING is an acronym for Heat Engineering And Transfer in Nine Geometries. HEATING5 is a modification of HEATING3. The major improvement is the incorporation of an implicit scheme to solve transient problems and the addition of change-of-phase capabilities. The program also uses two local plotting packages, HEATPLOT and REGPLOT.

9. STATUS - Abstract first distributed October 1972

IBM360 version submitted January 1972, replaced by revised Edition B June 1975, replaced by HEATING5 August 1977, revised September 1977, sample problem executed by NESC September 1977 on an IBM370/195

10. REFERENCES - W D Turner, D C Elrod, and I I Siman-Tov, HEATING5 - An IBM 360 Heat Conduction Program, ORNL/CSD/TM-15, March 1977

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 IBM 360 Heat Conduction Program, CTC-INF-980, 1969

S Levy, Use of Explicit Method in Heat Transfer Calculations with an Arbitrary Time Step, GE-98-C-262, 1968

T B Fowler and E R Volk, Generalized Heat Conduction Code for the IBM-704 Computer, ORNL-2734, October 1959

D C Elrod and W D Turner, HEATPLOT - A Temperature Distribution Plotting Program for HEATING, K/CSD/TM-11, July 1977

D C Elrod, REGPLOT - A Plotting Program to graphically check HEATING5 input Data, K/CSD/TM-12, August 1977

11. MACHINE REQUIREMENTS - 250K for one lattice point to 1256K for 6000 lattice points

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 - Assembly language routines are included to provide time and date information, to convert from integer to character format, to provide model identification of the IBM360 used, and to compare character strings. These routines IDAY, TIME, TICK, INTOBCD, MODEL, and ICOMPARE are part of the ORNL environment and may require replacement by their counterparts at other installations.

Dummy subroutines are included in the package for the intended user-supplied functions defining the thermal conductivity (CONDTN), density (DENSITY), specific heat (CPHEAT), initial temperature distribution (INITTP), volumetric heat generation rate (HEATGN), boundary temperature (BNDTMP), film coefficient for forced convective heat transfer (CONVTF), coefficient for radiative heat transfer (RADITN), coefficient and exponent for natural convective heat transfer (NATCON and NCONEX), and the flux across a boundary (BNFLUX).

15. NAME AND ESTABLISHMENT OF AUTHORS -

W D Turner, D C Elrod and I I Siman-Tov
Nuclear Division
Union Carbide Corporation
P O Box P
Oak Ridge, Tennessee 37830

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (HEATING5 6817 cards, Assembly routines 300 cards, HEATGN 85 cards)
Sample problem (135 cards)

Sample problem output (42 pages)
Reference report, ORNL/CSD/TM-15

17. CATEGORY - H

KEYWORDS - heat transfer, diffusion, thermal conductivity, iterative methods, x-y, x-y-z, r-z, r-theta, r-theta-z, HEATING codes, HEATPLOT codes, REGPLOT codes

18. SPONSOR - NRC Office of Nuclear Material Safety and Safeguards
DOE Office of Waste Isolation
Oak Ridge National Laboratory

1. NAME OR DESIGNATION OF PROGRAM - ERREST
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - ERREST sorts the rod bundle library of critical heat flux data and performs error calculations on sorted subsets
4. METHOD OF SOLUTION - Error calculations are performed by user supplied subroutines
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - 1 to 5 minutes are required
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed October 1972
IBM360 version submitted February 1972, sample problem executed by NESC
10. REFERENCES - E D Hughes, A Correlation of Rod Bundle Critical Heat Flux for Water in the Pressure Range 150 to 725 Psia, IN-1412, July 1970
Idaho Nuclear Corporation, Quarterly Technical Report Nuclear Safety Program Division, July 1 - September 30, 1969, IN-1319, May 1970
Michael A Linner, Least-squares Estimation of Nonlinear Parameters, P00950, June 1969
M A Linner, ERREST, A Program to Edit Data, Perform Error Calculations, and Do Non-linear Least Square Parameter Estimations, Idaho Nuclear Corporation, Idaho Falls, Idaho, June 1970
11. MACHINE REQUIREMENTS - 460K 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 -
M A Linner
EG&G Idaho, Inc
P O Box 1625
Idaho Falls, Idaho 83401
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (1403 cards)
Sample problem with library (9426 cards)
Control information (31 cards)
Sample problem output (25 selected pages)
Reference reports, IN-1412, ERREST Program Description, and P00950
17. CATEGORY - P
KEYWORDS - data, errors, least square fit, nonlinear problems, critical heat flux
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - NRTS OS/360 Remote Job Entry
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360/75
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Conversational mode operation of communication lines is used to allow concurrent input and output operation of multiple input/output devices. With the exception of interactive graphics, data sets created by the job are handled by OS data management routines. Interactive graphic data sets directed to an IBM2250 at a remote station are handled by a combination of SVC's and the RJE system. Output data sets created by remotely submitted jobs and those directed to a remote station by a central installation user are placed in special output classes and returned to the remote user under direction of the RJE program.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM - NRTS RJE supports interactive communication between a remote IBM2250 scope and an executing program. The remote work station program has been completely redesigned.
8. RELATED AND AUXILIARY PROGRAMS - NRTS requires the incorporation of two type one SVC's for operation.
9. STATUS - Abstract first distributed October 1972
IBM360 version submitted February 1972
10. REFERENCES - NRTS OS/360 Remote Job Entry System, Idaho Nuclear Corporation Manual
NRTS OS/360 Remote Job Entry System, Internal Description, Aerojet Nuclear Company Manual
1130 RJE (I F Version) Internal Documentation, Aerojet Nuclear Company Manual
11. MACHINE REQUIREMENTS - IBM360 with minimum of 512K bytes storage, using OS/360 MVT and an IBM2701 data adapter unit with synchronous data adapter TYPE11 with the binary synchronous features, equipped for EBCDIC code and full transparency operation. Dual interface feature is required if line is to be switched between slow and high-speed operation. Direct access storage for RJE tables is typically less than 1-2311 DASD or 1-2314 disk pack. SYSIN data requirements are installation dependent.
IBM1130 work station requirements include a single disk storage drive, 8K words of core storage, 1442-7 card read/punch, 1403-2 with RPD F20724 or 1403-8 printer, binary synchronous communications adapters. Optionally, a 1627-1 plotter, 2415 magnetic tape, 1134 paper tape reader, 1055 paper tape punch, 2501 card reader, and 2250-4 scope are supported.
12. PROGRAMMING LANGUAGE USED - Assembler
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 MVT Release 19.6
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Support for the IBM 2770/2780 terminals is being incorporated in the system for later release.
15. NAME AND ESTABLISHMENT OF AUTHOR -
Lynn C. Richardson
EG&G Idaho, Inc

P. O. Box 1625
Idaho Falls, Idaho 83401

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (PDS SYS1.RJESRC 1194 blocks)
Macro definitions (PDS SYS1.RJEMAC 793 blocks)
Object modules (PDS SYS1.RJEOBJ 98 blocks)
Assembly listings (PDS SYS1.RJELST 4990 blocks)
Reference reports
17. CATEGORY - P
KEYWORDS - data processing, computer networks, data transmission
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - PHROG
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The code recursively solves either a B-1 or P-1 approximation to the energy dependent transport equation utilizing cross section data obtained from a library. Logic is incorporated to calculate both resolved and unresolved resonance data to complement the library absorption and fission data where necessary. An option is available to calculate a Dancoff-Ginsburg correction factor to account for pin shadowing.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The code is restricted to a 68 group structure for input.
6. TYPICAL RUNNING TIME - A typical problem generally requires less than one minute of CPU time on the IBM360/75.
7. UNUSUAL FEATURES OF THE PROGRAM - The library is derived mainly from ENDF/B data.
8. RELATED AND AUXILIARY PROGRAMS - ETOP is the processing code which calculates the elastic cross section of infinite dilution and prepares the elastic scattering matrices for PHROG.
9. STATUS - Abstract first distributed October 1972.
IBM360 version submitted February 1972, sample problem executed by NESC.
10. REFERENCES - R. L. Curtis, G. L. Singer, F. J. Wheeler, R. A. Grimesey, PHROG--A FORTRAN IV Program to Generate Fast Neutron Spectra and Average Multigroup Constants, IN-1435, April 1971, with changes per Aerojet Nuclear Company Note, G. L. Singer, December 1971.
11. MACHINE REQUIREMENTS - 200K bytes memory and six I/O devices including card reader, printer, card punch, tape unit for cross section library, and 2 scratch 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 -
R. L. Curtis, G. L. Singer, F. J. Wheeler and
R. A. Grimesey
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (7209 cards)
Sample problem (17 cards)
Library (ESCDIC 473 blocks-)
Library processing routine (104 cards)
Control information (JCL 51 cards)
Sample problem output (43 pages)
Reference report, IN-1435 and Note
• DCB=(RECFM=YBS,LRECL=216,BLKSIZE=4324)

17. CATEGORY - B

KEYWORDS - multigroup, cross sections, fast neutrons, Dancoff correction, group constants, resonance, neutron spectra, ETOP codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SOCOOL2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360, UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - A unit cell consisting of a single spherical particle of molten material surrounded concentrically by sodium is used as the basis for the calculation. Heat transfer from the molten particle to the sodium is calculated by an implicit numerical technique assuming negligible contact resistance at the interface of the particle. The expansion of the heated sodium is calculated by the one-dimensional acoustic equation until vaporization conditions are attained. Upon vaporization, it is assumed that the particle becomes vapor-blanketed and that no further heat transfer to or from the sodium occurs. The heated sodium is then expanded to the specific final pressure in an isentropic expansion process.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The presence of an initial amount of sodium vapor or noncondensable gas cannot be taken into account. Time delays in the process of fragmentation and mixing of the molten material into the sodium cannot be considered. Heat transfer during the two-phase expansion of sodium is neglected.
6. TYPICAL RUNNING TIME - The sample problem executed on the UNIVAC1108 in 10 seconds, on the IBM360/75 in 15 seconds.
7. UNUSUAL FEATURES OF THE PROGRAM - The program has built-in thermophysical properties when the molten material is 25% PuO₂, 75% UO₂ and the user has the option of calculating the sodium properties according to three different methods.
8. RELATED AND AUXILIARY PROGRAMS - SOCOOL2 is a continuation in an analysis program to predict the mechanical work energy for hypothetical LMFBR maximum accidents. SOCOOL1 was a completely thermodynamic model whereas SOCOOL2 takes into account the finite rate of heat transfer.
9. STATUS - Abstract first distributed October 1972
UNIVAC1108 version submitted February 1972
IBM360 version submitted February 1972, sample problem executed by NESC
10. REFERENCES - A. Padilla, Jr., Mechanical Work Energy for Sodium Fuel Interaction, HEDL-TME-71-94, June 1971.
11. MACHINE REQUIREMENTS - UNIVAC1108 - 19K words of memory, IBM360 - 115K bytes of memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - CSCX (UNIVAC1108), OS/360 (IBM360)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
A. Padilla, Jr.
Reactor Analysis and Safety Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. MATERIAL AVAILABLE -
Source deck (1108-923 cards, 360-937 cards)
Sample problem (1108-5 cards, 360-7 cards)

Sample problem output (2 pages)
Reference report

17. CATEGORY - G

KEYWORDS - LMFBR reactors, reactor safety, accidents, containment, fuels, vapors, excursions, SOCOOL1 codes

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - ARC-SYSTEM
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360/50 and larger models
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - 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
4. **METHOD OF SOLUTION** - ARC-SYSTEM modules initialize the system, process the EBCDIC input data into ARC System data sets (OS/360 data sets) for use by the modules in a computational path, and provide communication linkage between ARC System interface data sets (binary and EBCDIC) and OS/360 logical units
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - BCD input data restrictions are set at 100 ARC System data blocks and 2000 EBCDIC data cards. An ARC System data block is a named set of data containing named subblocks of data which are processed into data sets by a call to the system routine BCDDS
6. **TYPICAL RUNNING TIME** - The processing of the data for the sample problem requires about 10 seconds on an IBM360/75
7. **UNUSUAL FEATURES OF THE PROGRAM** - ARC-SYSTEM supports the execution of computational paths consisting of dynamically-loaded modules which communicate data by means of binary and BCD interface data sets. One I/O package is utilized by all of the modules executed with I/O activity and is loaded by the first such module. Subprograms are provided which facilitate dynamic loading of modules, data processing and management, and I/O operations.
8. **RELATED AND AUXILIARY PROGRAMS** - All computational paths and modules of the ARC System are related. Some of the IBM utility programs are useful in updating and maintaining the libraries of the ARC System.
9. **STATUS** - Abstract first distributed October 1972
IBM360 version submitted February 1972, sample problem executed by NESC
10. **REFERENCES** - 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. J. Toppel, Editor, The Argonne Reactor Computation (ARC) System, ANL-7332, November 1967
ARC-SYSTEM - Contents of Partitioned Data Set Libraries, ACC Note, February 29, 1972
11. **MACHINE REQUIREMENTS** - The resident portion of the system itself requires about 15K bytes. To test the system requires about 220K bytes plus one peripheral I/O device.
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV, Assembler language, and macro definitions
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - OS/360 Release 19
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - The Assembler language routine IHCFIOSH (macro IHCFIOSM) is a slightly modified version of the IBM routine for Release 19 of OS/360. Systems operating under earlier releases should similarly modify this routine and re-linkedit the module ARCIBCOM.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
L. C. Just, H. Henryson II, A. S. Kennedy,
S. D. Sparck, B. J. Toppel, and P. M. Walker

Contact B. J. Toppel
Applied Physics Division

Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (PDS ARC.SOURCE)
Object modules (PDS ARC.SEGLIB)
Linkage editor control statements (PDS ARC.OVERLAY)
Load modules (PDS ARC.MOOLIB)
Macro definitions (PDS ARC.MACLIB)
Control information (JCL-IEHMOVE deck-16 cards)
Sample problem (153 cards)
Sample problem output (IEHMOVE-3 pages, execution-8 pages)
Reference reports and ACC Note

17. CATEGORY - M

KEYWORDS - data processing, reactors, engineering, numerical solution, ARC codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ESP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360/75,91
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - ESP utilizes standard Monte Carlo techniques in the neutron tracking and collision processes. Analysis of histories is performed by either collision density or track length estimation. The nuclides are assumed to be at rest except in the thermal energy range. Non-absorption weighting, spilling, and Russian roulette are used as variance reduction methods. In order to obtain estimates of the statistical error of ESP calculations, the neutron histories are processed in batches. The fission neutrons produced in a batch may be used as the starting neutrons for the next batch. Anisotropic scattering is handled by the Coveyou technique. The resonance cross sections are compiled using the Doppler-broadening, single-level Breit-Wigner model. A detailed statistical treatment is applied to this model in the unresolved resonance energy region.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The energy range is restricted to neutron energies for which data is available in the ENDF/B files. Each physical boundary of the system must be describable by a general second-order algebraic equation. There may be as many as 25 nuclides in as many as 16 different mixtures in the system.
6. TYPICAL RUNNING TIME - Running times are highly problem dependent. Less than 5 minutes are used on the IBM360/91 for data preparation, tracking, and analysis of 20,000 histories for GODIVA. A heterogeneous mockup of ZPR3 Assembly 4B takes 3 hours.
7. UNUSUAL FEATURES OF THE PROGRAM - ESP may be run in one problem setup and computer pass. No peripheral subroutine preparation or tape processing is necessary, although some information concerning a calculation may be retained on tape for use in future calculations. Realistic reactor systems may be calculated in complete geometric detail with a version of ESP which utilizes a fictitious scattering model and an array version of generalized geometry.
8. RELATED AND AUXILIARY PROGRAMS - ESP is one of several codes developed at Oak Ridge National Laboratory which has the O5R code as its predecessor.
9. STATUS - Abstract first distributed October 1972
IBM360 version submitted February 1972, sample problem executed by NESC
10. REFERENCES - S. N. Cramer, R. S. Carlsmith, G. W. Morrison, G. W. Perry, and J. L. Lucius, ESP, A General Monte Carlo Reactor Analysis Code, ORNL-TM-3164, January 1972.
D. C. Irving, R. M. Freestone, Jr., and F. B. K. Kam, O5R, A General-purpose Monte Carlo Neutron Transport Code, ORNL-3622, February 1965.
S. N. Cramer, Monte Carlo Analysis of the Exact Geometric Mockup of ZPR-III Assembly 4B, ORNL-TM-3596, October 1971.
ESP Tape Contents Description, ACC Programming Note 73-18, March 1973.
11. MACHINE REQUIREMENTS - At least 350K bytes of computer core.

12. PROGRAMMING LANGUAGES USED - FORTRAN IV and BAL
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
S. N. Ceamer, R. S. Carlsmith, G. W. Morrison,
G. W. Perry, and J. L. Lucius
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (PDS ESP.SORCELIB 1557 blocks, Assembly language routines 266 cards)
Object decks (ESP 15 blocks, GENL. GEOM. 17 blocks, RAFFLE GEOM. 26 blocks, SPH. GEOM. 2
blocks, CYL. GEOM. 7 blocks, ESPGUTS 309 blocks)
Sample problem (29 cards)
Library (85 blocks)
Control information (JCL 102 cards)
Reference report, ORNL-TM-3164, and ACC Programming Note 73-18
17. CATEGORY - C
KEYWORDS - Monte Carlo method, criticality, cell calculation, ENDF/B, cross sections, QSR
codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - BESFIT
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - BESFIT uses the diffraction model to solve the problem.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - A maximum of 101 angular points can be used.
6. TYPICAL RUNNING TIME - Each case runs in approximately 30 seconds.
7. UNUSUAL FEATURES OF THE PROGRAM - First order estimates of the differential elastic scattering cross section are obtained by specifying only the incident neutron energy and target mass.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed October 1972
CDC6600 version submitted March 1972
10. REFERENCES - S. Pearlstein, Program BESFIT, February 1972
S. Pearlstein, Neutron Angular Distribution Analysis Using Cylindrical Bessel Functions, BNL-16530, February 1972
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - Standard monitor
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
S. Pearlstein
National Nuclear Data Center
Brookhaven National Laboratory
Upton, Long Island, New York 11973
16. MATERIAL AVAILABLE -
Source deck (657 cards)
Sample problem (34 cards)
Reference report and Program Description
17. CATEGORY - A
KEYWORDS - elastic scattering, cross sections, angular distribution, diffraction models
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ORTHIS/ORTHAT
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - ORTHIS uses the iterative method of successive overrelaxation to solve the steady-state problem. In addition to overrelaxation it also uses a dominant-error-mode extrapolation procedure to increase the rate of convergence. ORTHAT uses a modified alternating-direction implicit method to solve the transient problem. The input for both programs has been designed in an easily usable free-form style.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 1000 vertical nodes
 - 1000 horizontal nodes
 - 10000 total nodes (rows+columns)
 - 50 vertical regions
 - 50 horizontal regions
 - 2500 total regions (rows+columns)
 - 300 materials
 - 1500 steady-state iterations
 - 5000 transient time-steps
6. TYPICAL RUNNING TIME - Both programs execute in 2 to 3 minutes.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed October 1972.
IBM360 version submitted March 1972, ORTHIS sample problem executed by NESC.
10. REFERENCES - R. C. Durfee and C. W. Nestor, Jr., ORTHIS, ORTHAT - Two Computer Programs for Solving Two-dimensional Steady-state and Transient Heat Conduction Problems, ORNL-TM-3324, July 1971.
ACC Programming Note 73-3, July 31, 1972.
11. MACHINE REQUIREMENTS - ORTHIS requires 700K, ORTHAT requires 1024K bytes.
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and BAL.
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Problems may be partially run and then restarted. The printout is made as readable as possible and includes a picture of the mesh assembly and temperature distributions and profiles.
15. NAME AND ESTABLISHMENT OF AUTHORS -
 - R. C. Durfee and C. W. Nestor, Jr.
 - Oak Ridge National Laboratory
 - P. O. Box X
 - Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal.
 - Source decks (ORTHIS 6644 cards, ORTHAT 7200 cards)
 - Auxiliary source decks (960 cards)
 - Sample problems (ORTHIS 36 cards, ORTHAT 57 cards)

Sample problem output (ORTHIS 12 pages, ORTHAT 23 pages)
Reference report and ACC Note

17. CATEGORY - H

KEYWORDS - two-dimensional, heat transfer, fuel elements, x-y, r-z, r-theta, steady-state conditions, transients, thermal conductivity, time dependence, temperature dependence

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - CLUP77
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
FACOM 230-60, IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The collision probabilities are computed by a numerical double integration. An array of fuel rods, a cruciform control rod and a poison curtain in the assembly are treated without smearing. When a one-group calculation with a fixed source is required, the flux distribution is calculated iteratively.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - A maximum of 120 assemblies are allowed and all assemblies must be symmetric both bilaterally and diagonally.
6. TYPICAL RUNNING TIME - 3.5 minutes execution time is required for the sample problem on the FACOM 230-60, 2.5 minutes is required on the IBM360/75.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed October 1972
Facom version submitted March 1972
IBM360 version submitted May 1972, sample problem executed by NESC
10. REFERENCES - Keiichiro Tsuchihashi, CLUP77 - A FORTRAN Program of Collision Probabilities for Square Clustered Assembly, JAERI-1196, January 1971
Kiyoshi Asai, Free Format, JAERI Memo 4458, May 1971
Remarks to Users, JAERI Memorandum
Input Data Requirements of CLUP-77, JAERI Memorandum
11. MACHINE REQUIREMENTS - 57K (octal) words on the FACOM, 250K bytes on the IBM360
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - FACOM Operating System (FACOM 230-60) and OS/360 (IBM360)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Subroutines PACK and UNPACK call a routine which finds the logical sum of two integers. This subroutine must be user-supplied.
15. NAME AND ESTABLISHMENT OF AUTHORS -
230-60 Keiichiro Tsuchihashi
 Japan Atomic Energy Research Institute
 Tokai Research Establishment
 Tokai-mura, Naka-gun, Ibaraki-ken
 Japan

360 P. Henline
 High Energy Physics Division
 Argonne National Laboratory
 9700 South Cass Avenue
 Argonne, Illinois 60439
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
 Source decks (FACOM-2645 cards, 360-2677 cards)

Sample problems (FACOM-43 cards, 360-47 cards)

Sample problem output (33 selected pages)

Reference report and Memoranda

17. CATEGORY - 8

KEYWORDS - fuel elements, cell calculation, neutron flux, poisoning

18. SPONSOR -

1

1. NAME OR DESIGNATION OF PROGRAM - HERMES
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The following are all approximate dimension restrictions -
 - 12 time-periods (months)
 - 50 radionuclides
 - 200 radionuclide sources (nuclear sites)
 - 300 receptor locations
6. TYPICAL RUNNING TIME - The HERMES model consists of ten submodels designed to be executed sequentially, but each of the submodels may be used individually to study a given aspect of the events leading to dose. Running time of each submodel varies from about one minute to an hour depending on the submodel and the complexity of the problem
7. UNUSUAL FEATURES OF THE PROGRAM - This program provides a regional analysis of radiation dose from the nuclear power industry, permitting evaluation of the resultant effects of operating large numbers of nuclear facilities. Options in component codes of the program permit consideration of a variety of radiation waste treatment systems. Dose evaluations may be obtained in varying detail
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed October 1972
UNIVAC1108 version submitted March 1972
10. REFERENCES - J. F. Fletcher and W. L. Dolson, HERMES - A Digital Computer Code for Estimating Regional Radiological Effects from the Nuclear Power Industry, HEDL-TME-71-168, December 1971
UNIVAC System Descriptions for NTRAN, ETIME, ETIMEF, and DOY
HERMES Control Cards, ACC Programming Note 74-6, September 7, 1973
11. MACHINE REQUIREMENTS - 65K memory and a magnetic drum or alternative device for storage of large amounts of data
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and SLEUTH
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - CSCX
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Most of the submodels of HERMES would require very little conversion effort to execute on other computers, although those submodels requiring drum devices for storage of data would require more effort. Assembly language routines are used for timing, input-output unit assignments, and similar activities. Several calls are made to subroutine SETDAR. This subroutine dynamically allocates storage for arrays and must be supplied by the user. Sample problem input decks for RADREL, ARTRAN and WTRAN contain UNIVAC1108 control statements which have a multiple 7-8 punch in column 1. For distribution using Center equipment it was necessary to modify such statements, the multiple 7-8 punch in column 1 was replaced by a multiple 12-1 punch, a letter A
15. NAME AND ESTABLISHMENT OF AUTHORS -
 - B. W. Bentley, W. E. Black, W. L. Dolson,
 - J. F. Fletcher, D. R. Hafner, L. D. Jacobson,
 - D. E. Peterson and K. R. Wise

Hanford Engineering Development Laboratory
 Westinghouse Hanford Company
 P. O. Box 1970
 Richland, Washington 99352
 J. K. Soldat
 Pacific Northwest Laboratories
 Battelle
 P. O. Box 999
 Richland, Washington 99352

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (SITE 173 cards, MOPOSH 427 cards, RADREL 796 cards, DOSIS 1355 cards, REPARE 1672 cards, TRANS 259 cards, FIGURE 338 cards, ARTRAN 1763 cards, WTRAN 2716 cards, DOSE 3280 cards)
 Sample problems (SITE 35 cards, MOPOSH 33 cards, RADREL 58 cards, DOSIS 5 cards, REPARE 5 cards, ARTRAN 152 cards, WTRAN 345 cards, DOSE 1315 cards)
 Sample problem output (SITE 4 pages, MOPOSH 13 pages, RADREL 20 pages, DOSIS 6 pages, REPARE 9 pages, ARTRAN 16 pages, WTRAN 14 pages, DOSE 17 pages)
 Documentation (480 cards)
 Reference report, System Descriptions, and ACC Note

17. CATEGORY - R

KEYWORDS - radiation effects, reactor safety, dose rates, power plants

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - PREP/KITT
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360, UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The PREP program obtains minimal cut sets by either direct deterministic testing or by an efficient Monte Carlo algorithm. The minimal path sets are obtained using the Monte Carlo algorithm. The reliability information is obtained by the KITT programs from numerical solution of the simple integral balance equations of kinetic tree theory.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The PREP program will obtain the minimal cut and/or path sets for any tree with up to 2000 components and 2000 logical gates. All gates of the fault tree must be and and or gates, and no gate may have more than 7 inputs consisting of both components and other gates. PREP can obtain at most 1000 minimal cut sets with a maximum of 19 components per set, and can obtain at most 500 minimal path sets with a maximum of 29 components per set. KITT1 will obtain reliability information for up to 500 minimal cut or path sets containing a total of at most 400 distinct components and inhibit conditions. KITT2 will obtain reliability information for up to 500 minimal cut or path sets containing a total of at most 350 distinct components and inhibit conditions. KITT2 can obtain reliability information for each of 50 different phases per component.
6. TYPICAL RUNNING TIME - On the IBM360/75 running time is about 0.06 second for a ten-component tree without repair.
7. UNUSUAL FEATURES OF THE PROGRAM - The KITT programs obtain exact reliability quantities as functions of time rather than the single point obtained by most other programs.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed October 1972
IBM360 version submitted February 1972
UNIVAC1108 version submitted February 1972
10. REFERENCES - W. E. Vesely, Analysis of Fault Trees by Kinetic Tree Theory, IN-1330, October 1969
W. E. Vesely and R. E. Narum, The User's Manual for the PREP and KITT Codes, IN-1349, August 1970
W. E. Vesely, Single Precision Modifications to the KITT-1 and KITT-2 Fault Tree Codes, Idaho Nuclear Corporation Memorandum, WEV-54-70, December 9, 1970
11. MACHINE REQUIREMENTS - 350K bytes on the IBM360

12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 MVT (IBM360).
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
W. E. Vesely and R. E. Narum
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (PREP 360-825 cards, 1108-785 cards, MINSET 360-654 cards, 1108-617 cards,
RAND 360-75 cards, KITT1 360-915 cards, 1108-870 cards, KITT2 360-1049 cards,
1108-1049 cards)
Sample problems (PREP 360-36 cards, 1108-35 cards, KITT1 360-17 cards, 1108-17 cards,
KITT2 360-44 cards, 1108-44 cards)
Load modules (360 PREP.TREBIL, KITT.KITT1, KITT.KITT2)
Object modules (360 PREP.MINSET)
Control information (JCL 360-56 cards)
Sample problem output (8 replacement pages)
Reference report, IN-1349, and Memorandum
17. CATEGORY - G
KEYWORDS - reliability, fault tree analysis, probability, accidents, failures, system failure analysis
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ANVENT
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - GE635 MARK2 Time-Sharing System
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The system is divided into three regions-- an upper region, a lower region, and the middle, or ice condenser region. Finite difference equations are solved to determine the temperatures at various nodes for both the steady-state and transient condition.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The model is one-dimensional with heat transfer occurring only in the radial direction. All physical properties are independent of temperature except the density of the annulus air which behaves as an ideal gas and exists uniformly at its mean mixed temperature. The air in the annulus has a transmissivity of 1. Radiative heat transfer occurs between the concrete reactor building and the steel containment building. Circulation of refrigerating air in the ice-condenser air ducts ceases at the initiation of the LOCA. Leakage of air across the concrete reactor building or the steel containment shell is negligible. Thermal contact resistances are neglected.
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed October 1972
GE635 version submitted February 1972
10. REFERENCE - R. S. Krell and J. L. Kelly, ANVENT Annulus Ventilation Program for Westinghouse Ice-Condenser Nuclear Unit, Duke Power Company Program Description, December 3, 1971.
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GE635 MARK 2 Time-Sharing System
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
J. L. Kelly and R. S. Krell
Duke Power Company
422 South Church Street
Charlotte, North Carolina 28201
16. MATERIAL AVAILABLE -
Source deck (432 cards)
Reference program description

17. CATEGORY - G

KEYWORDS - accidents, heat transfer, reactor safety, coolants

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GENRD
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
CDC6600, IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - GENRD will read and process free-format numeric and Hollerith input data from cards
4. METHOD OF SOLUTION - GENRD reads input data as a card image, decodes the resulting character string to form a set of integers, real constants, or Hollerith words, and stores the set into a container array specified in the parameter list
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - There is no provision for typing double precision, complex, or logical input. GENRD cannot recognize octal or other non-standard input forms. Hollerith information cannot be continued from one card to the next nor can it be contained within a repeat specification. Suggestions are included in the report for ways to overcome some of these difficulties. There is no provision for limiting the length of a digit string since the maximum number of digits which can be used to represent an integer is machine dependent.
6. TYPICAL RUNNING TIME - An input deck of mixed numeric and Hollerith data can be processed at the rate of 70 cards per second.
7. UNUSUAL FEATURES OF THE PROGRAM - GENRD has been written entirely in Standard FORTRAN IV language to make it easily available on a variety of computers. In addition to storing isolated data as it is encountered on the cards it can manipulate data according to the interpolate (i), repeat (r), or skip words (s) specifications. Thus, it can generate and insert a specified number of equally spaced interpolates between two constants, it can repeat the storage of a set of constants a specified number of times, and it can pass over a specified number of words in the container array when storing processed input. A numeric entity, such as a long R specification, may be continued from one card to the next.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed October 1972
CDC6600 version submitted April 1972
IBM360 version submitted April 1972, sample problem executed by NESC
10. REFERENCES - Clarice W. Cox, GENRD - A Free-format Card Input Processor, LA-4793, January, 1972
Clarice W. Cox, Notes on GENRD Package, IBM-360 Version, LASL Memorandum
Clarice W. Cox, Notes on GENRD Package, CDC-6600 Version, LASL Memorandum
11. MACHINE REQUIREMENTS - 3000 decimal words of core, usual I/O, and one tape or disk unit
12. PROGRAMMING LANGUAGE USED - ANSI Standard FORTRAN
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3 (CDC6600) and DOS (IBM360)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
Clarice W. Cox
Los Alamos Scientific Laboratory
University of California
Los Alamos, New Mexico 87544
16. MATERIAL AVAILABLE -
Source decks (360-696 cards, 6600-695 cards)
Sample problems (360-18 cards, 6600-18 cards)
Sample problem output (360-4 pages, 6600-3 pages)
Reference report and Memoranda

17. CATEGORY - L

KEYWORDS - data processing, data acquisition, interpolation

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - CLEM
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - CLEM generates constrained Legendre moments for neutron scattering angular distributions. The constraint is that the angular distribution itself should be non-negative.
4. METHOD OF SOLUTION - The angular distributions are expanded in terms of Legendre polynomials and a non-negative constraint is applied.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - The program will compile and execute the sample problem using 33 seconds CP time, 41 seconds PP time.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - CLEM calls subroutines GRLIN, SPLOT, PMARK, and PENEND. These routines are included in KAPLPLOT (NESC Abstract 496).
9. STATUS - Abstract first distributed October 1972
CDC6600 version submitted March 1972
10. REFERENCES - C. J. Slavik, C. R. Lubitz, J. T. Reynolds, CLEM - A Legendre Polynomial Fitting Program with a Non-negativity Constraint, KAPL-M-6923, May 22, 1968.
11. MACHINE REQUIREMENTS - 300K, usual I/O, and one tape unit.
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 -
15. NAME AND ESTABLISHMENT OF AUTHORS -
C. J. Slavik, C. R. Lubitz, J. T. Reynolds
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (979 cards)
Sample problem (116 cards)
Sample problem output (16 selected pages)
Reference report
17. CATEGORY - A
KEYWORDS - Legendre polynomials, angular distribution, scattering, KAPLPLOT codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - LASL GROUP-AVERAGED X-SECTIONS
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The tables are arranged in increasing nuclide number in the format used by the LASL transport theory programs. With a few exceptions, elements are given in alphabetical order. All cross sections are in barns.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - RDTAX, a program used at LASL to prepare a binary library tape for use with DTF from the BCD data tape has been included in this package.
9. STATUS - Abstract first distributed October 1972
CDC6600 version submitted October 1967
10. REFERENCES - G. I. Bell, J. J. Devaney, G. E. Hansen, C. B. Mills, and W. H. Roach, Los Alamos Group-Averaged Cross Sections, LAMS-2941, September 1963
F. Brinkley, LASL Memorandum (rough draft), October 10, 1967
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 -
C. B. Mills
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87544
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (RDTAX 62 cards)
18-group cross sections (4522 cards)
24-group cross sections (3111 cards)
25-group cross sections (15,373 cards)
Reference report and Memorandum
17. CATEGORY - Z
KEYWORDS - cross sections, group constants, libraries, sorting, DTF codes, RDTAX codes
18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - ARC-NU1002 BCD Input Processor
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - IBM360/50 and larger models
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - The module ARC(NU1002) processes general neutronics input data sets for subsequent use by the neutronics-computational modules of the Argonne Reactor Computation (ARC) System
4. **METHOD OF SOLUTION** - This module reads and analyzes the card image data in the data set A NIP. These data define reactor geometry, mesh structure, region and composition assignments, boundary conditions, problem type, critically search specifications, and external source data. Insufficient or inconsistent data are noted with error messages, and processing continues. Binary interface data sets are written for use by other modules. On option, edits of the data sets produced are provided including a map of the region-composition mesh of the reactor core
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** -
6. **TYPICAL RUNNING TIME** - The sample problem provided requires about 3 seconds on an IBM360/75
7. **UNUSUAL FEATURES OF THE PROGRAM** - The modular design allows the use of the same input processor, ARC(NU1002), for each of the neutronics computational modules with communication via interface data sets
8. **RELATED AND AUXILIARY PROGRAMS** - All neutronics paths of the ARC System utilize this module. The ARC System environment is provided by ARC-SYSTEM (NESC Abstract 522)
9. **STATUS** - Abstract first distributed October 1972
IBM360 version submitted April 1972, sample problem executed by NESC
10. **REFERENCES** - E. A. Kovalsky and D. E. Neal, The ARC System Neutronics Input Processor, ANL-7713, January 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
ARC(NU1002) Supplemental Information, 1972
11. **MACHINE REQUIREMENTS** - About 255K bytes are required with a 10,000 double-word container (default). One peripheral I/O device is required
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** - This module is executed in an ARC System environment (NESC Abstract 522)
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
E. A. Kovalsky
Applied Mathematics Division
B. J. Toppel
Applied Physics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
• Contact
16. **MATERIAL AVAILABLE** - Magnetic Tape Transmittal
Source decks (PDS NU1002 SOURCE)
Object modules (PDS NU1002 SEGLIB)

Linkage editor control statements (PDS NUI002.OVERLAY)
 Load modules (PDS NUI002.MOOLIB)
 Control information (JCL IEHMOVE 20 cards)
 Sample problem (263 cards)
 Sample problem output (IEHMOVE 2 pages, execution 16 pages)
 Reference reports and supplemental information

- 17. CATEGORY - L
 KEYWORDS - data processing, data acquisition, ARC codes
- 18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - EISPACK Release 2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370, CDC6000-7000, UNIVAC1108,1110, DEC-PDP10, Honeywell1635,6070, and Burroughs6700
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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	F251	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)
COMOR	F246	Find all values of complex Hess matrix (QR)
COMOR2	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)
EISPAC	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
HTRIDK	F285	Back transform vectors of matrix formed by HTRID1
HTRID3	F243	Back transform vectors of matrix formed by HTRID3
HTRID1	F284	Reduce Hermitian matrix to sym tridiag
HTRID3	F242	Reduce Hermitian packed matrix to sym tridiag
IMTQLV	F234	Find all values of sym tridiag matrix
IMTQL1	F291	Find all values of sym tridiag matrix
IMTQL2	F292	Find all values/vectors of sym tridiag matrix
INVIT	F288	Find some vectors of real Hess matrix
MINFIT	F293	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)
OZHES	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
RATOR	F298	Find extreme values of sym tridiag matrix
REBAK	F225	Back transform vectors of matrix formed by REDUC
REBAK8	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
RSE	F308	Driver subroutine for a real sym band matrix
RSG	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
SYD	F232	Singular value decomposition of rectangular matrix
TINVIT	F223	Find some vectors of sym tridiag matrix
TOLRAT	F235	Find all values of sym tridiag matrix
TQL1	F289	Find all values of sym tridiag matrix
TQL2	F290	Find all values/vectors of sym tridiag matrix
TRBAK1	F279	Back transform vectors of matrix formed by TRED1
TRBAK3	F228	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
TRIDIB	F237	Find some values of sym tridiag matrix
TSTURM	F293	Find some values/vectors of sym tridiag matrix

4. **METHOD OF SOLUTION** - QR, LR, QL, rational QR, bisection, QZ, and inverse iteration methods are used

5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** -

6. **TYPICAL RUNNING TIME** - Running time varies and detailed information appears in reference 2. The CP time required for compilation of the 28 sample cases on the CDC6600 ranged from slightly less than 1 second to almost 5 seconds. CDC6600 execution of the test drivers took from 0.11 to 7.2 CP seconds to compute the detailed results and varied from 0.04 to 3.8 CP seconds for the summary runs. On the IBM370/195 the total CPU time measured for compilation, link editing, and execution ranged from 3 to 15 seconds to compute the detailed results, all summary runs were completed in less than 15 seconds.

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.

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.

8. **RELATED AND AUXILIARY PROGRAMS** - EISPACK Release 2 replaces EISPACK, an earlier package submitted in May 1972 and distributed by the Center as NESC No. 534 prior to this release.

9. **STATUS** - Abstract first distributed October 1972.

IBM360 version of EISPACK submitted May 1972, replaced by IBM360,370 version of EISPACK2 July 1975, revised February 1976, revised to Edition B February 1977, test cases executed by NESC on IBM370/195, November 1975.

CDC6000-7000 version of EISPACK submitted May 1972, replaced by EISPACK2 July 1975, revised February 1976, revised to Edition B February 1977, test cases executed by NESC on CDC6600, November 1975.

UNIVAC1108 version of EISPACK submitted May 1972, replaced by UNIVAC1108,1110 version of EISPACK2 July 1975, revised February 1976, revised to Edition B February 1977.

DEC-PDP10 and Honeywell635 version of EISPACK submitted May 1972, replaced by DEC-PDP10 and Honeywell635,6070 version of EISPACK2 July 1975, revised February 1976, revised to Edition B February 1977.

Burroughs6700 version submitted July 1975, revised February 1976, revised to Edition B February 1977.

10. REFERENCES - J. H. Wilkinson and C. Reinsch, Handbook for Automatic Computation, Volume 11, Linear Algebra, Springer-Verlag, New York, Heidelberg, Berlin, 1971
B. T. Smith, J. M. Boyle, J. J. Dongarra, B. S. Garbow, Y. Ikebe, V. C. Klema, and C. B. Moler, Matrix Eigensystem Routines-EISPACK Guide, Lecture Notes in Computer Science, Volume 6 2nd Edition, G. Goos and J. Hartmanis, Springer-Verlag, New York, Heidelberg, Berlin, 1976
B. S. Garbow, J. M. Boyle, J. J. Dongarra, and C. B. Moler, Matrix Eigensystem Routines-EISPACK Guide Extension, Lecture Notes in Computer Science, Volume 51, G. Goos and J. Hartmanis, Springer-Verlag, Berlin, Heidelberg, New York, 1977
Burton S. Garbow and Jack J. Dongarra, EISPACK Eigensystem Package Path Chart Release 2, Informal Note, April 1974
Jack J. Dongarra & Burton S. Garbow, Instructions for the Use of Release 2 of EISPACK IBM Version, April 27, 1976
Jack J. Dongarra & Burton S. Garbow, Instructions for the Use of Release 2 of EISPACK Non-IBM Versions, May 4, 1976
James M. Boyle, Carl H. Hauser, and Harold R. Rothaar, EISPAC Eigensystem Package Path Chart Release 2, Informal Note, February 1975
J. J. Dongarra & B. S. Garbow, Incompatibility Between the Two Releases of the EISPAC Control Program, Informal Note, March 22, 1976
11. MACHINE REQUIREMENTS - Vary according to usage. Two machine-dependent parameters, RADIX and MACHEP, appear in various subroutines and all test drivers included in this package. RADIX specifies the base of the machine floating-point representation, MACHEP the relative precision of floating-point arithmetic. RADIX is included in routines BALANC and CBAL, MACHEP in BANDV, BISECT, CINVIT, COMLR, COMLR2, COMQR, COMQR2, HQR, HQR2, IMTQLV, IMTQL1, IMTQL2, INVIT, MINFIT, RATQR, SVD, TINVIT, TQLRAT, TQL1, TQL2, TRIDIB, and TSTURM.
12. PROGRAMMING LANGUAGES USED -

FORTTRAN IV(G)	IBM370/168, IBM370/195
FORTTRAN IV(H)	IBM370/168
FORTTRAN IV(H 21 7)	IBM360/75, IBM370/195
FORTTRAN IV(H Extended 2 1)	IBM360/75, IBM370/165
WATFIV	IBM370/195
FTN(3 0)	CDC6400
FTN(4 2)	CDC6600
FUN	CDC6400-6500
MNF	CDC6600-6400
RUN(2 3)	CDC6400, CDC6600
RUN(60 2)	CDC6600-6400
RUNW	CDC6600-6400
FORTTRAN V(9)	UNIVAC1110
FORTTRAN F40	DEC-PDP10
FORTTRAN-Y (SR-F)	Honeywell16070
FORTTRAN IV(2 6)	Burroughs6700
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 (IBM360/75, IBM370/165, IBM370/195), MTS (IBM370/168), KRONOS 2.1 (CDC6600), SCOPE 3.3 (CDC6400), SCOPE 3.4.2 (CDC6600), UT2D-85 (CDC6600-6400), EXEC8 (UNIVAC1110), TOPS-10 (S06B) (DEC-PDP10), GECOS SR-F (Honeywell16070), and MCP 2.6 (Burroughs6700)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The set of sample problems, or testing aids, consists of drivers, data input subroutines, residual calculation routines, and test data. The output available is from Center execution of summary runs.
The specification statements used in the IBM and DEC-Honeywell versions for inline and library functions are modified to comment statements in the Burroughs, CDC, and UNIVAC machine versions.
The IBM distribution includes all programs listed under item 3. Other machine versions do not include the EISPAC F299 control program.
The February 1976 revision consisted of modification of the F226 BANDR program and changes to the machine-readable documentation for F226 BANDR, F233 MINFIT, and F232 SVD.
Edition B revisions consisted of modifications of the F294 BISECT, F239 QZIT, F240 QZVAL, F237 TRIDIB, and F293 TSTURM programs and the associated machine-readable documentation.

Locations and machines used for EISPACK testing were -

Machine	Test Site
IBM360/75	Stockholm Data Center
IBM360/75	University of Illinois at Urbana-Champaign
IBM370/165	University of Toronto
IBM370/168	The University of Michigan
IBM370/195	Argonne National Laboratory
CDC6400	Northwestern University
CDC6400-6500	Purdue University
CDC6600-6400	The University of Texas at Austin
CDC6600	ICASE/NASA Langley Research Center
CDC6600	Kirtland Air Force Base/AFWL
CDC7600	National Center for Atmospheric Research
UNIVAC1110	The University of Wisconsin-Madison
DEC-PDP10	Yale University
Honeywell6070	Bell Laboratories at Murray Hill
Burroughs6700	University of California, San Diego

15. NAME AND ESTABLISHMENT OF AUTHOR -

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 (360-15,337 cards, 1110-11,612 cards, other machine versions-11,542 cards)
 Object decks (360-38 cards)
 Test drivers and data (360-18,237 cards, 1110-test drivers 10,156 cards, data 3344
 cards, other versions-test drivers 10,109 cards, data 3324 cards)
 Control information (JCL 360-1253 cards)
 Test output (360-36 selected pages, 6600-31 selected pages)
 Machine-readable documentation (360 2 files-22,854 cards each, other versions-20,966
 cards)
 Reference notes and instructions appropriate to machine version

17. CATEGORY - P

KEYWORDS - eigenvalues, eigenvectors, matrices, numerical solution

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - MULTI
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - MULTI computes scattering cross sections
4. METHOD OF SOLUTION - The multi-level resonance formula of H A Bethe is used to compute the scattering cross sections
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Only s-wave incident neutrons are allowed
6. TYPICAL RUNNING TIME - Compilation and execution of sample problem requires 10 seconds CP time and 22 seconds PP time
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - MULTI calls the plotting subroutines PLTSIZE, LINLG, SPLOT and PENEND which are included in the program package KAPLPLOT (NESC Abstract 496)
9. STATUS - Abstract first distributed October 1972
CDC6600 version submitted April 1972
10. REFERENCES - C J Slavik, MULTI, A Multi-level Resonance Theory Program, ADA-TP-15, May 1971
H A Bethe, Reviews of Modern Physics, Vol 9, p 69, 1937
H Feshbach, Nuclear Spectroscopy Part B, F Ajzenberg-Selove, (Ed), Academic Press, 1960
11. MACHINE REQUIREMENTS - Input, output, and two tape units
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - To avoid calling the plotting routines, subroutine PLT can be removed and the single CALL PLT in subroutine FUNK deleted
15. NAME AND ESTABLISHMENT OF AUTHOR -
C J Slavik
Knolls Atomic Power Laboratory
General Electric Company
Box 1072
Schenectady, New York 12301
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (371 cards)
Sample problem (61 cards)
Sample problem output (16 pages and 5 graphs)
Reference report, ADA-TP-15
17. CATEGORY - A
KEYWORDS - scattering, cross sections, resonance, multilevel analysis, KAPLPLOT codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - RAHAB Lattice Physics Modules
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - An iterative technique is used to solve the integral transport equations. An inner iteration is used to compute the spatial shape for one energy group with source terms from other energy groups held constant. An outer iteration settles the thermal flux energy distribution and fission source shape.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The code is restricted to 150 mesh points, 100 energy groups and 50 different isotopes.
6. TYPICAL RUNNING TIME - A problem containing 100 mesh points, 37 energy groups, usually requires about 1 minute CPU time on an IBM360/195.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - JOSHUA Operating System
9. STATUS - Abstract first distributed October 1972
IBM360 version submitted April 1972
10. REFERENCES - The JOSHUA System, DPSTM-500
Vol 1 General November 1969
Vol 2 User's Guide October 1970
Vol 3 Data Set Specs December 1969, Rev 5/70
Vol 4 Lattice Physics June 1970
11. MACHINE REQUIREMENTS - 260K bytes
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 and HASP
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
H. C. Honeck
Savannah River Laboratory
E. I. duPont de Nemours and Company, Inc.
Aiken, South Carolina 29801
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (22,729 cards)
Auxiliary routines (280 cards)
17. CATEGORY - B
KEYWORDS - two-dimensional, multigroup, reactor lattices, transport theory, iterative methods, JOSHUA codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - M0678(FUGIT1)
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The FALICE routine is used to solve first-order transient equations of motion by modified Euler method of integration.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
 - 1 to 6 degrees of freedom in the base motion
 - 1 to 30 rows and columns in the flexibility matrix
 - 0 to 3 types of damping
6. TYPICAL RUNNING TIME - 5 minutes are required for a typical problem.
7. UNUSUAL FEATURES OF THE PROGRAM - Either the flexibility or stiffness matrices may be input. Nonlinear constraints and damping may be used. Frequency analyses of output may be plotted.
8. RELATED AND AUXILIARY PROGRAMS - M0397 determines the flexibility or stiffness matrix of an elastic structure. FUGIT1 uses the Battis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed October 1972
CDC6600 version submitted April 1972
10. REFERENCES - C. M. Friedrich, FUGIT-1, A Computer Program for the Dynamic Response of Elastic Structures with Nonlinear Constraints and Damping, WAPD-TM-650, October 1969.
C. J. Pfeiffer, CDC-6600 FORTRAN Programming - Battis Environmental Report, WAPD-TM-666, January 1967.
11. MACHINE REQUIREMENTS - Input tape, output tape, 150,000 (octal) central memory, plot routines.
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 -
 - C. M. Friedrich
 - Battis Atomic Power Laboratory
 - Westinghouse Electric Corporation
 - Box 79
 - West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
 - Source deck (1340 cards)
 - Sample problem (26 cards)
 - Sample problem output (25 pages)
 - Reference report, WAPD-TM-650
17. CATEGORY - 1
KEYWORDS - equations of motion, mechanical structures, flexibility, matrices, damping, M0397 codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ETOG3
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - ETOG3 performs a straightforward group average of cross sections using an input weighting function and the microscopic data from the ENDF/B files. The Breit-Wigner single-level and multi-level formulae are assumed to yield resolved resonance cross sections with reasonable accuracy
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - In addition to the restrictions on the ENDF/B data itself, ETOG3 has the following maxima -
 99 multigroups
 500 resolved resonances

6. TYPICAL RUNNING TIME -

Library	ENDF data has few resonance parameters	ENDF data has no resonance parameters
MUFT, 54 group	35 seconds*	8 seconds
GAM1, 68 group	100 seconds**	48 seconds**
GAM2, 99 group	180 seconds**	96 seconds**
ANISN, 99 group	180 seconds**	96 seconds**
* easily goes up to 450 seconds for 400 resonances		
** estimate		

7. UNUSUAL FEATURES OF THE PROGRAM - In the establishment of transfer matrices, analytical results are employed where possible in the normalization of output data. For example, in the generation of the elastic scattering matrix in the energy range in which the scatter is isotropic in the center-of-mass system, results of the numerical integration performed are normalized to values derived analytically
8. RELATED AND AUXILIARY PROGRAMS - ETOG3 supersedes ETOG1 in that (a) more accurate data decks are produced for use in creating libraries, (b) additional data decks may be generated for use in creating LASER libraries, and (c) Version-III ENDF/B formats and formulae are digestible. In the program, use is made of the general purpose processor and retrieval subroutines written at Brookhaven for handling ENDF/B data files (NESC Abstracts 384, 465, 475)
9. STATUS - Abstract first distributed December 1973
 CDC7600 version submitted September 1973
10. REFERENCES - M. Raymond, 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 (ENDF-114) Supplement, August 1973
 D. E. Kushner 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, and Errata
 M. K. Drake, Ed., Data Formats and Procedures for the ENDF Neutron Cross Section Library, BNL-50274 (ENDF-102), Vol. 1, October 1970
 C. G. Poncelet, LASER - A Depletion Program for Lattice Calculations Based on MUFT and THERMOS, WCAP-6073, April 1966
 O. Ozer, Description of the ENDF/B Processing Codes and Retrieval Subroutines, ENDF-110, Revised June 1971
 H. Bohl, Jr., E. M. Gelbard, and G. H. Ryan, MUFT-4, Fast Neutron Spectrum Code for the IBM-704, WAPD-TM-72, July 1957

H. Bohl, Jr. and A. P. Hemphill, MUFT-5 - A Fast Neutron Spectrum Program for the Philco-2000, WAPD-TM-218, February 1961.

G. D. Jeanou and J. S. Dudek, GAM-I, A Consistent P1 Multigroup Code for the Calculation of Fast Neutron Spectra and Multigroup Constants, GA-1850, May 1961.

G. D. Jeanou and J. S. Dudek, GAM-II, A B3 Code for Calculation of Slowing Down Spectrum and Associated Multigroup Constants, GA-4285, September 16, 1963.

W. W. Engle, Jr., A User's Manual for ANISN, A One-dimensional Discrete Ordinates Code with Anisotropic Scattering, K-1683, March 30, 1967.

D. M. O'Shea, B. J. Toppel and A. L. Rago, MC-2 - A Code to Calculate Multigroup Cross Sections, ANL-7318, June 1967.

11. MACHINE REQUIREMENTS - 42,000 decimal locations and 4 scratch and punch units, 17,000 decimal locations of extended core memory
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 - The program consists of 9 overlays.
15. NAME AND ESTABLISHMENT OF AUTHORS -
M. Raymond, D. E. Kusner, R. A. Dannels,
and S. Kellman
Nuclear Energy Systems
Westinghouse Electric Corporation
Box 355
Pittsburgh, Pennsylvania 15230
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (ETOG3 13,877 cards, UPDATE 13,947 cards, modifications 77 cards)
Sample problem (2 cards)
Reference report, WCAP-3845-1, and Supplement 1
17. CATEGORY - B
KEYWORDS - cross sections, Breit-Wigner formula, group constants, averages, libraries, ETOM codes, GAM codes, ANISN codes, MUFT codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - STRAP
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - STRAP-S generates the stiffness matrix of a structure by the finite element method and solves the resulting equations for structural displacements and member forces. STRAP-D generates the stiffness matrix, solves for eigenvalues and eigenvectors, uncouples and solves the series of second-order ordinary differential equations, and then calculates and plots the requested member forces.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
 STRAP-S maxima -
 250 degrees of freedom
 100 members
 STRAP-D maxima -
 100 degrees of freedom
 80 time-steps in the forcing function input
6. TYPICAL RUNNING TIME - STRAP-S running time is about 5 seconds for a 97 degree of freedom problem. STRAP-D running time is approximately 15 seconds for a plane frame, 6 degrees of freedom, 6 modal shape (0 to 1 second) problem with 3 plots, while 15 minutes are required for a vibrating beam, 41 degrees of freedom, 2 modes (0 to 1 second) problem with 5 plots.
7. UNUSUAL FEATURES OF THE PROGRAM - STRAP-D allows forcing functions input to be in the form of pressures, forces, or ground accelerations. Initial conditions (displacements and velocities) can be specified as zero, or displacements can be calculated, or displacements and velocities can be read from input. Member forces can be calculated and plotted by STRAP-D.
8. RELATED AND AUXILIARY PROGRAMS - Integral parts of STRAP-D include an eigenvalue-eigenvector routine (THJCOB) by C. Noble, a stiffness generator (STIFGN) by J. A. Dearien, a Runge-Kutta integration technique (RKINTZ) by R. D. Peak, and a matrix inversion routine (MAINV) by D. H. Gipson.
9. STATUS - Abstract first distributed December 1973.
 IBM360 version of STRAP-S submitted April 1972, sample problem executed by NESC.
 IBM360 version of STRAP-D submitted April 1972, sample problem executed by NESC.
10. REFERENCES - J. A. Dearien, C. Noble, and E. D. Uldrich, STRAP, A Computer Code for Static and Dynamic Structural Analysis and Studies Made Using the Code, IN-1362, June 1970.
 J. A. Dearien, STRAP-S, Structural Analysis Package-Static, ANC Program Writeup, October 1969.
 L. J. Siskin, STRAP-D, Structural Analysis Package-Dynamic, ANC Program Writeup, October 1971.
 W. Weaver, Jr., Computer Programs for Structural Analysis, D. Van Nostrand Co., Inc., Princeton, New Jersey, 1967.
 W. C. Hurly and M. F. Rubinstein, Dynamics of Structures, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1964.
 S. L. Rogers, Dynamics of Framed Structures, John Wiley & Sons, Inc., New York, 1959.
 J. B. Scarborough, Numerical Mathematical Analysis, The John Hopkins Press, Baltimore, Maryland, 1955.
 W. T. Thomson, Vibration Theory and Applications, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1965.

N. Willemis and W. M. Lucas, Matrix Analysis for Structural Engineers, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1968.

11. MACHINE REQUIREMENTS - 300K bytes of memory for each program plus 5 to 7 direct access storage devices besides standard I/O for STRAP-D
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - STRAP-D uses plotting subroutines currently in the NRTS operating system.
15. NAME AND ESTABLISHMENT OF AUTHORS -
J. A. Dearien and E. D. Uldrich
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (STRAP-S 1209 cards, STRAP-D 5067 cards)
Sample problems (STRAP-S 34 cards, STRAP-D 136 cards)
Control information (JCL STRAP-S 18 cards, STRAP-D 61 cards)
Load modules (STRAP-S, STRAP-D STEP1, STRAP-D STEP2, and STRAP-D STEP3)
Sample problem output (STRAP-S 7 pages, STRAP-D 31 selected pages)
Reference report, IN-1362, and Program Writeups
17. CATEGORY - I
KEYWORDS - differential equations, mechanical structures, static loads, temperature gradients, dynamic loads, finite element method, matrices
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - PACTOLUS/CLOTHO
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Plant lifetime power costs are calculated using the discounted cash flow method.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 40 annual time periods into which all costs and mass flows are accumulated
 20 isotopic mass flows charged into and discharged from the reactor model
6. TYPICAL RUNNING TIME - For typical nuclear plants having a lifetime of 30 years and between 50 and 200 charge-discharge fueling events, a run time of 10 to 25 seconds can be expected.
7. UNUSUAL FEATURES OF THE PROGRAM - Although the PACTOLUS/CLOTHO code is designed primarily for nuclear power plant cost analysis, by proper input of mass flows and unit costs any similar plant such as a fossil-fueled power plant or a hydroelectric plant can be simulated. An option of PACTOLUS allows direct reading of mass flows of light-water reactors from a burnup tape provided by the ALTHAEA burnup code described in reference 4. Any similar burnup tape could be used for any specific reactor design, or card input can be provided through CLOTHO.
8. RELATED AND AUXILIARY PROGRAMS - The power cost calculation in PACTOLUS/CLOTHO is a modified version of a technique developed by Royce Salmon of Oak Ridge National Laboratory and described in the report, A Procedure and a Computer Code (POWERCO) for Calculating the Cost of Electricity Produced by Nuclear Power Stations, ORNL-3844, June 1966. See NESC Abstract 340.
9. STATUS - Abstract first distributed December 1973
 UNIVAC1108 version submitted April 1972
10. REFERENCES - C. H. Bloomster, J. H. Nail, and D. R. Haffner, PACTOLUS, A Code for Computing Nuclear Power Costs, BNWL-1189, January 1970
 J. H. Nail, PACTOLUS, A Code for Computing Nuclear Power Costs, Part 1, User's Manual, BNWL-429, June 1967
 J. H. Nail, CLOTHO, A Code for Communicating Reactor Mass Balance Data to Reactor Economics Codes, BNWL-770, June 1968
 E. T. Merrill, ALTHAEA Part 1, A One-dimensional Two-group Diffusion Code with an Effective Four-group Burnup, BNWL-462, May 1971
 R. Salmon, Excerpted Pages from ORNL-4116, August 1969
 D. R. Haffner, Operation of the PACTOLUS/CLOTHO Code, HEDL Memo, February 21, 1973
 Selected Pages from CSCX RJE/CRJE Reference, E00003-02-00, Vol. 2
 NTRAN I/O Routines Description, Excerpt from UP-3569, Rev. 1
11. MACHINE REQUIREMENTS - 65K memory with drum storage of input data to speed up processing.
12. PROGRAMMING LANGUAGE USED - FORTRAN V
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - CSCX
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHOR -

D. R. Haffner
Hanford Engineering Development Laboratory
Westinghouse Hanford Company
P. O. Box 1970
Richland, Washington 99352

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (PACTOLUS 4793 cards, PDOC 782 cards)
Sample problems (PACTOLUS 16 cards, PDOC 40 cards, CLOTHO 311 cards)
Sample problem output (PACTOLUS 20 pages, CLOTHO 2 pages)
Reference reports, BNWL-770 and BNWL-1169, Excerpts, and Memo

17. CATEGORY - D

KEYWORDS - depletion, fuel management, cost, power plants, economics, POWERCO codes, ALTHAEA codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - WSP-HASP/DOS
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - WSP is a modification of a component of the HASP II (360D-05 1 014) Version 3, modification level 1 IBM program WSP runs in a foreground partition of a DOS MFT system
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - WSP normally runs continuously in the foreground partition
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - HASP/RMT360 package
9. STATUS - Abstract first distributed December 1973
IBM360 DOS version submitted September 1973, revised September 1974
10. REFERENCES - Robert J. McMahon, The Argonne HASP/DOS Workstation Package (WSP), Argonne National Laboratory Memorandum, September, 1973
11. MACHINE REQUIREMENTS - WSP has been designed for a System/360/30 with an IBM 2540 reader-punch, two IBM 1403 printers, an IBM 1052 printer keyboard console, and an IBM 2701 data adapter unit
12. PROGRAMMING LANGUAGE USED - DOS Assembler language
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - 360 DOS Release 26 1 The ANL System/360/195 ASP central CPU is operating with Version 2 6 5 of ASP requiring no changes
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The person responsible for WSP installation and operation should be well-versed in HASP, DOS, and ASP Deviations from the configuration specified in 11, may require additional programming
15. NAME AND ESTABLISHMENT OF AUTHOR -
Robert J. McMahon
Applied Mathematics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (610 cards)
Object deck (467 cards)
Control information (driver and JCL 42 cards)
Reference memorandum
17. CATEGORY - P
KEYWORDS - operating systems, data processing, computer networks
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - PSA2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The linear equations for the statically indeterminate pipe system are set up by a generalization of Brock's matrix method. By a systematic use of linear transforms, the matrix of the system of linear equations can be obtained by incidence algebra in the form of a symmetric banded matrix.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maximum of -
36 sections
6. TYPICAL RUNNING TIME - 1 to 3 minutes are required on a Model 50.
7. UNUSUAL FEATURES OF THE PROGRAM - PSA2 takes into account -
 - (a) elasticity of the attachment of the pipe to the foundation,
 - (b) restraints on pipe displacements by anchors and intermediate partial constraints of linear type,
 - (c) given constant forces and moments acting upon the pipe system,
 - (d) thermal expansion,
 - (e) any geometrical structure of the pipe system,
 - (f) several cases of stressing per pipe system, and
 - (g) both metric and English units.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1973.
IBM360 version submitted May 1972, sample problem executed by NESC.
10. REFERENCE - B. H. Boonsira, A. N. Nickols, W. J. Hughes, and W. D. Gross, Pipe Stress Analysis Code, PSA2, AI-64-MEMO-142, Revision 1.
11. MACHINE REQUIREMENTS - 64K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV (M)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Function LOC must be user-supplied. It returns the address of its argument as an integer to the calling program.
15. NAME AND ESTABLISHMENT OF AUTHOR -
A. N. Nickols
Codes Coordinator
Atomica International
P. O. Box 308
Canoga Park, California 91304
16. MATERIAL AVAILABLE -
Source deck (1356 cards)
Sample problem (20 cards)
Control information (JCL 21 cards)
Reference report
17. CATEGORY - I
KEYWORDS - stresses, thermal expansion, pipes

1. NAME OR DESIGNATION OF PROGRAM - ENDF/B-THERMOS

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

3. DESCRIPTION OF PROBLEM OR FUNCTION - 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	108 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

4. METHOD OF SOLUTION - Kernel generation is performed by direct integration of the thermal scattering law data to obtain the differential scattering cross sections for each Legendre order. The integral parameter calculation is done by precision integration of the diffusion length equation for several moderator absorption cross sections followed by a least squares fit to obtain the first three moments of k^{-2}/σ_a as a function of σ_a . The diffusion parameters D_0 , C and other integral parameters were then obtained from the fitted moments.

5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -

6. TYPICAL RUNNING TIME -

7. UNUSUAL FEATURES OF THE PROGRAM -

8. RELATED AND AUXILIARY PROGRAMS - A retrieval program to print and/ or punch scattering kernels from the libraries is included. Part of the routine is a general subroutine that will position a library in front of a specified kernel. The subroutine may be used in any user program.

9. STATUS - Abstract first distributed December 1973
This version submitted April 1972

10. REFERENCE - F. J. McCrosson, D. R. Finch, and E. C. Olsen, Testing of ENDF/B - THERMOS Cross Sections for H₂O, D₂O, C, ZrH₂, (C₂H₄)_x, Be, BeO, C₆H₆, and UO₂. DP-1276 (ENDF-158), October 1971.
11. MACHINE REQUIREMENTS - The retrieval program requires 1 tape drive and a small amount of high-speed core.
12. PROGRAMMING LANGUAGE USED - Auxiliary program written in FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
F. J. McCrosson and D. R. Finch
Savannah River Laboratory
E. I. duPont de Nemours and Company
Aiken, South Carolina 29801
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal (3 tapes)
Library (tape 1 22,787 cards, tape 2 24,875 cards)
Auxiliary program (203 cards)
Reference report
17. CATEGORY - 2
KEYWORDS - scattering, ENDF/B, libraries, information retrieval, THERMOS codes, FLANGE2 codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - PLOT-3D
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360/75 with an IBM2280 film recorder or a CalComp 780 plotter
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - PLOT-3D is a computer program to plot any surface for which each coordinate pair (x,y) is associated with a unique z in the set of points (x,y,z) . It uses matrix transformation of the points to generate different views of the surface after arbitrary rotations about the three coordinate axes. Four versions of PLOT-3D are available. Output of version 1 and 3 is by film recorder. Output of version 2 and 4 is by CalComp plotter. Versions 3 and 4 do not draw lines which would be invisible to a viewer looking at an opaque surface, whereas versions 1 and 2 draw every line on the surface.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Versions 3 and 4 limit number of rows in arrays (x,y,z) to 100 and also number of columns in arrays (x,y,z) to 100.
6. TYPICAL RUNNING TIME - Using a 20 x 10 grid and producing six 3-D pictures requires 15 seconds with version 1, 20 seconds with version 2, 4 minutes and 30 seconds with version 3, and 3 minutes and 28 seconds with version 4.
7. UNUSUAL FEATURES OF THE PROGRAM - The PLOT-3D package is readily adaptable to other hardware. It is intended for graphical representation of surfaces determined by single-valued functions of two independent variables.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1973
IBM360 version submitted May 1972, sample problem executed by NESC
10. REFERENCES - D. Basinger and J. Gvildys, Three-dimensional Graphical Representation of Surfaces by Computer (Fast Reactor Containment Program), ANL-7633, November 1971.
R. Bruce Canwright, Jr. and Paul Swiger, PLOT 3-D - A Package of FORTRAN Subprograms to Draw Three-dimensional Surfaces, NASA TM-X-1598, June 1968.
Ruth A. Neiss, BE VISION, A Package of IBM 7090 FORTRAN Programs to Draw Orthographic Views of Combinations of Plane and Quatric Surfaces, Journal of the Association of Computer Machinery, pp. 194-204, April 1966.
Henry Margenau and George M. Murphy, The Mathematics of Physics and Chemistry, Second Edition, D. Van Nostrand Co., Inc., pp. 585-570, 1956.
D. Carson, A Film-plotting Subroutine Package (FSP) for the IBM 2280 Film Recorder, ANL-AMD Technical Memorandum No. 167, June 17, 1968.
Ronald F. Krupp, S/360 Programming Techniques for the CalComp 780, ANL-AMD Technical Memorandum No. 130, Revised June 13, 1972.
11. MACHINE REQUIREMENTS - Versions 1 and 3, for the IBM 2280 film recorder, require 7810 and 58,285 bytes of core storage, exclusive of film recorder subroutines and arrays. Versions 2 and 4, for the CalComp plotter, require 6670 and 62,435 bytes of core storage, exclusive of CalComp plotter subroutines and arrays.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 ASP
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
D. Basinger and J. Gvildys
Reactor Analysis and Safety Division
Argonne National Laboratory

9700 South Cass Avenue
Argonne, Illinois 60439

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (version 1 251 cards, version 2 246 cards, version 3 557 cards, version 4 558 cards)
Sample problem output (12 pages)
Reference report, ANL-7633
17. CATEGORY - N
KEYWORDS - three-dimensional, x-y-z, computer graphics
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - BETTY
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - BETTY describes spatial and temporal concentration behavior of a suspension in a pipe, as a result of deposition and erosion of the particles
4. METHOD OF SOLUTION - The partial differential equations describing the concentration behavior are solved by a combination of analytical and numerical integration using a simple forward differencing technique
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - No more than 900 axial increments may be used
6. TYPICAL RUNNING TIME - A problem with 100 axial increments requires about two seconds
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - BETTY uses several routines from the Bettis Environmental package (NESC Abstract 478) and subroutine HOH (NESC Abstract 294) to calculate water and steam properties
9. STATUS - Abstract first distributed December 1973
CDC6600 version submitted June 1972
10. REFERENCES - S. K. Beal, The Role of Erosion and Deposition in Sampling Entrained Particles, WAPD-TM-1014, April 1972
C. J. Pleier, CDC-5500 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967
L. L. Lynn, A Digital Computer Program for Nuclear Design Water Properties, WAPD-TM-660, July 1967
11. MACHINE REQUIREMENTS - 63K 60-bit words of core storage
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 -
15. NAME AND ESTABLISHMENT OF AUTHOR -
S. K. Beal
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (599 cards)
Sample problem (22 cards)
Sample problem output (13 pages)
Reference report, WAPD-TM-1014
17. CATEGORY - H
KEYWORDS - pipes, particles, sampling, HOH codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - EMERALD REVISION 1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
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 - Maxima of -
 - 25 isotopes
 - 7 time periods
 - 15 volumes or components
 - 10 distances
6. TYPICAL RUNNING TIME - Less than 2 minutes is required to run the sample problems.
7. UNUSUAL FEATURES OF THE PROGRAM - The use of FORTRAN IV language, modular design, generic variable names, and extensive internal comments makes EMERALD 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.

EMERALD REVISION 1, is used to assess accidental releases, while a companion code, EMERALD-NORMAL, (NESC Abstract 685), has been developed to assess conditions and releases during normal operation of a PWR. Both EMERALD REVISION 1 and EMERALD-NORMAL are derived from the original EMERALD program.
9. STATUS - Abstract first distributed December 1973.

IBM360 version of EMERALD submitted May 1972, replaced by EMERALD REVISION 1 in April 1974, sample problems executed by NESC October 1975 on an IBM370/185
10. REFERENCES - W. K. Brunot, R. R. Fray, and S. G. Gillespie, EMERALD (Revision 1) - A Program for the Calculation of Activity Releases and Potential Doses from a Pressurized Water Reactor Plant, Pacific Gas and Electric Company, March 1974.

EMERALD - A Program for the Calculation of PWR Radiation Doses, Transactions of the American Nuclear Society, June 1972
11. MACHINE REQUIREMENTS - 520K bytes of memory are required
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 -
15. NAME AND ESTABLISHMENT OF AUTHORS -
W. K. Brunol, R. R. Fray, and S. G. Gillespie
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 (4847 cards)
Sample problem input (file 2-design basis analysis cases 2525 cards, file 3-expected cases 2236 cards)
Sample problem output (65 selected pages and 9 microfiche)
Reference report
17. CATEGORY - G
KEYWORDS - dose rates, accidents, fission products, gamma radiation, power plants, radioactivity, PWR reactors, EMERALD-NORMAL codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GAMB1T
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - GAMB1T provides broad-group flux and current-averaged neutron cross sections. They are based on a thermal cross section library consisting of 99 line groups (0-2.38 eV), and a fast neutron library consisting of 68 line groups (0.414 eV - 10 MeV, 1/4 lethargy intervals). The fluxes and currents required to obtain the broad-group cross sections may be calculated with GAMB1T or may be entered into the program. In addition, a Maxwellian spectrum may be used in the thermal range. If the flux is calculated, either the B1 or P1 methods of solving the transport equation may be used. In effect, the steady-state transport equation is solved for an infinite medium problem. The program provides cross sections for a full P1 transport calculation. Cards are punched out in a format suitable for input to the ANISN and DOT discrete-ordinates transport codes.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
20 nuclides per problem
32 GAM (fast) broad energy groups
48 B1T (thermal) broad energy groups
6. TYPICAL RUNNING TIME - 5 minutes are required for a typical problem.
7. UNUSUAL FEATURES OF THE PROGRAM - B1T solves equations in the thermal energy range (0 less than or equal to less than or equal to 2.38 eV) that are consistent with the equations solved within the GAM program and comparable to those solved with the GATHER program. B1T provides fluxes and currents and includes both P0 and P1 scattering matrices in its cross section library. Initial line energy group fluxes and currents may be obtained from GAMB1T which can be used in obtaining broad-group cross sections. Subsequently fine-group fluxes and currents obtained from a transport theory calculation may be input to GAMB1T to obtain improved broad-group cross sections.
8. RELATED AND AUXILIARY PROGRAMS - GAM, GATHER, and QUERY
9. STATUS - Abstract first distributed December 1973
CDC6600 version submitted May 1972
10. REFERENCES - G. Collier, G. Gibson, L. L. Moran, R. K. Disney, and R. S. Kaiser, Second Version of the GAMB1T Code, WANL-TME-1969, November 1969
W. H. Gray and G. Collier, GAMB1T User's Manual, WANL-TME-1751, February 1968
G. Collier and G. Gibson, GAMB1T Program, WANL-TME-1752, April 1968
L. L. Moran, G. Collier, A. S. Johnston, and G. Gibson, Thermal Range Library for GAMB1T Program, WANL-TME-1830, July 1968
G. Collier and L. L. Moran, Utility Programs for GAMB1T Thermal Range Library, WANL-TME-1970, October 1969
G. Collier, S. A. Fody, G. Gibson, and L. L. Moran, New Cross Sections for the GAMB1T Library, Tapes FSGAM24 and CGB1T11, WANL-TME-1985, October 1969
S. A. Fody, G. Gibson, N. A. Nica, and J. L. Wytiaz, New Cross Sections for the GAMB1T Library, Tapes FSGAM29 and CGB1T15, WANL-TME-2690, April 1970
11. MACHINE REQUIREMENTS - 84K memory and 8 tapes
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.0

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Options included in the second version of GAMBIT are -

- (a) the flux and current spectrum calculated in a preceding problem may be reused in a subsequent slacked problem without recalculation,
- (b) cross section data in the EXTERMINATOR2 (NESC Abstract 156) two-dimensional diffusion theory code format can be produced,
- (c) the total elastic scattering cross section including the anisotropic scattering effect in the center-of-mass system is calculated in the APPROPPOS data preparation code format, and
- (d) all output may be produced on either cards or magnetic tape or both. All cross section sets that are punched and/or put on tape are printed.

GAMBIT is of limited use to other than CDC6600 installations because the library tapes are in CDC6600 binary format not readily adapted to other machines.

15. NAME AND ESTABLISHMENT OF AUTHORS -

G. Gibson
Advanced Reactor Division
Westinghouse Electric Corporation
Wallz Mill Site
Box 158
Madison, Pennsylvania 15663
G. Collier
Nuclear Energy Systems
Westinghouse Electric Corporation
Box 355
Pittsburgh, Pennsylvania 15230

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal (5 tapes)

Source deck (4992 cards)

Sample problem (28 cards)

Control information (15 cards)

Libraries (tape 2 - GAM library 762 binary records, tape 3 - BIT library 2761 binary records, tape 4 - QUERY library 27 binary records, tape 5 - GAS library 1754 binary records)

Reference reports, all except WANL-TME-1751 which is available only on microfiche

17. CATEGORY - B

KEYWORDS - multigroup, cross sections, neutron spectra, GAM codes, BIT codes, GATHER codes, QUERY codes, ANISN codes, DOT codes, EXTERMINATOR2 codes, APPROPPOS codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - CEBUG
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6400,6600,7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - The method of finite elements is used to calculate the pressures in the multi-dimensional bubble growth region
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 140 elements in 3-D region (including transition elements)
 - 30 channels
 - 30 channel nodes
 - 5 transition elements
 - 1 cover gas space
 - 28 connections to finite elements for each transition element
 - 4 connections to channels for each transition element
 - 200 time-steps saved in plot output array
 In general, the following assumptions also apply -
 - A single water leak occurs instantaneously
 - The chemical reaction is instantaneous
 - All water reacts to form Na_2O and H_2 at 1800 degrees F
 - The hydrogen bubble expands isothermally
 - The sodium is incompressible
 - The steam generator does not deform
 - The analysis stops when the hydrogen bubble reaches a cover gas space or completely fills a flow channel
6. TYPICAL RUNNING TIME - This is highly problem dependent. The sample problem with 130 finite elements, 1 transition element, and 1 channel is used as an example. This was a 5-tube leak which took 0.39 seconds for the hydrogen bubble to reach the transition element

Computer	CPU time
6400	435 seconds
6600	158 seconds
7600	20 seconds
7. UNUSUAL FEATURES OF THE PROGRAM -
 - (a) Leak rate - User specification of water leak rate allows any desired situation to be modeled (all leaks must be in one finite element). Any axial and radial location of the leak is possible. Back pressure effects on the leak rate are calculated automatically.
 - (b) Model - Up to 3 dimensions may be modeled in the finite element region. One-dimensional lumped-parameter channels may be used to model remainder of system. A cover gas may be modeled. Form, frictional, and inertial flow resistances may be used.
 - (c) Pressure relief system - Triggered by pressure above user-set threshold. Two-component compressible flow is modeled.
 - (d) General - Any 1/d steam generator may be modeled. Bubble pressure, sodium pressure and sodium flow throughout the system are calculated. Relief system flow and material inventory are calculated. Selected pressures and flows are retained for an automated plotting package.

8. **RELATED AND AUXILIARY PROGRAMS** - This program is a major extension of the APDA program BUG3. A plotting package specific to C-E is called by CEBUG. A dummy subroutine, GRAPH, is provided in place of it and can be replaced by a local equivalent with appropriate calls.
9. **STATUS** - Abstract first distributed December 1973
CDC7800 version submitted June 1973
10. **REFERENCES** - P. K. Doherty and D. W. Stuleville, CEBUG - A Code for Steam Generator Sodium-Water Reaction Analysis, CEND-388, December 21, 1972
P. K. Doherty, Double Precision Version of CEBUG, CEND Note, May 17, 1973
11. **MACHINE REQUIREMENTS** - 21,000 word memory (CDC6400,6600), 17,000 word memory (CDC7600)
12. **PROGRAMMING LANGUAGE USED** - ANSI FORTRAN IV
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - SCOPE 3 3 (CDC6400,6600), SCOPE 2 0 (CDC7600)
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - For computers with word length less than 60 bits, double precision may be necessary. See reference on double precision use with CEBUG.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
P. K. Doherty and D. W. Stuleville
Combustion Engineering, Inc.
1000 Prospect Hill Road
Windsor, Connecticut 06095
16. **MATERIAL AVAILABLE** -
Source deck (1299 cards)
Sample problem (146 cards)
Reference report and Note
17. **CATEGORY** - G
KEYWORDS - finite element method, steam generators, leaks, water, sodium, molten metal-water reactions, BUG3 codes
18. **SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - REXCO-H (Release 1)
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 - Equation of hydrodynamics and equation 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 per run, 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 - The sample problem requires about 1.5 minutes for 100 cycles
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)
9. STATUS - Abstract first distributed December 1973
IBM360 version submitted October 1973, sample problem executed by NESC
10. REFERENCES - Y. W. Chang, J. Gvildys, and S. H. Fistedis, Two-dimensional Hydrodynamics Analysis for Primary Containment, ANL-7498, November 1969
Y. W. Chang, J. Gvildys and S. H. Fistedis, Hydrodynamic Response of Primary Reactor Containment to High-energy Excursion, Nuclear Engineering 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
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 Hydrodynamics Code (REXCO) to Excursion Experiments for Fast Reactor Containment, ANL-7911, Suppl. 1, July 1972
11. MACHINE REQUIREMENTS - 500K 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 - To execute the pictorial display, the program uses the ANL system installation subroutines 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 subroutines described in ANL-AMD Technical Memorandum No. 130, S/360 Programming Techniques for the CalComp 780, by R. F. Krupp, January 8, 1967

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHORS -

Y. W. Chang, J. Gvildys, and S. H. Fistadis
Reactor Analysis and Safety Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (2440 cards)
Sample problem (300 cards)
Control information (JCL 18 cards)
Sample problem output (59 selected pages)
Reference report, ANL-7490

17. CATEGORY - F

KEYWORDS - two-dimensional, containment, excursions, hydrodynamics, reactor safety, fast reactors, PLOT3D codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - MOXY/MOD032
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - An implicit numerical solution of the one-dimensional Fourier heat conduction equation is used to compute heat conduction in fuel rods, solid inactive rods, and hollow inactive rods. Interchange of thermal radiation among surfaces is calculated using the network method described by Sparrow and Cess (see reference 5).
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 10 time-step sets
 - 10 print-interval sets
 - 50 normalized power-time pairs in considering time-dependent heat source
 - 50 convection heat transfer coefficient-time pairs in considering time-dependent convection
 - 50 fluid temperature-time pairs in considering time-dependent fluid temperature
6. TYPICAL RUNNING TIME - Approximately 3 minutes of CPU time are required to execute the sample problems on an IBM370/195.
7. UNUSUAL FEATURES OF THE PROGRAM - MOXY allows the use of fairly large time-steps (greater than 1 second).
8. RELATED AND AUXILIARY PROGRAMS - MOXY/MOD032 is part of the Water Reactor Evaluation Model (WREM) as are RELAP4/MOD5 (NESC Abstract 369) and WREM-TOODEE2/MOD3 (NESC Abstract 712). View factors are computed using an extension of the method used in the VIEWPIN code (NESC Abstract 569). The model for fuel-to-cladding gap heat transfer coefficient was adapted from the GAPCON-THERMAL1 code.
9. STATUS - Abstract first distributed December 1973.
 - IBM360 version of MOXY/MOD001 submitted June 1972, replaced by MOXY/MOD032 revised Edition B February 1977, sample problems executed by NESC April 1977 on an IBM370/195.
 - UNIVAC1108 version submitted June 1972, deleted April 1977.
10. REFERENCES - D. R. Evans, MOXY, A Digital Computer Code for Core Heat Transfer Analysis, IN-1392, August 1970.
 - D. R. Evans, The MOXY Core Heat Transfer Code Model Description and User's Guide, PG-R-76-003, December 1976.
 - D. R. Evans, The MOXY Core Heat Transfer Program View Factor Model Improvements, RE-E-77-114, February 8, 1977.
 - WREM Water Reactor Evaluation Model, Revision 1, NUREG-75/056.
 - E. M. Sparrow and R. D. Cess, Radiation Heat Transfer, Belmont, California, Brooks-Cole, 1966.
 - NRTS Environmental Subroutine Manual, ANS Document, December 1972.
 - MOXY/MOD032, ACC No. 551 360B, Tape Contents Description, Argonne Code Center Programming Note 77-23.

11. MACHINE REQUIREMENTS - 300K bytes of storage (IBM360) and 5 units are required in addition to the standard input/output 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 - MOXY reads the radiation matrix from a direct access storage device.
15. NAME AND ESTABLISHMENT OF AUTHOR -
D. R. Evans
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (3906 cards)
2314 load modules (MOXY32LM 261 blocks; ENVIR 479 blocks)
Sample problems (96 cards)
Auxiliary source deck (Conversion program 24 cards)
Environmental subroutines (22,152 cards)
Control information (JCL 114 cards)
Sample problems output (55 selected pages, 1292 blocks)
Reference reports, PG-R-7600-003, RE-E-77-114, ANC document, and ACC Programming Note
17. CATEGORY - H
KEYWORDS - heat transfer, fuel elements, LOCA, molten metal-water reactions, thermal analysis, blowdown, thermal radiation, BWR reactors, RELAP4 codes, TOODEE2 codes, GAPCON-THERMAL1 codes, VIEWPIN codes
18. SPONSOR - NRC Division of Systems Safety

1. NAME OR DESIGNATION OF PROGRAM - PWR-PPM
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6400 series
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - PWR-PPM utilizes the explicit solution of the single system dilution and boration equations and linear interpolation of the compressed liquid tables.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The temperature between and including 100 degrees F to 600 degrees F and the pressure between and including 200 psig to 6000 psig.
6. TYPICAL RUNNING TIME - Running time usually does not exceed 5 seconds.
7. UNUSUAL FEATURES OF THE PROGRAM - Only five input parameters are required -
 - (1) weight per cent of boric solution in make-up steam,
 - (2) volume of the reactor coolant system,
 - (3) temperature of the reactor coolant system,
 - (4) pressure of the reactor coolant system, and
 - (5) title card.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1973
CDC6400 version submitted June 1972
10. REFERENCE - J. H. Keenan and F. G. Keyes, Thermodynamic Properties of Steam, Wiley and Sons, Inc., New York, 1967.
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - KRONOS SCOPE 3.3
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The program will compute a set of boration-dilution tables for each set of pressure and temperature data input.
15. NAME AND ESTABLISHMENT OF AUTHORS -

R. L. Jaworski and V. I. Swisher
Fort Calhoun Nuclear Station
Omaha Public Power District
1623 Harney Street
Omaha, Nebraska 68102
16. MATERIAL AVAILABLE -

Source deck (250 cards)
Sample problem (5 cards)
Sample problem output (2 selected pages)
17. CATEGORY - M
KEYWORDS - operation, PWR reactors, coolants, boron
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - U3R
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - U3R numerically constructs a table of the cumulative probability distribution functions of unresolved resonance cross sections in a narrow energy range
4. METHOD OF SOLUTION - The procedure is
 - (a) to generate a ladder of resolved resonances over the energy range using prescribed average values and distribution functions of resonance parameters,
 - (b) to calculate Doppler-broadened point cross sections for the ladder,
 - (c) to distribute the point cross sections with their probabilities (fractional energy increments) into a table

Additional ladders are accumulated into the table until the desired accuracy of table entries is obtained. Thus, pointwise cross section data which are properties of the individual isotopes, rather than group average sets are obtained
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 20 unresolved resonance (1.) series
 - 4 temperatures
 - 100 ladders
 - unlimited energies
 - 99 as the table length
6. TYPICAL RUNNING TIME - 1 minute per energy point is required for a non-fissile problem and 5 minutes per energy point for a fissile problem
7. UNUSUAL FEATURES OF THE PROGRAM - U3R provides pointwise unresolved resonance cross section data in a highly compact form
8. RELATED AND AUXILIARY PROGRAMS - A single-precision version of the code was produced for the CDC8600
9. STATUS - Abstract first distributed December 1973
IBM360 version submitted June 1972, sample problem executed by NESC
10. REFERENCES - J. M. Otter, R. C. Lewis, and L. B. Levitt, U3R, A Code to Calculate Unresolved Resonance Cross Section Probability Tables, AI-AEC-13024, July 31, 1972
INTERNAL SORT, North American Rockwell Corporation Aerospace and Systems Group Engineer's Computing Manual Excerpt, December 8, 1969
11. MACHINE REQUIREMENTS - 470K memory (double precision)
12. PROGRAMMING LANGUAGES USED - FORTRAN IV, Assembly language random number generator
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
 - J. M. Otter, R. C. Lewis, and L. B. Levitt
 - Applied Physics Unit
 - Nuclear Engineering Report Unit
 - Atomics International
 - P. O. Box 309
 - Canoga Park, California 91304

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (2148 cards)
 Sample problem (12 cards)
 Control information (JCL 14 cards)
 Reference report and Manual Excerpt

17. CATEGORY - A

KEYWORDS - probability, Doppler broadening, resonance, cross sections, data processing, statistics, ENDF/B, uranium 238, uranium 235, plutonium 239

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - DISPER1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The code operates in two modes - (1) pressure dependent, and (2) pressure independent. In the pressure dependent mode, the number and radius of the leak paths are computed by the code based on an enclosure leakage rate at a given overpressure and a pair of pressure response parameters. In the pressure independent mode, the complete description of the leak paths is code input. In both modes, the aerosol particle source strength and size distribution is input along with parameters which determine the probability of particles (1) entering leak paths, and (2) being deposited in the leak paths. The particle source strength, along with thermal input constants specifying the thermal equilibrium in the enclosure, determine the enclosure overpressure and resultant leakage path gas flow velocity.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maximum of -
20 leakage path sets
6. TYPICAL RUNNING TIME - 8 seconds are required for each source strength value computed in the pressure dependent mode and 5 seconds in the pressure independent mode.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - The original CDC3600 version of DISPER was prepared by D C Hunt of the Rocky Flats Division, Dow Chemical Company, Golden, Colorado.
9. STATUS - Abstract first distributed December 1973
CDC3600 version of DISPER submitted July 1972, deleted July 1976
IBM360,370 version of DISPER1 submitted July 1976, sample problem executed by NESC June 1978 on an IBM370/195
10. REFERENCES - D C Hunt, DISPER - An Aerosol Particle Transport Code, RFP-1855, September 1972
D C Hunt, The Probability of Hazardous Environmental Plutonium Releases, RFP-1543, April 14, 1971
N A Frigerio, N A Clark, and R S Stowe, DISPER1 - An Aerosol Particle Transport Code, ANL Note, July 1976
11. MACHINE REQUIREMENTS - Execution of the sample problem required 48K bytes
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 -
N A Frigerio and R S Stowe
Environmental Impact Studies Division
N A Clark
Applied Mathematics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

16. MATERIAL AVAILABLE -

Source deck (366 cards)
Sample problem (50 cards)
Sample problem output (18 selected pages)
Reference reports and ANL Note

17. CATEGORY - G

KEYWORDS - particles, aerosols, leaks

18. SPONSOR - NRC Division of Fuel Cycle and Material Safety

1. NAME OR DESIGNATION OF PROGRAM - PARET
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - This program is designed for use in predicting the course and consequences of nondestructive reactivity accidents in small reactor cores
4. METHOD OF SOLUTION - The analysis is based on coupled thermal, hydrodynamic, and nuclear effects in the core. The model consists of a water-cooled core with a maximum of four fuel elements. Thus the core can be divided into four or fewer regions, each having different power generation, coolant mass flow rate, hydraulic parameters, and other associated conditions, with each region represented by a single fuel pin or plate plus its associated coolant channel. A transient problem is forced through specification of externally inserted reactivity versus time, or average core power versus time. The program embodies heat transfer calculations, continuous reactivity feedback, and hydrodynamic calculations allowing for coolant flow reversal.

Heat transfer in each fuel element is computed on the basis of a one-dimensional conduction solution in each of up to a maximum of 20 axial sections. Local heat generation is determined from the calculated or specified core average power level and spatial weighting factors. PARET employs empirical convective heat transfer correlations in estimating the rate of heat transfer at the clad-coolant interface.

The hydrodynamic calculations are based on a one-dimensional modified momentum integral model in which equations representing conservation laws are solved in each coolant channel at each time node. The solutions to these equations yield the pressure drop across the core, and the point-wise fluid enthalpies, pressures, and mass flow rates along each channel. The coolant is allowed to range from subcooled liquid, through the two-phase region, up to and including superheated steam.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The PARET model is subject to several recognized limitations which may limit the applicability in any specific situation, depending on the nature of the transient under consideration. The code employs steady-state heat transfer correlations throughout, possibly being unrealistic in certain transient situations. Any complete description of a severe transient must include provision for some sort of thermal or hydraulic crisis. PARET is limited in predicting a thermal crisis by the fact that it employs a steady-state DNB correlation, since no transient correlation with demonstrated reliability was developed. Accurate description of hydraulic instability depends upon accurate calculation of transient pressure and flow fluctuations. PARET is limited in this respect because it employs an incompressible model and a simplified void volume generation equation. Also, the magnitude of local pressures predicted to accompany coolant expulsion is strongly affected by the number of axial sections chosen in the computations. As a result, the hydrodynamic output should be interpreted as a qualitative indication of a possible crisis rather than a reliable quantitative prediction.

The principal uncertainties in the code lie in the realm of boiling. These uncertainties, coupled with the fact that application of the code to boiling situations has not been fully verified, make it imperative to consider the boiling model to be in the development stage.

PARET is not applicable to either destructive excursions or situations in which there is a space-time effect in neutron flux.
6. TYPICAL RUNNING TIME - The sample problem requires less than 22 seconds of CPU time to process 65 time-steps on 4 channels
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - This code is an extension of the CHIC-KIN code (NESC Abstract 473)
9. STATUS - Abstract first distributed December 1973

IBM360 version submitted August 1972, replaced by revised version May 1973, sample problem executed by NESC.

10. REFERENCES - C. F. Obenchain, PARET, A Program for the Analysis of Reactor Transients, IDO-17262, January 1969.
J. A. Redfield, CHIC-KIN, A FORTRAN Program for Intermediate and Fast Transients in a Water-moderated Reactor, WAPD-TM-479, January 1965.
Change to PARET Program, Aerojet Note, 1972.
Excerpts from NRTS Environmental Subroutine Manual, December 1972.
C. J. Smith and W. A. Cody, ANL DATE Routine, ANL Subroutine Description Q054S, February 1968.
11. MACHINE REQUIREMENTS - 240K bytes plus one magnetic tape
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and BAL
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Subroutine INLK was compiled with the FORTH450 compiler with 640K. The normal compiler could not process OPT=2 because this routine is too long.
15. NAME AND ESTABLISHMENT OF AUTHOR -
P. D. Adoff
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (6771 cards)
Object decks (2692 cards)
Sample problem (103 cards)
Control information (JCL 20 cards)
Library (62 blocks of variable-sized binary records)
Sample problem output (38 selected pages)
Reference report, IDO-17262, and Notes
17. CATEGORY - G
KEYWORDS - reactivity, accidents, heat transfer, hydrodynamics, feedback, CHIC-KIN codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - KEELE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - A variable metric procedure is used where the direction of search at each iteration is obtained by multiplying the negative of the gradient vector by a positive definite matrix which approximates the inverse of the matrix of second partial derivatives associated with the function
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Array dimensions limit the number of variables to 20 and the number of constraints to 50. These can be changed by the user
6. TYPICAL RUNNING TIME - Total execution time for the four examples in the report is approximately 10 seconds
7. UNUSUAL FEATURES OF THE PROGRAM - All input is through the argument list and/or the common block /BAMRWH/
8. RELATED AND AUXILIARY PROGRAMS - This program is a modification of the corresponding program described in reference 2
9. STATUS - Abstract first distributed December 1973
IBM360 version submitted August 1972, sample problem executed by NESC
10. REFERENCES - G W Westley, A Linearly Constrained Nonlinear Programming Algorithm, ORNL-4644, January 1971
G W Westley and J A Watts, The Computing Technology Center Numerical Analysis Library, CTC-39, 1970
11. MACHINE REQUIREMENTS - 31K 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 - Three subroutines must be user-supplied. GRADNT defines the gradient of the response surface, CONSTR defines the constraints on the variables, and EVAL defines the response surface
15. NAME AND ESTABLISHMENT OF AUTHOR -
G W Westley
Mathematics Division
Oak Ridge National Laboratory
P O Box X
Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE -
Source deck (1019 cards)
Sample problems (117 cards)
Sample problem output (9 pages)
Reference report, ORNL-4644
17. CATEGORY - P
KEYWORDS - nonlinear programming, algorithms, iterative methods
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SHLOG
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
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 - SHLOG uses the Bellis Environmental Routines (NESC Abstract 478)
9. STATUS - Abstract first distributed December 1973
CDC6600 version submitted August 1972
10. REFERENCES - H. Bohl, Jr., SHLOG. A FORTRAN Program to Provide General Technical Data Functions, WAPD-TM-963, January 1972
C. J. Fleiter, CDC-6600 FORTRAN Programming - Bellis Environmental Report, WAPD-TM-668, January 1967
H. Bohl, Jr. and O. J. Marlowe, The Fink/Pantry Storage and Retrieval System for a Computer, WAPD-TM-710, Rev., July 1969
11. MACHINE REQUIREMENTS - 100,000 (octal) central memory, input/output via magnetic tape or disk, MAP output on line printer or microfilm device, graphs on microfilm device
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and COMPASS
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3 1
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
H. Bohl, Jr.
Bellis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 79
West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (10,686 cards)
Sample problem (302 cards)
Reference report, WAPD-TM-963
17. CATEGORY - M
KEYWORDS - data processing, libraries, maintenance, statistics, utility routines, computer graphics, information retrieval
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - TASK
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - TASK employs a combination scattering and transfer matrix method to eliminate certain difficulties that arise in classical finite difference approximations. As such, within-group (inner) iterations are eliminated and solution convergence is independent of spatial mesh size. The time variable is removed by Laplace transformation. (A later version will permit direct time solutions.) The code can be run either in an outer iteration mode or in closed (noniterative) form. The running mode is dictated by the number of groups times the number of angles, consistent with available storage.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The principal restrictions are available storage and computation time. Since the code is flexibly-dimensioned and has an outer iteration option there are no internal restrictions on group structure, quadrature, and number of ordinates. The flexible-dimensioning scheme allows optional use of core storage. The generalized cylindrical geometry option is not complete in Version 1 of the code. The feedback options and omega-mode search options are not included in Version 1.
6. TYPICAL RUNNING TIME - A typical 13-region, 5-group, S4, fast reactor static problem requires about 0.5 minutes on the IBM360/91, whereas the entire kinetic response can be computed in 8 to 10 minutes. A 16-group, S16, static, 125-cm Fe slab shielding problem requires about 4 minutes.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - Two auxiliary programs are included with TASK. Program ACPSD reads the flux tape(s) written (optionally) by TASK and computes an arbitrary number of detector responses, using detector energy responses as provided by the user and the group fluxes at space points selected by the user. The program also calculates the cross-power spectral density (CPSD) and auto-power spectral density (APSD) for selected pairs of detectors. Program FITSPEC fits the point reactor model to the real part of the cross-power spectral densities and to the auto-power spectral densities generated by program ACPSD.
9. STATUS - Abstract first distributed December 1973.
IBM360 version submitted August 1972, replaced by revised Version 1 January 1973, sample problem executed by NESC.
10. REFERENCE - A. R. Buhl, R. A. Lillie, H. L. Dodds, Jr., O. W. Hermann, J. C. Robinson, and R. J. Hinton, A Users Manual for TASK, A Generalized One-dimensional Transport and Diffusion Kinetics Code, ORNL-TM-3811, December 1972.
11. MACHINE REQUIREMENTS - TASK requires 154K bytes of storage plus data block storage and 1 tape if using the flux tape option.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

16. NAME AND ESTABLISHMENT OF AUTHORS -

A. R. Buhl
Neutron Physics Division
O. W. Hermann and R. J. Hinton
Mathematics Division
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37830
H. L. Dodds, Jr.
Savannah River Laboratory
E. I. duPont de Nemours and Company, Inc.
Aiken, South Carolina 29801
J. C. Robinson and R. A. Lillie
The University of Tennessee
Knoxville, Tennessee 37901

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (TASK 3817 cards, ACPSD 362 cards, FITSPEC 270 cards)
Sample problems (TASK 984 cards, ACPSD 6 cards, FITSPEC 281 cards)
Control information (JCL TASK 13 cards, ACPSD 12 cards, FITSPEC 9 cards)
Punched output (ACPSD 30 cards)
Sample problem printed output, available upon request (TASK 391 blocks, ACPSD 18 blocks,
FITSPEC 36 blocks)
Reference report

17. CATEGORY - E

KEYWORDS - one-dimensional, multigroup, reactor kinetics, ACPSD codes, FITSPEC codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SOFIRE2 1- and 2-CELL
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Both programs use the finite difference method to calculate transient temperatures in a nodal network designed to simulate a physical system (ONE CELL program) or the two cell geometry (TWO CELL program).
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The ONE CELL program has a total of 12 nodes available for system components, while the TWO CELL program has a total of 16 nodes.
6. TYPICAL RUNNING TIME - The ONE CELL program requires 1 minute for a 12 hour real time problem, while the TWO CELL program requires 12 seconds for a 24 hour real time problem.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1973
IBM360 version of both programs submitted August 1972, sample problems executed by NESC
10. REFERENCE - P. Berriger, J. Hopenfeld, M. Silberberg, R. P. Johnson, L. Baumash, and R. L. Kooniz, SOFIRE II User Report, AI-AEC-13055, March 30, 1973
11. MACHINE REQUIREMENTS - 134K bytes (ONE CELL program), 148K bytes (TWO CELL program)
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 dummy routine can be used for subroutine AICRT3, or the subroutine may be replaced to utilize local graphics capabilities.
15. NAME AND ESTABLISHMENT OF AUTHOR -
Malvin Silberberg
Atomics International
P. O. Box 309
Canoga Park, California 91304
16. MATERIAL AVAILABLE -
Source decks (1-CELL 489 cards, 2-CELL 570 cards)
Sample problems (1-CELL 37 cards, 2-CELL 49 cards)
Reference report
17. CATEGORY - G
KEYWORDS - containment, sodium, fires, reactor safety, accidents
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - HYMAS
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Formulation of the general matrix equation for hydrodynamic mass was accomplished by first developing the governing equation for fluid flow in a channel of unit depth bounded by two parallel surfaces which may move in translation both perpendicular and parallel to the direction of flow. This result was then utilized to obtain the equation for a variable area flow-channel. Next, the continuity equation for an arbitrary node was written. The general matrix equation for computing hydrodynamic mass was then obtained by applying the developed equations to a particular problem. The program HYMAS is in essence this general matrix equation.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The number of subdivisions in a flow-channel is limited to 50.
6. TYPICAL RUNNING TIME - Less than 30 seconds is required for a typical problem.
7. UNUSUAL FEATURES OF THE PROGRAM - HYMAS computes the hydrodynamic mass matrix for a lumped-parameter system.
8. RELATED AND AUXILIARY PROGRAMS - The output of HYMAS may become part of the mass matrix input to any lumped-parameter dynamic analysis program. HYMAS uses subroutines INTTAP, OUTTAP, FINISH, SUBERR, and JOBCRD from the Bellis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed January 1974
CDC6600 version submitted December 1973
10. REFERENCES - G. R. Sharp and W. A. Wenzel, Hydrodynamic Mass Matrix for a Multibodied System, WAPD-TM-1087, September 1973.
C. J. Fleiter, CDC-6600 FORTRAN Programming - Bellis Environmental Report, WAPD-TM-668, January 1967.
11. MACHINE REQUIREMENTS - 30000 (octal) of fast memory, plus extended core storage.
12. PROGRAMMING LANGUAGES USED - FORTRAN IV and COMPASS
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3 i 5
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
G. R. Sharp and W. A. Wenzel
Bellis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 78
West Mifflin, Pennsylvania 15122
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (806 cards)

Sample problem (14 cards)
Reference report, WAPD-TM-1087

17. CATEGORY - H
KEYWORDS - fluid flow, hydrodynamics, matrices
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - TOKMINA/TOKMINA2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - TOKMINA finds the minimum magnetic field, B_m , required at the toroidal coil of a Tokamak type fusion reactor when the input is beta (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.
4. METHOD OF SOLUTION - TOKMINA the aspect ratio (a) is minimized, giving a minimum value for B_m . TOKMINA2 a search is made for PT , the value of PT which minimizes B_m to the required value within 50 Gauss is chosen.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Input arrays presently are dimensioned at 20. This restriction can be overcome by changing a dimension card.
6. TYPICAL RUNNING TIME -
 TOKMINA - approximately 30 seconds for 100 sets of input values
 TOKMINA2 - approximately 1 minute for 700 sets of input values
7. UNUSUAL FEATURES OF THE PROGRAM - Output for each set of input values are TB , B_t (toroidal magnetic field on the minor axis), R (major radius of the toroid), r_p , R_m (distance between the major axis and the blanket in the midplane), n (density of the plasma) and I (plasma current). These values, as well as B_m and PT may be studied as a function of blanket thickness.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1973
 IBM360 version submitted August 1972, sample problems executed by NESC
10. REFERENCES - 1. N. Golovin, Yu. N. Dnevstrovsky and D. P. Kostomarov, Tokamak as a Possible Fusion Reactor - Comparison with Other C-T-R Devices, BNES Nuclear Fusion Reactor Conference at Culham Laboratory, September 1969.
 A. J. Hatch and J. Eizweiller, A Simplified Parametric Study of Tokamak Fusion Reactors, Proceedings of the Texas Symposium on Fusion Reactors, November 22-23, 1972, CONF-721111
11. MACHINE REQUIREMENTS - 160K bytes of core
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 -
 A. J. Hatch
 Physics Division
 Argonne National Laboratory
 9700 South Cass Avenue
 Argonne, Illinois 60439
16. MATERIAL AVAILABLE -
 Source decks (TOKMINA-153 cards, TOKMINA2-198 cards)
 Sample problems (TOKMINA-4 cards, TOKMINA2-5 cards)

Sample problem output (TOKMINA-2 pages, TOKMINA2-28 pages)
Reference reprint, CONF-721111

17. CATEGORY - X
KEYWORDS - aspect ratio, Tokamak reactors, tritium, breeding, magnetic fields, fusion reactions, plasma, toroidal configuration
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - AMDLIBAE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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	Multi prec floating point arith package
B156S A ARSIN	Arccine, 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 ARGFDXPD	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 IRCOL	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 GEARDY	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 + function 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	BGLSSO	Least squares fit with arbitrary function
E350S F	SMOOTH	Smoothing by cubic splines

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 - AMDLIBF (NESC Abstract 563) and AMDLIBGZ (NESC Abstract 564)
9. STATUS - Abstract first distributed December 1973
IBM360 version submitted September 1972, replaced by revised Edition 8 October 1977
10. REFERENCES - B T Smith, The ANL-AMD Subroutine Library (ACC 562, 563, and 564). ACC Programming Note 73-5, September 1, 1972
ANL-AMD System/360 Library Subroutine Descriptions
K E Hillstrom, MPA, Multiple-precision Floating-point Arithmetic Package for the System/360, A152S, November 1971
W J Cody and K Paciorek, ARGARSIN, OS/360 FORTRAN IV Systems Subroutine for Arcsine, Arccosine Function (Single Precision), B156S, February 1969
K Hillstrom, DSIN/DCOS, OS/360 FORTRAN IV Compatible Routine for the Sine and Cosine Function, B158S, October 1969, Rev by J Wang, July 1975
K Hillstrom, DTAN/DCOTAN, FORTRAN IV Compatible Routine for the Tangent and Cotangent Function, B159S, October 1969, Rev by J Wang, July 1975
W J Cody and K Paciorek, ARG SINH, OS/360 FORTRAN IV Library Routine for Hyperbolic Sine and Cosine Functions (Single-precision), B252S, February 1969
Nancy W Clark, ALOG, OS/360 FORTRAN IV Systems Routine for Natural or Base 10 DP Logarithms, B353S, February 1969
Nancy Clark, DEXP, OS/360 FORTRAN IV Systems Routine for Double-precision E-X, B354S, February 1969
Nancy W Clark, DLOG, FORTRAN IV Systems Routine for Natural or Base 10 DP Logarithms, B355S, February 1969
Kathleen A Paciorek, DOUBRT, System/360 Assembly Language Subroutine which Computes the DP Cube Root of a Normalized DP Floating Point Argument, B456S, October 1967
Donald F Jordan, ARGPOWER, IBM S/360 FORTRAN IV Single-precision Power Function, B457S, January 1968, Rev by W J Cody, February 1969 and October 1974
N A Clark, W J Cody, and K A Paciorek, ARGFDXPD, IBM S/360 FORTRAN IV DP Power Function, B458S, May 1969, Rev by W J Cody, October 1974
H C Thatcher, Jr and Kathleen A Paciorek, DQD, DP FORTRAN IV Quotient-Difference Algorithm, C150S, July 1969
H C Thatcher, Jr and Kathleen A Paciorek, DCONF1, DP FORTRAN IV Routine to Evaluate an S-fraction, C151S, July 1969
Burton S Garbow, CUBIC, Roots of Cubic Polynomial Equations, C250S, December 1967, Rev September 1977
Burton S Garbow, QUART1, Roots of Quartic Polynomial Equations, C251S, December 1967
Burton S Garbow, RSSR, Zeroes of Polynomials with Real Coefficients, C252S, December 1968, Rev April 1977
K Paciorek, POLDRV, FORTRAN IV Double-precision Driver for ANL C254S, C263S, April 1969
Kathleen Paciorek, CPOLY, RPOLY, BNDZRO, A FORTRAN IV Double-precision Polynomial Rootfinder Package, C254S, April 1969

- S Pieper, CLEBSH, Clebsch-Gordan, Racah, Wigner 3J, Wigner 6J, and Wigner 9J Coefficients, C353S, June 1977
- K Hillstrom, ALGAMA, FORTRAN IV Compatible Routine for the Natural Log of the Real Gamma Function, C365S, March 1967
- K Hillstrom, DGAMMA/DLGAMA, OS/360 FORTRAN IV Compatible Routine for the Gamma Function and the Natural Log of the Gamma Function, C366S, May 1969, Rev April 1973 and November 1974
- Donald F Jordan, EONE, Exponential Integral, C368S, March 1968
- Donald F Jordan, BESJY, Bessel Functions, C370S, October 1967
- Donald F Jordan, BESIK, Bessel Functions, C371S, November 1967
- Kathleen Paciorek, CHIPRB, FORTRAN IV Double-precision Subroutine which Finds the Probability that $X \geq 2$ for N Degrees of Freedom Exceeds X, C372S, January 1968
- K Hillstrom, DRZETA, FORTRAN IV (H) Routine for the Riemann Zeta Function ZETA(S) or ZETA(S)-1, C380S, October 1970
- K Hillstrom and H Kuki, DCGAM/CDLGAM/CDGAMA/CDLGAM, OS/360 FORTRAN IV(H) Routine for the Double-precision Complex Gamma and Log Gamma Functions, C382S-1, November 1970
- K Hillstrom, DERF/DERFC, OS/360 FORTRAN IV Compatible Routine for the Error Function and the Complementary Error Function, C383S, March 1968, Rev by J Wang, July 1975
- K Hillstrom, BFJ1, OS/360 FORTRAN IV Routine for the Bessel Function of the First Kind and Order, C384S, April 1969
- Kathleen A Paciorek, COULMB, A DP FORTRAN IV Routine to Calculate Regular Coulomb Wave Functions, C385S, August 1969
- K Hillstrom, DSGMAL, OS/360 FORTRAN IV(H) Routine for the Coulomb Phase Shift SIGMAL(N), (L=0,1,2,...,N), C386S-2, July 1970, Rev January 1975
- J Gregory, BFJYR, OS/360 FORTRAN IV Routine for the Bessel Function of the First and Second Kind and of Order Zero and Order One, C387S, July 1970
- A Střecok, IRCOUL, Irregular Coulomb Wave Functions GL(N,P), C388S, August 1970, Rev by J Wang, April 1976
- A Střecok, GAMIN, OS/360 FORTRAN IV (H) DP Routine for the Incomplete Gamma Function, C389S, January 1971
- A Střecok, LQ, A FORTRAN IV DP Routine for Associated Legendre Functions of the Second Kind, C390S, September 1971
- P Kinnucan and H Kuki, DAERF, A FORTRAN IV Double Precision Subroutine for the Inverses of the Error Function, the Complemented Error Function and the Gaussian Function, C392S, July 1976
- A Střecok, CODEONE, Modified Complex Exponential Integral, C393S, May 1972, Rev September 1976
- K Hillstrom, DROMB, OS/360 FORTRAN IV Routine for Two-dimensional Romberg Quadrature, C153S, November 1968
- K Hillstrom, DROMBP, OS/360 PL/I Routine for Two-dimensional Romberg Quadrature, D153S-P, July 1970
- K Hillstrom, ANC4, OS/360 FORTRAN IV Routine for Adaptive Quadrature Using the 4th Newton-Cotes Formula, D158S, November 1968
- K Hillstrom, ANC4P, PL/I Routine for Adaptive Quadrature Based on the Newton-Cotes 5-point Rule, D158S-P, July 1970
- K Hillstrom, GAUSS, OS/360 FORTRAN IV Routine to Gaussian Quadrature Formula Generation, D161S, December 1968, Rev by J Wang, September 1977
- J N Lyness and K E Hillstrom, SQUANK, FORTRAN IV Routine for Adaptive Simpson Rule Quadrature, D162S, July 1970
- Kathleen Paciorek, DDFSUB, FORTRAN IV Subroutine which Performs One DP Integration Step for a System of First-order Ordinary Differential Equations, D252S, September 1968
- Kathleen Paciorek, DDFSYS, FORTRAN IV DP Routine which Provides Input/Output and Control for Use with the DP Ordinary Differential Equations, D253S, May 1967
- Kathleen Paciorek, DFBND-DIFI, FORTRAN IV Double-precision Routines which Estimate the Error in the Bulirsch-Stoer Method for Solution of a System of First-order Ordinary Differential Equations, D255S, October 1969
- Kathleen A Paciorek, DFBDRV, FORTRAN IV DP Routine which Provides Input/Output and Control for Use with the DP Routines ANL D255S DFBND-DIFI to Integrate a System of First-order Ordinary Differential Equations, D256S, October 1969

A C Hindmarsh, GEARDV, Numerical Integration of an Initial Value Problem for a System of Ordinary Differential Equations, D257S, July 1975
 J N Lyness, ENDACE, Evaluate Numerical Differentiation and Corresponding Errors, D452S, August 1976
 Kathleen Paciorek, LSQPOL, Least Square Polynomial Fit, E206S, September 1967
 K Szabo and K Hillstrom, Arbitrary Functional Fit, E208S-1, January 1970
 K Paciorek, CALLSQ, FORTRAN IV DP Routine which Provides Input/Output and Control for Use with the DP Version of ANL E206S - LSQPOL to Do a Least Square Polynomial Fit, E209S, September 1967
 J B Cohen, A General Program for the Evaluation of an Arbitrary Function, and for the Least Squares Determination of the Coefficients of a Function, Linear in the Coefficients, Involving One or More Independent Variables, E212S, January 1967
 Burton S Garbow, VA02A,SV01A, Least Squares Functional Minimization without Derivatives, E250S, August 1968
 Burton S Garbow, MINMAX, Chebyshev Line Fit, E252S, October 1968
 A Meyer and I K Abu-Shumays, Arbitrary Functional Fit II, E253S, April 1969
 K E Hillstrom and W J Cody, BGPOL, Linear Least Squares Solution by Householder Transformations, E256S, December 1971
 K E Hillstrom and W J Cody, BGLSS, Least Squares Solutions of Systems of Linear Equations by Orthogonal Householder Transformations with Statistical Calculations, E257S, December 1971
 Burton S Garbow, SMOOTH, Smoothing by Cubic Splines, E250S, December 1968, Rev by B Garbow, April 1975

11. MACHINE REQUIREMENTS -

12. PROGRAMMING LANGUAGES USED - Assembly language, FORTRAN IV, and PL/I each indicated by A, F or P in the identification given in item 3 above

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 Release 19.6

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

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 deck (20,067 cards)
 ACC Note and Subroutine Descriptions

17. CATEGORY - P

KEYWORDS - elementary functions, polynomials, differential equations, quadratures, interpolation, special functions

18. SPONSOR - Argonne National Laboratory

1. NAME OR DESIGNATION OF PROGRAM - AMDLIBF
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360/75
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
F240S 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
F318S 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
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 - EISPACK2 (NESC Abstract 534), AMDLIBAE (NESC Abstract 562), and AMDLIBGZ (NESC Abstract 564)
9. STATUS - Abstract first distributed December 1973
IBM360 version submitted September 1972, replaced by revised Edition B November 1977
10. REFERENCES - B T Smith, The ANL-AMD Subroutine Library (ACC 562, 563, and 564), ACC Programming Note 73-5, September 1, 1972
ANL-AMD System/360 Library Subroutine Descriptions
Burton S Garbow, SYMINV, Symmetric Matrix Inversion with Accompanying Solution of Linear Equations, F152S, June 1968, Rev by B Garbow, March 1975
Donald F Jordan, DOTP, Extra-Precision Accumulating Inner Product, F154S, November, 1967
Virginia Kieme, RAYCOR, Rayleigh Corrections to Eigenvalues of a Real Symmetric Matrix, F156S, May 1969
A T Strecok, XTRADP, A FORTRAN IV Function Subroutine to Calculate a Fast Extended Precision Inner Product of Two REAL-8 Vectors, F161S, September 1971
Dwight W Smith, XTRADP, An Assembly Function Subroutine to Calculate the REAL-16 Inner Product of Two REAL-8 Vectors, F162S, August 1973
Burton S Garbow, EIGEN, Eigenvalues and Eigenvectors of a Real Symmetric Matrix, F202S-1, December 1969
Burton S Garbow, MAIN, A General Program for the Computation of Eigenvalues and Eigenvectors of a Real Symmetric Matrix, F203S, December 1969

B Garbow, RITZIT, A FORTRAN IV Subroutine to Determine the Absolutely Largest Eigenvalues and Corresponding Eigenvectors of a Real Symmetric Matrix, F248S, February 1976

Burton S Garbow, EIGINV, Solution of the Inverse Eigenvalue Problem, F261S, October 1968

B Garbow, CQZHES, A FORTRAN IV Subroutine to Simultaneously Reduce One of a Pair of Complex General Matrices to Upper Hessenberg Form and the Other to Upper Triangular Form Using and Optionally Accumulating Unitary Transformations, F313S, May 1976

B Garbow, CQZVAL, A FORTRAN IV Subroutine to Reduce One of a Pair of Complex Matrices from Upper Hessenberg to Upper Triangular Form while Maintaining the Upper Triangular Form of the Other Using and Optionally Accumulating Unitary Transformations, F314S, May 1976

B Garbow, CQZVEC, A FORTRAN IV Subroutine to Determine the Generalized Eigenvectors of a Complex Upper Triangular Matrix System Using Back Substitution, F315S, May 1976

B Garbow, CGG, A FORTRAN IV Driver Subroutine to Determine the Eigenvalues and Eigenvectors for the Complex General Generalized Eigenproblem $A \cdot X = (\text{LAMBDA}) \cdot B \cdot X$, F316S, May 1976

Burton S Garbow and C Chamot, MATINV, Matrix Inversion with Accompanying Solution of Linear Equations, F402S, February 1969, Rev by B Garbow, March 1975

Burton S Garbow, MAIN, A General Program for Matrix Inversion and Solution of Linear Equations, F403S, December 1968

Burton S Garbow, CHOLLU, CHOLEQ, Symmetric Decomposition of Positive-Definite Band Matrices, F452S, July 1968, Rev by B Garbow, March 1975 and March 1976

Burton S Garbow, MATINC, Complex Matrix Inversion with Accompanying Solution of Linear Equations, F453S, June 1968, Rev by B Garbow, March 1975

Burton S Garbow, CROUT, Solution of Linear Equations by the Crout Method, F454S, April 1968, Rev by B Garbow, March and September 1975

Burton S Garbow, CROUTC, Solution of Complex Linear Equations by the Crout Method, F455S, June 1968, Rev by B Garbow March and September 1975

Burton S Garbow, DIAG, Integer-Preserving Gaussian Elimination, F456S-1, September 1970

11. MACHINE REQUIREMENTS -

12. PROGRAMMING LANGUAGES USED - Assembly language and FORTRAN IV each indicated by A or F in the identification given in item 3

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 Release 19.8

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHOR -

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16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (2953 cards)
ACC Note and Subroutine Descriptions

17. CATEGORY - P

KEYWORDS - matrices, eigenvalues, eigenvectors

18. SPONSOR - Argonne National Laboratory

1. NAME OR DESIGNATION OF PROGRAM - AMDLIBGZ
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360/75
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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-2.

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 funcis
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 - AMDLIBAE (NESC Abstract 562) and AMDLIBF (NESC Abstract 563)
9. STATUS - Abstract first distributed December 1973
IBM360 version submitted September 1972, replaced by revised Edition 8 November 1977
10. REFERENCES - B. T. Smith, The ANL-AMD Subroutine Library (ACC 562, 563, and 564), ACC Programming Note 73-5, September 1, 1972
ANL-AMD System/360 Library Subroutine Descriptions
Nancy W. Clark, RANF, OS/360 FORTRAN IV Routine to Produce a Series of Random Numbers, G552S, July 1967
Cynthia Chamol, YOLYPLOT, J952S, December 1968
George M. Hauser, GRAF, A PL/I Procedure to Plot Points on a Line Printer, J955S, October 1971
Daniel Carson, Core to Core Conversion, K250S-1, February 1970
Anthony J. Sirecok, HEXINP, Hexadecimal Conversion for PL/I, K251S, April 1970
Anthony J. Sirecok, HEXOUT, Hexadecimal Output for PL/I, K252S, April 1970
Kathleen A. Paciorek, SORT, M101S, October 1968
Kathleen A. Paciorek, CSORT, M150S, October 1968
Donald F. Jordan, K. Ortiz, W. J. Cody, and K. Hillstrom, ANL KWIC Key Word in Context, M151S-2, May 1971
Robert P. Tannura, SMALLIST, M250S, December 1967

T Pawitt, ABEND, An Assembly Language Subroutine Produces an Abnormal Termination Dump upon Calls from FORTRAN IV, N251S-1, April 1967, Rev February 1975
 G Duffy, CLOCK, Value of Clock upon Call from Tape to Disk and Execute It, Q052S, April 19, 1967
 G Duffy, COPYAGO, Copy a Load Module from Tape to Disk and Execute It, Q053S, April 19, 1967
 C J Smith and W J Cody, DATE, Current Date in Gregorian Calendar, FORTRAN IV Callable, Q054S, February 1968
 K Hillestrom, TIME, 24 Hour Clock, FORTRAN IV Callable, Q055S, February 1970
 Janet Herman, Variable Metric Minimization, Z013S, April 1967
 John A Ohde, LOCF, Z057S, October 1968
 John A Ohde, ALLOC, Z071S, October 1968
 K E Hillestrom, ANLMNP, Exponent and Mantissa Manipulation Functions, Z074S, July 1971, Rev January 1974

11. MACHINE REQUIREMENTS -

12. PROGRAMMING LANGUAGES USED - Assembly language, FORTRAN IV, and PL/I each indicated by A, F or P in the identification given in item 3 above

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 Release 19.6

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHOR -

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 Applied Mathematics Division
 Argonne National Laboratory
 9700 South Cass Avenue
 Argonne, Illinois 60439

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
 Source deck (2671 cards)
 ACC Note and Subroutine Descriptions

17. CATEGORY - P

KEYWORDS - data processing, utility routines, computer graphics, sorting, libraries

18. SPONSOR - Argonne National Laboratory

1. NAME OR DESIGNATION OF PROGRAM - INCITE
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The program employs a normalized Gauss-Seidel iteration technique to solve the energy-dependent integral form of the B₁ approximation to the Boltzmann transport equation.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - A maximum of 101 fine energy points and 50 broad groups is permitted. A library tape containing the appropriate absorption and scattering cross sections at these energy points is required.
6. TYPICAL RUNNING TIME - The running time for a typical problem on the IBM360 is normally less than 15 seconds.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - LIBMOD, an auxiliary program for modification or creation of INCITE cross section data libraries. The current master library is for the energy range 0.0 to 2.38 eV.
9. STATUS - Abstract first distributed January 1974.
IBM360 version submitted January 1973, sample problem executed by NESC February 1974.
10. REFERENCES - R. L. Curtis and R. A. Grimesey, INCITE - A FORTRAN-IV Program to Generate Thermal Neutron Spectra and Multigroup Constants Using Arbitrary Scattering Kernels, IN-1062, November 1967.
11. MACHINE REQUIREMENTS - Approximately 300K bytes of core memory, one cross section library tape, and three I/O scratch units are required for 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 -
15. NAME AND ESTABLISHMENT OF AUTHORS -
R. L. Curtis and R. A. Grimesey
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (2022 cards)
Sample problem (26 cards)
Library (569 blocks of variable-sized binary records)
Control information (JCL 29 cards)
Sample problem output (37 pages)
Reference report
17. CATEGORY - B
KEYWORDS - thermal neutrons, neutron spectra, multigroup, cross sections, libraries, inelastic scattering, kernels, thermalization, LIBMOD codes

1. NAME OR DESIGNATION OF PROGRAM - RESPOND
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - The relative energy absorbed by the small region from energetic electrons produced in the surrounding medium and the relative energy absorbed from the electrons produced within the region are calculated as a function of photon energy and combined by the method of T E Burlin. This energy-dependent response function is averaged over an input photon spectrum
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The energy division is into 100 equal intervals. Only 2 regions may be specified
6. TYPICAL RUNNING TIME - 14 seconds per case are required
7. UNUSUAL FEATURES OF THE PROGRAM - RESPOND is specifically intended for calculating the correction factor for thermoluminescent dosimeters (TLD) in dissimilar medium
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1973
IBM360 version submitted September 1972, sample problem executed by NESC
10. REFERENCES - R J Tuttle, Measurements of Gamma-ray Heating by Thermoluminescent Dosimeters, TI-707-140-022, May 1972
T E Burlin, Radiation Dosimetry, Vol 1, p 331, Frank H Attix and William C Roesch, Editors, Academic Press, New York, 1968
11. MACHINE REQUIREMENTS - 84K memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV (H)
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 J Tuttle
Atomics International
P O Box 309
Canoga Park, California 91304
16. MATERIAL AVAILABLE -
Source deck (266 cards)
Sample problem (207 cards)
Sample problem output (10 pages)
Reference report, TI-707-140-022
17. CATEGORY - Q
KEYWORDS - dose rates, gamma radiation, heating
18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM** - 3DB
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE** - UNIVAC1108, IBM360
3. **DESCRIPTION OF PROBLEM OR FUNCTION** - 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 keff 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
4. **METHOD OF SOLUTION** - Eigenvalues are computed by standard source-iteration techniques. Group rebalancing and successive overrelaxation with line inversion are used to accelerate convergence. Adjoint solutions are obtained by inverting the input data and redefining the source terms. Material burnup is by reactor zone. The burnup rate is determined by the zone and energy-averaged cross sections which are recomputed after each time-step. The isotopic chains, which can contain any number of isotopes are formed by the user. The code does not contain built-in or internal chains.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM** - Since variable dimensioning is employed, no simple bounds can be stated.
6. **TYPICAL RUNNING TIME** - A keff calculation with a 20 x 20 x 20 mesh using 2 energy groups requires approximately 30 minutes on a UNIVAC1108. Each successive burnup time-step takes about a quarter of the above time. On an IBM360/185 compilation and link edit require about 1 minute and execution about 7 minutes for the sample problem with 10 x 10 x 10 mesh using 2 zones and 2 energy groups.
7. **UNUSUAL FEATURES OF THE PROGRAM** - The input data are arranged so the code can be used easily for keff and search calculations without burdening the user with burnup parameters.
8. **RELATED AND AUXILIARY PROGRAMS** - The format of the input data (e.g. cross sections, geometry, and composition specifications) is compatible with the one- and two-dimensional transport codes DTF4 (NESC Abstract 209) and 2DF (NESC Abstract 173), the perturbation code PERT5, the one-dimensional cross section generating code 1DX (NESC Abstract 374), and the two-dimensional diffusion burnup code 2DB (NESC Abstract 325). All six codes use the same input module.
9. **STATUS** - Abstract first distributed December 1973
 UNIVAC1108 version submitted October 1972
 IBM360 version submitted July 1973, sample problem executed by NESC
10. **REFERENCES** - R. W. Hardie and W. W. Little, Jr., 3DB, A Three-dimensional Diffusion Theory Burnup Code, BNWL-1264, March 1970.
 K. D. Lathrop, DTF-IV, A FORTRAN-IV Program for Solving the Multigroup Transport Equation with Anisotropic Scattering, LA-3373, July 15, 1965.
 2DF, A Two-dimensional Transport Code, Developed at the Los Alamos Scientific Laboratory, (unpublished).
 R. W. Hardie and W. W. Little, Jr., PERT-V, A Two-dimensional Perturbation Code for Fast Reactor Analysis, BNWL-1162, September 1969.
 R. W. Hardie and W. W. Little, Jr., 1DX, A One-dimensional Diffusion Code for Generating Effective Nuclear Cross Sections, BNWL-954, March 1969.
 W. W. Little, Jr. and R. W. Hardie, 2DB User's Manual Revision 1, BNWL-831, Rev. 1, February 1969.
 NTRAN Description, excerpt from UNIVAC1107 FORTRAN IV Manual, UP-3569, Rev. 1

ETIME,ETIMEF,SETOR Descriptions, excerpt from CSCXRJE/CRJE Reference, Vol. 2, Library Elements, E00003-02-00, April 1971.

11. MACHINE REQUIREMENTS - 65K word memory and 11 peripheral storage devices (UNIVAC1108), 500K bytes and same number of mass storage units (IBM360)
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC8 (UNIVAC1108), OS/360 (IBM360).
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Due to differences in word size, the IBM version uses double precision. In addition, certain I/O routines from the UNIVAC library had to be written in FORTRAN for the IBM version.
15. NAME AND ESTABLISHMENT OF AUTHORS -
1108 R. W. Hardie and W. W. Little, Jr.
Hanford Engineering Development Laboratory
Westinghouse Hanford Company
P. O. Box 1970
Richland, Washington 99352

360 W. Mroz
Applied Mathematics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (1108-2971 cards, 360-3804 cards)
Sample problems (1108-76 cards, 360-76 cards)
Control information (JCL 360-20 cards)
Reference report, BNWL-1264, and Excerpts
17. CATEGORY - D
KEYWORDS - three-dimensional, x-y-z, r-theta-z, triangular-z, multigroup, fast reactors, criticality, burnup, diffusion equations, DTF4 codes, 2DF codes, PERT5 codes, tDX codes, 2DB codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - BEHAVE2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - GE635
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
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. 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 pressure boundary condition. Within the inviscid zone, axial transfer of fuel by a flow process occurs under certain conditions. Swelling of fuel and cladding and fission gas releases are represented by empirically derived models.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The program is dimensioned for a maximum grid structure as defined below -
 - cladding divided radially into 10 rings,
 - outer (structural) fuel zone divided radially into 10 rings,
 - middle (nontransport) fuel region divided radially into 10 rings,
 - inner (transport) fuel region divided radially into 10 rings,
 - fuel and cladding divided axially into 5 sections
6. TYPICAL RUNNING TIME - A problem employing the maximum grid structure in the fuel, 2 rings in the cladding, and 37 time-steps requires about 13 minutes of GE635 processor time.
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 positive 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 -
9. STATUS - Abstract first distributed December 1973
GE635 version submitted October 1972
10. REFERENCES - S. Oldberg, Jr., BEHAVE-2, Oxide Fuel Performance Code in Two Spatial Dimensions and Time, GEAP-13788, February 1972
LLINK Description, GE Note, BN90, pp 3-18, 7-1 through 7-5, 1972

11. MACHINE REQUIREMENTS - 41K fast memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GECOS III, SAL-3.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
S. Oldberg, Jr.
Breeder Reactor Department
General Electric Company
310 Deguigne Drive
Sunnyvale, California 94086
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal
Source deck (6288 cards)
Sample problem (37 cards)
Control information (129 cards)
Sample problem output (36 selected pages)
Reference report and GE Note
17. CATEGORY - I
KEYWORDS - fuel elements, stresses, cladding, thermal expansion, finite element method
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - VIEWPIN
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - The program calculates view factors for cylindrical pins whenever the problem can be represented two-dimensionally.
4. METHOD OF SOLUTION - The program uses a maximum of two shadowing pins and performs a single integration.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The length of the cylindrical pins of the physical problem must be much greater than the diameter of any of the pins.
6. TYPICAL RUNNING TIME - The code will calculate four view factors per second with an accuracy exceeding 0.01%, on the IBM360/75.
7. UNUSUAL FEATURES OF THE PROGRAM - A renormalization procedure is provided by the code.
8. RELATED AND AUXILIARY PROGRAMS - RADHT, a routine for computing radiation heat transfer in the BWR-FLECHT rod bundle.
9. STATUS - Abstract first distributed December 1973.
IBM360 version submitted October 1972, sample problem executed by NESC.
10. REFERENCE - G. L. Singer, VIEWPIN, A FORTRAN Program to Calculate View Factors for Cylindrical Pins, ANCR-1054, March 1972.
11. MACHINE REQUIREMENTS - 50K 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 -
G. L. Singer
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (550 cards)
Load module PROLIBC (39 blocks)
Sample problem (106 cards)
Control information (JCL 9 cards)
Reference report
17. CATEGORY - J
KEYWORDS - fuel elements, cylinders, radiation effects, two-dimensional, RADHT codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - STRIPE(M0650)
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Thick-walled integral solutions are used for various regions of the fuel pellets and cladding. Trapezoidal integration is used in finite-difference equations to approximate these integrals that result in describing differential thermal expansion. The method of bisection iteration scheme is used to solve a pair of nonlinear algebraic-integral equations to determine the depth of cracking.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
100 radial sections in the fuel for the computing grid
50 radial sections in the clad for the computing grid
Elastic-perfectly plastic properties are used for both the pellet and clad.
6. TYPICAL RUNNING TIME - Running time is typically about 5 seconds per case. If plastic flow or clad yielding calculations are required, the computer time increases to about 30 seconds per case.
7. UNUSUAL FEATURES OF THE PROGRAM - STRIPE determines the depth of radial cracking and its effects on pellet expansion. It accounts for a plastic inner zone in the fuel pellet as well as yielding of the cladding. Several axial restraint options such as plane strain or plane stress are available.
8. RELATED AND AUXILIARY PROGRAMS - Essential temperature profiles may be obtained from output of the program FIGRO (NESC Abstract 272), which solves the radial heat conduction problem for cylindrical fuel elements, using a temperature varying thermal conductivity for oxide fuels. STRIPE uses the Bettis Environmental Routines (NESC Abstract 478).
9. STATUS - Abstract first distributed December 1973
CDC6600 version submitted November 1972
10. REFERENCES - W. J. O'Donnell, W. G. Clarke, and W. R. Campbell, An Analysis of Transient Clad Strains in Cylindrical Fuel Elements including the Effects of Oxide Pellet Cracking (STRIPE), WAPD-TM-652, February 1970.
C. J. Pfeiffer, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967.
11. MACHINE REQUIREMENTS - 45,000 octal locations of central memory
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3.1
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
W. J. O'Donnell
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5100 Centre Avenue
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W. G. Clarke and W. R. Campbell
Bettis Atomic Power Laboratory
Westinghouse Electric Corporation

Box 79
West Milford, Pennsylvania 15122

16. MATERIAL AVAILABLE - Restricted Distribution

Source deck (987 cards)

Sample problem (114 cards)

Reference report, WAPD-TM-652

17. CATEGORY - I

KEYWORDS - deformation, cylinders, fuel elements, cladding, thermal expansion, stresses, FIGRO codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - CHECK3/RIGEL3
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600, IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 9 ENDF/B result tapes, change tape arrangement (from standard to alternate or vice-versa) and change tape mode.
4. METHOD OF SOLUTION - In CHECK3 most data are submitted to range limit checks to insure the structure agrees with ENDF/B-defined specifications. The deviant point check (detection of mispunched values) is accomplished by sequentially checking five data points, two points on either side of the point under scrutiny, forward extrapolation on the first two points, reverse extrapolation on the fourth and fifth, and interpolations between the second and fourth points. If the third point does not fall within the range of the values calculated by extrapolations and interpolation, the value is listed as deviant. In essence, the above procedure merely simulates a checking of graphical data by eye. Checking of Legendre coefficients for feasibility and positivity is accomplished by converting the coefficients to moments, checking whether moments are physically possible and testing whether the Legendre expansion is negative within the interval -1 to 1 by the Sturm sequence method. If the Legendre expansion is negative, it is defined over the negative region(s) and integrated, thus determining the total negative probability.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - In CHECK3 correct structure of the data tape is assumed and minor anomalies are noted. Common and major irregularities cause termination of execution accompanied by a core dump.
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM - In CHECK3 there are two output options: (a) long form, which lists each card image as well as the anomalies encountered, and (b) short form, which lists only the anomalies encountered by the program (minimum output option).
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1973
CDC6600 versions of CHECK3 and RIGEL3 submitted August 1972
IBM360 version of RIGEL3 submitted June 1972
10. REFERENCE - 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 September 1970, Revised June 1971.
11. MACHINE REQUIREMENTS - 2 scratch devices for CHECK3
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE (CDC6600), OS/360 (IBM360)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHORS -
6600 Odell Ozer
National Nuclear Data Center
Brookhaven National Laboratory
Upton, Long Island, New York 11973

360

E. M. Pennington
Applied Physics Division
Argonne National Laboratory
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Argonne, Illinois 60439

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Palo Alto, California 94304

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (CHECK3 8600-3455 cards, RIGEL3 6600-2125 cards, 360-2123 cards)
Reference report
17. CATEGORY - M
KEYWORDS - data processing, cross sections, ENDF/B, libraries, maintenance, information retrieval
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - TWOTRAN-PNVW
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6800, 7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - TWOTRAN-PNVW is designed to solve discrete ordinates equations that have been converted to equations like spherical harmonics equations to eliminate ray effects. The conversion is accomplished by using a specially constructed source. Construction of the special source is optional so that normal discrete ordinates equation solutions are also possible. Space dependence is approximated using a variable-weighted diamond-difference scheme for calculating spatial derivatives. Energy dependence is treated by the multigroup approximation. Anisotropic scattering and anisotropic inhomogeneous sources are represented by finite spherical harmonics expansions. Within group iterations, keff iterations and eigenvalue search iterations are accelerated by a coarse mesh particle rebalancing algorithm.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The variable-dimensioning capability of FORTRAN IV is used so that any combination of problem parameters leading to a common vector length less than MAXLEN can be used. MAXLEN is slightly greater than 40,000 words for the CDC7600. With a few exceptions only within-group problem data are stored in fast memory. Data for all other groups are stored in auxiliary storage. Arbitrary numbers of groups of up or down scattering are allowed.
6. TYPICAL RUNNING TIME - A one-group, S8 converted to P5, isotropic problem with mesh size 20 x 20 requires 12 seconds on the CDC7600.
7. UNUSUAL FEATURES OF THE PROGRAM - Unusual features include optional spherical harmonic or discrete ordinate solution, coarse mesh convergence acceleration, coarse mesh spatial and angular organization to permit larger problems, general anisotropic scattering and inhomogeneous source option, input specification of top, bottom, or right boundary fluxes, built-in discrete ordinates constants (S2, S4, S16) and FIDO cross section input option.
8. RELATED AND AUXILIARY PROGRAMS - TWOTRAN GENERAL-GEOMETRY (NESC Abstract 358)
9. STATUS - Abstract first distributed December 1973
CDC7600 version submitted November 1972
10. REFERENCES - K. D. Lathrop, F. W. Brinkley, and P. Reed, Theory and Use of the Spherical Harmonics, First Collision Source, and Variable Weight Versions of the TWOTRAN Program, LA-4600, March 1972.
K. D. Lathrop and F. W. Brinkley, Theory and Use of the General-Geometry TWOTRAN Program, LA-4432, May 1970.
Ray Davenport (Ed.), Elementary Guide to the Control Data 7600, University of California, Los Alamos Scientific Laboratory, Programmer's Information Manual, Vol. 5A, 1972.
11. MACHINE REQUIREMENTS - 5 output units (disk, drums or tapes) in addition to 2 system input/output units, a CDC Extended Core Storage unit or a large bulk memory (disk, drums or tapes can be substituted for this requirement).
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - CROS
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHORS -

K. D. Lathrop and F. W. Brinkley
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87544

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (6394 cards)
Sample problem (88 cards)
Sample problem output (30 pages)
Reference report, LA-4600

17. CATEGORY - C

KEYWORDS - two-dimensional, x-y, r-z, r-theta, transport theory, spherical harmonics,
TWOTRAN GENERAL GEOMETRY codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - MACS LATTICE VIBRATION CODES

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

3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 valence 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 valence 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.

4. METHOD OF SOLUTION - In MACS-C, ADJUSTER, and REVISED-D, matrix manipulations are applied to matrices which describe physical conditions.

In MACS-J, first-order difference equations are substituted for partial differential equations for Jacobian elements.

In MVFC the user employs a set of criteria for defining different types of interactions to prepare by hand the input to the program. For example, if two-angle coordinates which have a common atom at the end of a leg of each angle interact, the user must specify the associated criteria which include the distance between the two apex atoms and between the farthest separated leg atoms. The REVISED-MVFC code uses the positions in the primitive cell and searches for all coordinate interactions which satisfy each of the criteria stipulated in MVFC. The user is spared the tedious task of calculating angles between bonds, distances between atoms, etc.

In DIPOLE-SUM, the procedure of Kaplan and Sullivan is applied.

In MODEL-PI, the eigenvalues and eigenvectors of a complex Hermitian matrix are used.

5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - For all codes which produce eigenvectors, nearly equal eigenvalues can be encountered, in which case the basis vectors for the corresponding vector subspace are not uniquely determined.

In MACS-C, the largest Jacobian matrix which can be computed is 40×16 . The largest force constant vector applied is of dimension 15. The largest real or complex matrices are 40×40 .

In MACS-J, the largest real and complex matrices are 32×32 . The largest force constant vector is of dimension 50.

In REVISED-D, the largest number of elements in 3-dimensional arrays is 2400. The maximum number of groups is 20. The maximum number of atoms per group is 50. The largest force constant vector is of dimension 30.

In REVISED-MVFC, the largest indices of 3-dimensional variables are (20,8,8). The largest matrices are 150×150 . The dimension of the largest force constant vector is 60.

In ADJUSTER, the largest matrices are 32×32 .

In DIPOLE-SUM, the largest number of alpha-beta pairs is 15. The largest number of k-prime pairs is 15.

In MODEL-PI, there cannot be more than 4 dipoles per primitive cell. The largest matrices are 32×32 . The dimension of the largest force constant vector is 50.

6. **TYPICAL RUNNING TIME** - A MACS-C sample problem dealing with 8 matrices of size 16 x 6 requires less than 3 seconds with compile-run-wait time less than 42 seconds
 A MACS-J sample problem dealing with 6 matrices of size 16 x 6 and 7-dimensional force constant vectors requires less than 50 seconds with compile-run-wait time less than 74 seconds
 A REVISED-D sample problem dealing with 6 atom groups containing (4,4,2,2,2,2) atoms requires less than 4 seconds with compile-run-wait time less than 26 seconds
 A REVISED-MVFC sample problem which defines 21 elements in h, using 8 atoms in each of 2 groups requires less than 10 seconds with compile-run-wait time less than 47 seconds
 An ADJUSTER sample problem dealing with a 13 x 6 matrix requires less than 7 seconds with compile-run-wait time less than 25 seconds
 A DIPOLE-SUM sample problem with 4 atom positions requires less than 10 seconds with compile-run-wait time less than 27 seconds
 A MODEL-PI sample problem dealing with five 32 x 12 matrices requires less than 92 seconds with compile-run-wait time less than 140 seconds
7. **UNUSUAL FEATURES OF THE PROGRAM** - Valence force potential functions for crystals may be used as well as conventional interactions between atom pairs
8. **RELATED AND AUXILIARY PROGRAMS** - MACS-C is a revision of at least two predecessor codes. The improvements and reasons for the changes are described in detail in reference report IN-1280
9. **STATUS** - Abstract first distributed December 1973
 IBM360 versions submitted November 1972, sample problems executed by NESC
10. **REFERENCES** - J. K. Boyter, H. L. McMurry, A. W. Solbrig, Jr., and R. M. Martin, MACS C, A Computing Program for Crystal Vibrations which includes Long-Range Coulomb Interactions, IN-1280, March 1969
 J. K. Boyter and A. W. Solbrig, Jr., MACS J, A Program for Computing Crystal Phonon Dispersion Relations, Structure Factors for Neutron Inelastic Scattering, and Jacobian Matrices, IN-1147, January 1968
 C. Noble, A. W. Solbrig, Jr., and H. L. McMurry, MACS M, A Program for Computing the Crystal Dynamical Matrix, Phonon Dispersion Relations, and Structure Factors for Neutron Inelastic Scattering, IN-1125, October 1967
 J. K. Boyter and H. L. McMurry, REVISED D, A Computer Program for Calculating Valence Coordinates in Terms of Mass Adjusted Atom Displacements, Together with Coordinates Defining Rigid Group Rotations, ANC Note P00441 (PPCO 40-1176), January 1969
 J. K. Boyter and H. L. McMurry, REVISED MVFC, A Computer Program for Constructing Force Constant Matrices for Use in Valence Force Potential Functions in Molecules and Crystals, ANC Note P00311, August 1969
 J. K. Boyter and H. L. McMurry, MVFC, A Computer Program for Constructing Force Constant Matrices for Use in Valence Force Potential Functions in Molecules and Crystals, IN-1282, April 1969
 J. K. Boyter and H. L. McMurry, ADJUSTER, A Force Constant Adjuster Program to Obtain Least Squares Fit to Observed Frequencies of Molecules and Crystals, IN-1148, December 1967
 J. K. Boyter and T. G. Worlton, DIPOLE SUM, A Computer Program for Calculating Dipole Sums for an Arbitrary Crystal, IN-1228, October 1968
 W. J. Swill and A. W. Solbrig, Jr., MODEL PI, ANC Note P01800, July 1970
 H. Kaplan and J. J. Sullivan, Physical Review, Vol. 130, p. 120, 1963
 H. McMurry, Comments on Using Some of the Codes in ACC No. 574 'MACS LATTICE VIBRATION CODES', July 31, 1975
11. **MACHINE REQUIREMENTS** - 650K bytes of core are required for each of the programs
 In addition to standard input/output, MACS-C uses scratch units 1, 2, 3, 4, 8, 9, and 10
 162K of LCS was indicated after compiling
 In addition to standard input/output, MACS-J uses scratch units 1, 2, 3, 4, 8, 9, and 10
 158K of LCS was indicated after compiling
 144K of LCS was indicated after compiling REVISED-D
 356K of LCS was indicated after compiling REVISED-MVFC
 100K of LCS was indicated after compiling ADJUSTER
 50K of LCS was indicated after compiling DIPOLE-SUM

In addition to standard input/output, MODEL-PI uses scratch units 2, 3, 4, 8, 9, 11, 12, 13, 14, 15, 16, and 17. 330K of LCS was indicated after compiling.

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 source programs require the FORTH450 compiler using 650K

MACS-J results can be affected by cross-over errors in certain parts of Jacobian results. See page 10 of reference IN-1147. The sample problem results contained nearly equal eigenvalues, as did sample problems for MACS-C and MODEL-PI.

REVISED-D results for rigid group rotations may be in error and should be carefully examined. See page 2, reference P00441.

REVISED-MVFC inserts 7 7777E-07 into the calculations when the number of unique interactions for two sets of coordinates of a particular interaction type exceeds twenty.

15. NAME AND ESTABLISHMENT OF AUTHORS -

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16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source decks (MACS-C 1259 cards, MACS-J 1208 cards, REVISED-D 947 cards, REVISED-MVFC 1518 cards, ADJUSTER 195 cards, DIPOLE-SUM 212 cards, MODEL-PI 1919 cards)

Sample problems (MACS-C 190 cards, MACS-J 274 cards, REVISED-D 56 cards, REVISED-MVFC 145 cards, ADJUSTER 20 cards, DIPOLE-SUM 18 cards, MODEL-PI 234 cards)

Control information (MACS-C 14 cards, MACS-J 14 cards, REVISED-D 6 cards, REVISED-MVFC 6 cards, ADJUSTER 6 cards, DIPOLE-SUM 6 cards, MODEL-PI 30 cards)

Sample problem output (MACS-C 3 pages, MACS-J 28 selected pages, REVISED-D 11 pages, REVISED-MVFC 41 selected pages, DIPOLE-SUM 3 pages, MODEL-PI 35 selected pages)

Reference reports and Notes

17. CATEGORY - W

KEYWORDS - lattice vibrations, inelastic scattering, moderators, eigenvalues, eigenvectors, crystals

18. SPONSOR -

1. **NAME OR DESIGNATION OF PROGRAM -** MSCAT
2. **COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -** IBM360
3. **DESCRIPTION OF PROBLEM OR FUNCTION -** 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.
4. **METHOD OF SOLUTION -** MSCAT is adapted from a program written by Bischoff (see reference 2). The basic structure is unchanged, but many modifications have been incorporated in order to treat a wider variety of problems. Given a scattering function, the program tracks successive neutrons within the sample and/or sample container in a Monte Carlo fashion. At each scattering point, the response, within each time channel and for each detector, is calculated. A cutoff is imposed to avoid tracking neutrons indefinitely. Single and multiple scattering contributions for each time channel and for each angle are separately accumulated.
5. **RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -** Apart from space and time limitations, the program is limited to three target geometries, and to no more than 8 scattering angles. These and other less significant restrictions may be removed by suitably modifying the program. The sample (and sample container) must be isotropic materials.
6. **TYPICAL RUNNING TIME -** Once the scattering function has been set up, the Monte Carlo loop takes 0.2 to 0.5 milliseconds per collision, per angle, per time channel. Typical running times for a complete problem are of order 1 to 10 minutes on the IBM360/195. If elastic coherent scattering is to be calculated, the program may take considerably longer to obtain adequate statistics.
7. **UNUSUAL FEATURES OF THE PROGRAM -**
8. **RELATED AND AUXILIARY PROGRAMS -** MSCAT represents a modified, extended, and largely rewritten, version of the program described by Bischoff.
9. **STATUS -** Abstract first distributed December 1973.
IBM360 version submitted August 1973, sample problem executed by NESC.
10. **REFERENCES -** J. R. D. Copley, Monte Carlo Calculation of Multiple Scattering Effects in Thermal Neutron Scattering Experiments, Computer Physics Communications preprint, 1973.
F. G. Bischoff, M. L. Yeater, and W. E. Moore, Monte Carlo Evaluation of Multiple Scattering and Resolution Effects in Double-differential Neutron Scattering Cross-section Measurements, Nuclear Science and Engineering, Vol. 45, pp. 266-280, 1972.
F. G. Bischoff, Generalized Monte Carlo Methods for Multiple Scattering Problems in Neutron and Reactor Physics, Ph.D. Thesis, Rensselaer Polytechnic Institute, University Microfilms 70-19931, 1970.
J. R. D. Copley, Monte Carlo Calculation of Multiple Scattering Effects in Thermal Neutron Scattering Experiments, Modification to Horizontal Cylinder Geometry, Computer Physics Communications preprint, 1973.
J. R. D. Copley, Monte Carlo Calculation of Multiple Scattering Effects in Thermal Neutron Scattering Experiments, Modification to Slab Geometry, Computer Physics Communications preprint, 1973.
11. **MACHINE REQUIREMENTS -** Normal I/O devices plus a high speed disk to store up to 3 files written by the program and a core requirement of 46,000 words.

12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 Release 20.1.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - If inelastic scattering is included, further high speed storage is required. The amount of extra storage is at the discretion of the user, depending on how accurately he wishes to define the inelastic scattering functions. In the present case an extra 26,000 words are used to store these functions. MSCAT is written for vertical cylinder geometry, with source decks included in the package enabling the user to modify MSCAT for either slab or horizontal cylinder geometry.
15. NAME AND ESTABLISHMENT OF AUTHOR -
J. R. D. Copley
Institut Laue-Langevin
B.P. 156 Centre de Tri
38 Grenoble, France
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (MSCAT-5472 cards, target slab-392 cards, target cyl-298 cards)
Sample problem (37 cards)
Control information (JCL-10 cards)
Sample problem output (MSCAT, MSLAB, MCYL 16 pages each)
Reference preprints as submitted by author
17. CATEGORY - W
KEYWORDS - thermal neutrons, elastic scattering, inelastic scattering, Monte Carlo method
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GEM
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - Costs are calculated using present-worth techniques and continuous compounding. The equations are based on an investor-owned utility capitalization structure which easily covers the range of industrial, private, and public (government) owned utilities. Three distinct types of analysis (cashflow, allocated costs, yearly cashflow) are performed, each yielding identical results. Using these as a basis many other analyses are undertaken.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Dimensions of all arrays are carried as variables throughout the analysis. The maximum size of each array is set by the user in program MAIN. Current values are set so that maxima are -
 - 50 batches per case study
 - 20 year batch life
 - 30 year case study
 - 120 batch burn time-steps
 - 20 individual payments (sales) associated with each cost component
6. TYPICAL RUNNING TIME - 1/3 second per batch is required
7. UNUSUAL FEATURES OF THE PROGRAM - GEM
 - (1) is broken into three major sections - input, general economic analysis, and output. The last two sections are able to perform an economic analysis of any type reactor system to any desired degree of precision. The input section converts data specific to a reactor type into a general form acceptable to the last two sections. The current input sections available handle BWR, PWR, and HTGR.
 - (2) uses continuous compounding
 - (3) contains three distinct types of economic analysis - cashflow, allocated cost, and yearly cashflow
 - (4) calculates fuel cycle cost on a batch, year, case, cumulative batchwise, and cumulative yearwise basis
 - (5) has separate escalation routines available for each type of cost component
 - (6) accepts Pu and U recycle bids
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1973
IBM360 version submitted October 1973, sample problem executed by NESC
10. REFERENCES - J. A. Hughes and D. F. Hang, Program GEM, General Economic Model to Analyze Nuclear Fuel Cycle Costs, University of Illinois Nuclear Engineering Program Report, September 1973
D. F. Hang, Fuel Cycle Economics, Education and Research in the Nuclear Fuel Cycle, pp 67-83, 1972

J. A. Hughes and D. F. Hang, Development of Engineering Economic Basis to Analyze Nuclear Fuel Cycle Costs. Transactions of American Nuclear Society Annual Meeting, pp. 48-50, June 1972.

11. MACHINE REQUIREMENTS - 274K bytes (202K with overlay structure) and one non-system disk (or tape)
12. PROGRAMMING LANGUAGES 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 -
J. A. Hughes and D. F. Hang
University of Illinois
217 Nuclear Engineering Laboratory
Urbana, Illinois 61801
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (4479 cards)
Sample problem (431 cards)
Control information (JCL 10 cards)
Reference report
17. CATEGORY - D
KEYWORDS - fuel cycle, economics, power plants, production, reactors, operation
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FFEARS
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600, 7600, IBM360, 370
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 equipotential plots, if desired.
4. METHOD OF SOLUTION - Basic relaxation techniques are used. The difference equations employed are derived from Laplace's equation for isotropic dielectrics. These are solved iteratively at all points within the electrode configuration except on the interfaces between materials of different dielectric constant. Dielectric interfaces are solved by a technique developed by C. N. Dorny (Letters, Proc. IEEE, Vol. 57, pp. 858-859). Floating electrodes are treated as special dielectrics.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The program treats any rectangular or axisymmetric configuration of dielectrics and small floating electrodes that can be described by a matrix of up to 201 x 201 points. All electrode and dielectric surfaces must lie on matrix points.
6. TYPICAL RUNNING TIME - Solutions with errors of less than five percent are obtained in less than ten minutes.
7. UNUSUAL FEATURES OF THE PROGRAM - A blowup routine permits the expansion and recomputation of sections of the plot to permit greater resolution.
8. RELATED AND AUXILIARY PROGRAMS - This package is a modification of ALO-00262, transferred from the ALO-COSMIC collection.
9. STATUS - Abstract first distributed January 1974.
CDC6600 version submitted May 1973, 1st revision Edition B submitted February 1975, sample problem executed with dummy plotting routines by NESC October 1976 on a CDC7600.
IBM360 version converted from CDC6600 Edition B by NESC July 1975, sample problem executed by NESC October 1976 on an IBM370/195.
10. REFERENCES - J. E. Boers, FFEARS, A Digital Computer Program for the Simulation of Laplace Equation Including Dielectric Interfaces and Small Ungrounded Electrodes, SC-RR-71 0377, July 1971.
Argonne Code Center Programming Note 77-6, FFEARS, ACC No. 577 360, November 22, 1976.
Argonne Code Center Programming Note 74-21, Environmental Subroutines Required by FFEARS, ACC No. 577 6600B, Rev. November 18, 1976.
11. MACHINE REQUIREMENTS - The CDC6600 version requires 122,000 (total) words of memory, 12 files on disk storage, and a SC-4020 plotter. The IBM360 version requires 350K bytes to compile, 288K bytes to execute, 11 files on disk storage, and a CalComp plotter.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - SCOPE 3 3 (CDC6600), SCOPE 2 1 (CDC7600), OS/360 (IBM360), OS/370 (IBM370)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Several subroutines and functions necessary to the operation of the plotting portion of the program are not included in the source deck. For the CDC6600 version, they are a part of the standard SCORS plotter package for the SC-4020 plotter, and must be furnished by the user or replaced by equivalent locally-available subroutines. The IBM360 version uses standard CalComp plotting calls.

15. NAME AND ESTABLISHMENT OF AUTHOR -

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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 (6600-1434 cards, 360-1690 cards)
Sample problems (6600-258 cards, 360-259 cards)
Control Information (JCL 360-80 cards)
Sample problem output (42 selected pages, 1 microfiche, and 5 plots)
Reference report and ACC Programming Note applicable to machine version

17. CATEGORY - T

KEYWORDS - Laplace equation, dielectric materials, electrodes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - PLOTR
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - PLOTR and the auxiliary routine XYGRD contour a function defined over a two-dimensional grid and compute the area within the contours
4. METHOD OF SOLUTION - PLOTR and XYGRD utilize a so-called four-point cell method. The function to be contoured must be tabulated in a two-dimensional array where the position of each element $f(i,j)$ is specified by the coordinates $x(i)$ and $y(j)$. These coordinates may be in either Cartesian or polar form.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The maximum allowable range between minimum and maximum angles is 180 degrees.
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - PLOTR utilizes the SCORS plotting routines (reference 2) to produce an output file for the SC-4020 microfilm plotter.
9. STATUS - Abstract first distributed December 1973
CDC6600 version submitted January 1970
10. REFERENCES - Susan M. Milly, PLOTR, A Two-dimensional Contouring and Area-Calculating Routine, SC-RR-69-685, October 1969
Division 9424, SC-4020 Usage with IBM-7090/7094, CDC-3600, UNIVAC-1107/1108, CDC-6600, Sandia Laboratories, Albuquerque, New Mexico, May 1969
Plotting Routines Required by PLOTR, ACC No. 578, ACC Programming Note 74-24, February 1974
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The reference SC-RR-69-685 does not correspond exactly to the latest version. In the current version of PLOTR, the parameter F has been dropped from the call list. The parameter ANS should now contain the array of function values to be contoured on input.
15. NAME AND ESTABLISHMENT OF AUTHOR -
Susan Milly Davenport
Sandia Laboratories
P. O. Box 5800
Albuquerque, New Mexico 87115
16. MATERIAL AVAILABLE - Restricted Distribution
Source deck (714 cards)
Sample problem (114 cards)
Reference report, SC-RR-69-685, and ACC Note
17. CATEGORY - P
KEYWORDS - x-y, r-theta, two-dimensional, computer graphics
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - DWARF
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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
4. METHOD OF SOLUTION - The few-group, neutron diffusion theory equations are reduced to a system of finite-difference equations that are solved for each group by the Gauss method at each time point. Fission neutron source iteration can be accelerated with Chebyshev extrapolation. A thermal feedback iterative loop is used to obtain consistent solutions for the distributions of reactor power, neutron flux, and fuel and coolant properties with the neutron group constants functions of the latter. Solutions for the new nuclide concentrations of a time-point are made with the flux assumed constant in the time interval.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 4 groups
 - 40 regions
 - 50 macroscopic materials
 - 50 nuclides per region
 - 250 mesh points* Only 10 are functions of the feedback variables
6. TYPICAL RUNNING TIME - Primarily a function of the number of feedback iterations required, running time ranges from less than a second to several seconds per time-step
7. UNUSUAL FEATURES OF THE PROGRAM - The neutron group constants for the macroscopic materials can be user-specified functions of the feedback variables and the group constants can be a mixture of the nondepletion macroscopic and depletion microscopic material data in a region. Automatic searches on buckling, poison, region dimensions, a region interface position, or total power can be done at each time-point. Basic input data and material constants can be changed freely at any time during problem execution. The solutions for the coolant thermal properties cover the entire range from the subcooled through the superheated vapor regimes with constant pressure and mass flow rate assumed. A plotted output routine can plot up to three distributions (of flux, power, temperatures, densities, etc.) per frame versus the one-dimensional space variable.
8. RELATED AND AUXILIARY PROGRAMS - CORA, a few-group, one-dimensional diffusion program and SINBAD, a nuclide depletion program
9. STATUS - Abstract first distributed December 1973
IBM360 version submitted June 1973, sample problem executed by NESC
10. REFERENCES - E. C. Anderson and G. E. Putnam, DWARF, A Few Group, One-dimensional Diffusion Theory Program for Reactor Depletion with Adjustable Reactivity Feedback, ANCR-1083, November 1972
11. MACHINE REQUIREMENTS - 330K bytes of core storage plus 8 FORTRAN logical units, including units for card input, printed output, and plotted output
12. PROGRAMMING LANGUAGE USED - FORTRAN IV (H)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The program compiles with the FORTRAN H compiler, optimization level 2. It consists of a root main segment that calls 5 overlays serially. The clock and plotted output routines are installation dependent.

15. NAME AND ESTABLISHMENT OF AUTHORS -

E. C. Anderson and G. E. Pulnam,
EG&G Idaho, Inc.
P. O. Box 1625
Idaho Falls, Idaho 83401

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (8278 cards)
Sample problem (149 cards)
Control information (JCL 66 cards)
Load module DWARF (289 blocks)
Sample problem output (26 pages)
Reference report

17. CATEGORY - D

KEYWORDS - few-group, one-dimensional, diffusion, slabs, cylinders, spheres, feedback, burnup, xenon oscillations, CORA codes, SINBAD codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ASTEM
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370/195, CDC6600,7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Unless redimensioned by the user, the highest derivative allowed is order 9. All arrays within ASTEM are one-dimensional to save storage area.
6. TYPICAL RUNNING TIME - The sample problem requires less than a minute.
7. UNUSUAL FEATURES OF THE PROGRAM - The main program is the sample problem.
8. RELATED AND AUXILIARY PROGRAMS - STEAM-67 (NESC Abstract 487)
9. STATUS - Abstract first distributed December 1973.
IBM360 version submitted June 1973, PROPS routine added to package August 1978, sample problem executed by NESC August 1978 on an IBM3033.
CDC6600 version submitted October 1973, sample problem executed by NESC May 1975 on a CDC6600 and a CDC7600.
10. REFERENCES - 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.
C. A. Meyer, R. B. McClintock, G. J. Silvestri, and R. C. Spencer, Jr., 1967 ASME Steam Tables - Thermodynamic and Transport Properties of Steam, The American Society of Mechanical Engineers, New York, 1967.
P. W. Bridgman, The Thermodynamics of Electrical Phenomena in Metals and a Condensed Collection of Thermodynamic Formulas, New York, Dover Publications, Inc., 1961.
M. P. Burgess, G. L. Fuller, and A. H. Kaiser, Thermodynamic Properties of Steam and Water Adapted for the IBM 360/195 Computer, DPSPU 76-11-3, September 1976.
11. MACHINE REQUIREMENTS - 68K bytes (IBM370/195), 21,000 (octal) words (CDC6600,7600). When using PROPS, 90K bytes of memory is required on the IBM system.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360,370 (IBM360,370), SCOPE (CDC6600,7600)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - In moving ASTEM to the CDC6600 the variable argument list calls to the CONU subroutine were converted to fixed to conform to CDC conventions, and double-precision data statements and arithmetic functions were changed to single-precision. The rounded arithmetic option of the FTN compiler was necessary for execution of the sample problem on the CDC7600. To relieve convergence failure in subroutine ROOT during CDC executions, the convergence criterion may be relaxed, but with caution.
The output values from the PROPS routine are returned through the labeled COMMON block /CPROPS/. When using PROPS in conjunction with the ASTEM routines, a "larger" H or H-extended compiler is needed requiring 450K at SYSGEN time. The G and G1 compilers will compile in a normal region. These compilers, however, will delete some of the beginning comments of the ASTEM routine BINOMX, as there are more than 30 consecutive comments. Variables passed to PROPS must be either non-zero (INPUT) or zero.

15. NAME AND ESTABLISHMENT OF AUTHORS -

360	K. V. Moore EG&G Idaho, Inc. P. O. Box 1625 Idaho Falls, Idaho 83401
360 PROPS	M. P. Burgess*, G. L. Fuller, and A. H. Kaiser Savannah River Plant E. I. duPont de Nemours and Company Aiken, South Carolina 29801
6600	D. L. Jaeger Boeing Commercial Airplane Company P. O. Box 3707 Seattle, Washington 98124

* Contact

16. MATERIAL AVAILABLE → Magnetic Tape Transmittal

Source decks (360-1551 cards, 6600-1531 cards)
 Sample problems (360-83 cards, 6600-84 cards)
 Auxiliary information (360 PROPS source-227 cards, sample problem-154 cards)
 Reference reports, ANCR-1026 and DPSPU 76-11-3, as appropriate to machine version

17. CATEGORY - H

KEYWORDS - thermodynamics, water, pressure, temperature, liquids, vapors, STEAM-67 codes

18. SPONSOR - NRC Division of Reactor Safety Research

1. NAME OR DESIGNATION OF PROGRAM - SLADE-D
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - SLADE-D analyzes the transient dynamic response of elastic shells
4. METHOD OF SOLUTION - SLADE-D uses the finite-element method in space and central-difference scheme in time
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
650 elements
700 nodal points
6. TYPICAL RUNNING TIME - Running time is controlled by the size of the mesh and the length in time for which the response is sought
7. UNUSUAL FEATURES OF THE PROGRAM - SLADE-D is designed for the dynamic analysis of thin shells. A doubly-curved, arbitrary quadrilateral element is utilized. The element is based on a minimum potential energy principle for thin shells. A simple central-difference time integration scheme together with a diagonal mass matrix is used to compute the transient dynamic response. Since the majority of aerospace structures are based on shells of revolution, the program is designed specifically for a shell the reference surface of which is a portion of an axisymmetric surface. The program allows up to five separate layers and up to five separate elastic anisotropic materials with temperature-dependent properties. SLADE-D handles variable-thickness shells and allows thickness discontinuities along element boundaries. It provides for both normal and tangential surface loads and for temperature changes through the thickness as well as varying temperatures over the reference surface. Over any portion of the boundary, a choice of thirteen separate boundary conditions is available. To ease data preparation, simple but effective generation schemes are built into the program. SLADE-D computes dynamic deformations, velocities, stresses, and stress resultants occurring in the shell. Since it is designed for use by a large number of people, it contains error checks wherever possible and, except where needed for efficiency, very straightforward logic. SLADE-D uses a single dimensioned storage array for the total stiffness matrix, mass matrix, and load vector. If a given problem fits within the limits of this storage array, the program functions as an in-core program. If additional storage is required, the program seeks on-line auxiliary storage which must be randomly accessible.
8. RELATED AND AUXILIARY PROGRAMS - SLADE-D is an outgrowth of an earlier static shell program, SLADE.
9. STATUS - Abstract first distributed December 1973
CDC6600 version submitted September 1973
10. REFERENCES - Samuel W. Key and Zelma E. Beisinger, SLADE D, A Computer Program for the Dynamic Analysis of Thin Shells, SLA-73-0079, January 1973
S. W. Key and Z. E. Beisinger, SLADE, A Computer Program for the Static Analysis of Thin Shells, SC-RR-69-369, November 1970
11. MACHINE REQUIREMENTS - 79,000 (decimal) words of core, extended core storage, and mass storage disk files
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 - The stiffness matrix, mass matrix, and load vector generated are stored in A, a one-dimensional array of 8056 locations. If the matrices and vector generated require more than 8056 core locations,

either random access extended core storage, random access mass storage disk files, or the equivalent is required. As the program is currently written, the mass storage calls WRITEC and READEC are used in conjunction with a CDC6635 extended core storage unit, and the mass storage calls OPENMS, WRITMS, and READMS are used in conjunction with the system disk files.

The required number of blocks needed to store the stiffness matrix, mass matrix, and load vector is set up as one file of information in extended core storage or in disk file storage. Extended core storage is sought first, and, if the file length exceeds the space available, the file is placed in disk storage. Each block comprises 6056 core locations, located in the array A when in the core of the computer. The mass storage calls allow any number of words to be transferred to or from the file starting at any point in the file. The result is a randomly-accessible file. Any block is accessible at any time. The random access feature is required in the assembly of the stiffness matrix, mass matrix, and load vector in MERGEX. The time integration in INTEGX uses the file sequentially.

15. NAME AND ESTABLISHMENT OF AUTHORS -

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Division 1541
Sandia Laboratories
P. O. Box 5800
Albuquerque, New Mexico 87115

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (3408 cards)
Sample problem (61 cards)
Reference report, SLA-73-0079

17. CATEGORY - I

KEYWORDS - shells, finite element method, mechanical structures, deformation, stresses, matrices, SLADE codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - MONA
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The system of finite difference equations of a group are solved by the Gauss method. Outer iterations on the neutron fission source can be accelerated with three-point Chebyshev extrapolation, and inner iterations on multiple thermal groups can be accelerated with two-point extrapolation or group scaling.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
 - 50 groups
 - 50 regions
 - 20 macroscopic materials
 - 999 library materials
 - 500 mesh points
6. TYPICAL RUNNING TIME - A sample problem with 22 groups, 41 mesh points and no upscaler requires 0.35 seconds of CPU time per outer iteration.
7. UNUSUAL FEATURES OF THE PROGRAM - Flux-volume weighted few-group constants can be generated. Parameter searches that converge to user-specified eigenvalues include buckling, poison, dimension, boundary, and concentration searches. Output edits include arbitrarily normalized flux, source, and power distributions, flux spectra, median and average energy distributions for various reaction rates, detailed neutron balance data, activation traverses, and distributions of ratios of arbitrary reaction rates.
8. RELATED AND AUXILIARY PROGRAMS - Many of the detailed algorithms and general methods of the MONA code were taken directly from the few-group, one-dimensional diffusion code CORA.
9. STATUS - Abstract first distributed December 1973.
IBM360 version submitted November 1972, sample problem executed by NESC.
10. REFERENCES - G. E. Putnam, MONA, A Multigroup One-dimensional Neutronics Analysis Code, ANCR-1051, March 1972.
R. L. Mueller, 360/75 Interval Timer Routine, Excerpt from NRTS Environmental Subroutine Manual, October 1968.
11. MACHINE REQUIREMENTS - 300K bytes of core storage, 5 FORTRAN logical units for program-required data sets, 3 FORTRAN logical units for card input, printed output, and punched card output.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV (H)
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The program compiles with the FORTRAN H compiler, optimization level 2. It consists of a root main segment that calls 8 overlays serially. MONA calls 3 installation-dependent routines--TIMSET, TIMER, and TIMJ. The first 2 are described in reference 2. TIMJ is a small clock (elapsed CPU time) routine that can be easily replaced or dummiad. An IBM360 system routine ERRSET, described in GC28-6817-2, IBM System/360 Operating System, FORTRAN IV (G and H) Programmer's Guide, is also called and may be dummiad.
15. NAME AND ESTABLISHMENT OF AUTHOR -
 - G. E. Putnam
 - EG&G Idaho, Inc.

P. O. Box 1625
Idaho Falls, Idaho 83401

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal

Source deck (9282 cards)
Load module MONA (250 blocks)
Sample problem (223 cards)
Control information (JCL 35 cards)
Reference report and Excerpt

17. CATEGORY - C

KEYWORDS - multigroup, one-dimensional, diffusion, criticality searches, slabs, cylinders, spheres, CORA codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - STEFEG
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - STEFEG calculates gaseous source terms. It computes the gaseous releases through various paths from boiling water reactors and/or pressurized water reactors.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - 20 isotopes, and 6 reports each for pressurized water reactor and boiling water reactor.
6. TYPICAL RUNNING TIME - 12 reports require about 14 seconds.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1973.
IBM360 version submitted December 1972, sample problem executed by NESC.
10. REFERENCES - F. T. Binford, T. P. Hamrick, G. W. Parker, and T. H. Row, Analysis of Power Reactor Gaseous Waste Systems, 12th AEC Air Cleaning Conference, and Errata.
11. MACHINE REQUIREMENTS -
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 -
F. T. Binford, T. P. Hamrick,
G. W. Parker, and T. H. Row
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee 37830
16. MATERIAL AVAILABLE -
Source deck (652 cards)
Sample problem (63 cards)
Control information (JCL 9 cards)
Reference report and Errata
17. CATEGORY - G
KEYWORDS - power reactors, gases, radioactivity, liquids, solutions
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - FPFM
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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)
4. METHOD OF SOLUTION - An analytical method is used based on a steady-state release model. This method which employs fission gas capsule data and conservative assumptions has provided good correlations of capsule release data and described fission product distribution in uranium oxide fuels. The assumptions used are that the release of iodine-131 is equal to the fractional release observed for xenon-131, and that all the fuel pins have a low fuel-to-sheath heat transfer coefficient and, therefore, a high fuel surface temperature which increases release for all corresponding heat ratings.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - FPFM applies only to water-cooled reactors.
6. TYPICAL RUNNING TIME - Less than 1 minute is required for a typical problem.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1973.
IBM360 version submitted January 1973, sample problem executed by NESC.
10. REFERENCES - V. F. Baston, J. H. McFadden, W. A. Yuill, An Analytical Method for Calculating Steady-state Fission Gas Release--Fission Product Fuel Mode (FPFM) Code, ANCR-1010, September 1971.
11. MACHINE REQUIREMENTS - 70K storage single-precision.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV.
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Source code deck is modified to call later version of the CalComp plotting package.
15. NAME AND ESTABLISHMENT OF AUTHOR -
V. F. Baston
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P. O. Box 1625
Idaho Falls, Idaho 83401
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (131 cards)
Sample problem (18 cards)
Control information (8 cards)
Load module (PROLIBC-89 blocks)
Reference report
17. CATEGORY - G
KEYWORDS - gases, fission products, radioactivity, cladding, water, coolants, power reactors, operation
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - TRIAL
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - Honeywell 6000
3. DESCRIPTION OF PROBLEM OR FUNCTION - TRIAL carries out a simple linking of several two-dimensional, multigroup neutron (direct or adjoint) flux sets to give a three-dimensional representation
4. METHOD OF SOLUTION - The flux linking approach assumes that the reactor system can be well represented in cylindrical geometry and requires input of one (r,z) multigroup flux set and one or more (x,y) multigroup flux sets for selected planes perpendicular to the z-axis. Points of intersection between the transverse planes and selected axial line shape functions are used to establish functional distributions which depend on the spectra (e.g., the Pu239 fission rate, B10 absorption rate, etc.). For each transverse plane, a weighted functional is determined by averaging the pointwise functionals over all the intersecting nodes of the axial lines and that plane. The weighted functionals are then used as normalization constants in a simple interpolation (or extrapolation) routine for computing the three-dimensional flux representation.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - A maximum of 25 two-dimensional flux sets may be input to TRIAL. Otherwise, variable-dimensional arrays are used exclusively within the program and problem size limitations will be dictated by the amount of available computer memory.
6. TYPICAL RUNNING TIME - A problem consisting of a 20 x 20 x 31 mesh array, 7 input (x,y) flux sets and 3 axial line shape functions requires approximately 3 minutes.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - TRIAL uses the GENED Environmental Subroutine package (NESC Abstract 515).
9. STATUS - Abstract first distributed December 1973
H6000 version submitted February 1973
10. REFERENCES - C. L. Cowan, P. Greebler, B. A. Hutchins, M. D. Kelley, and R. Protsik, A Description and Evaluation of the Flux Linking Approach for Computing Three-dimensional Fluxes - The Computer Code TRIAL, GEAP-13931, March 1973.
B. M. Carmichael, D. A. Meneley, and D. R. Vondy, Report on the Subcommittee on Standard Interface Files, prepared for the Committee on Computer Code Coordination, September 1, 1971.
11. MACHINE REQUIREMENTS - 32K memory, a minimum of 4 logical units for the peripheral storage of input, working, and output flux sets, plus an additional logical unit for each additional input (x,y) flux set greater than one.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GCOS6000
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - All input flux sets and the output 3-D flux set are prescribed in the format of the standard interface file, as recommended by the Standard Interface File Subcommittee of the Computer Code Coordination Committee (see reference 2).
15. NAME AND ESTABLISHMENT OF AUTHOR -
C. L. Cowan
Breeder Reactor Department
General Electric Company
310 Deguigne Drive
Sunnyvale, California 94086

16. MATERIAL AVAILABLE -

Source deck (971 cards)
 Sample problem (23 cards)
 Control information (96 cards)
 Reference report, GEAP-13931

17. CATEGORY - C

KEYWORDS - three-dimensional, reaction kinetics, power distribution, LMFBR reactors

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - PLENUM
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - Bulk flow distribution in a cylindrical reactor coolant inlet plenum is calculated using potential flow theory
4. METHOD OF SOLUTION - The Laplace equation for the velocity potential is solved for general, symmetric boundary conditions and one inlet nozzle by Gauss-Seidel relaxation (part 1). Nonsymmetric, dimensional solutions are then formed by superposition of the general solution (part 2)
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The code is dimensioned for 8000 mesh points in an (r,theta,z) array. Dimensions can be expanded at the expense of run time and core size
6. TYPICAL RUNNING TIME - Run time for part 1 is proportional to n^2 , where n is the number of mesh points. With 2299 mesh points CPU time is 42 seconds on a 360/195. Run time for part 2 is 1 second per problem. Sample problem running time is 2 minutes for part 1 and 1 minute for part 2
7. UNUSUAL FEATURES OF THE PROGRAM - The code approximates bulk fluid motion through large cylindrical headers in circumstances where details of the flow, such as boundary layer effects, may be neglected. Three-dimensional effects are calculated, so that asymmetric fluid input and output problems may be calculated. Use of a linear field equation permits rapid solution by superposition of many combinations of input and output boundary conditions. First order effects of friction may be included by addition of constant coefficients in the finite difference formulations
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1973
IBM360 version submitted June 1973, sample problem executed by NESC
10. REFERENCE - S. D. Harris and J. W. Reece, Application of Potential Flow Theory to Reactor Coolant Circulation, Proceedings of the Eighth Southeastern Seminar on Thermal Sciences, OF-MS-71-13, March 23-24, 1972
11. MACHINE REQUIREMENTS - 240K bytes of storage and an on-line punch and printer
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - PLENUM is written as two separate programs. Part 1 provides a general dimensionless solution to the field equation. For a given header this code need only be executed once. Part 2 uses punched output from part 1 to determine solutions for a variety of user-specified boundary conditions by dimensionalization and superposition
15. NAME AND ESTABLISHMENT OF AUTHOR -
S. D. Harris
Savannah River Laboratory
E. I. duPont de Nemours and Company, Inc
Aiken, South Carolina 29801
16. MATERIAL AVAILABLE -
Source decks (part 1 312 cards, part 2 220 cards)
Sample problems (part 1 3 cards, part 2 16 cards)
Punched output (part 1 419 cards)

Sample problem output (part1 31 pages, part2 11 pages)
Reference report

17. CATEGORY - H
KEYWORDS - cylinders, coolants, r -theta- z , Laplace equation, potential flow
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - AEC-ALO FAU
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360/50
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - A general familiarity with AEC Appendix 0270, Part IV and the OTP Manual is assumed.
6. TYPICAL RUNNING TIME - 5 minutes are required for seven reports, 1000 records.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - An earlier version of this program was written for the Burroughs B-5500. This is a modified COBOL version of a USAEC NUO FORTRAN program.
9. STATUS - Abstract first distributed December 1973.
IBM360 version submitted February 1973, sample problem executed by NESC.
10. REFERENCES - AEC-ALO Memorandum, AEC-ALO Radio Frequency Assignments and Uses (FAU), (1973)
AEC-ALO Memorandum, Description of Radio Frequency Bookkeeping Program, (1973)
11. MACHINE REQUIREMENTS - This system requires disk-sort of input data and the master tape records. Peripheral equipment required is card reader, line printer (132 character/line), and two magnetic tape units.
12. PROGRAMMING LANGUAGE USED - COBOL
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The system consists of two programs, M2501 the tape update program, and M2502 the report preparation program.
15. NAME AND ESTABLISHMENT OF AUTHORS -
J. H. Grayson, G. S. Hearron,
and George Kojima
Albuquerque Operations Office
U. S. Department of Energy
P. O. Box 5400
Albuquerque, New Mexico 87115
16. MATERIAL AVAILABLE -
Source decks (M2501-485 cards, M2502-374 cards)
Sample problems (M2501-43 cards, M2502-1 card)
Sample problem output (M2501-11 pages, M2502-10 pages)
Reference memoranda
17. CATEGORY - M
KEYWORDS - maintenance, sorting, information systems, radio equipment
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ORCOST2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The code follows the guidelines of AEC Report NUS-531. A base capital-cost model and a base operating- and maintenance-cost model are selected and adjusted for desired size, location, date, etc. Costs are discounted to the year of first commercial operation and levelized to provide annual cost of electric power generation.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - The capital cost models are of doubtful validity outside the 500 to 1500 MW(e) range.
6. TYPICAL RUNNING TIME - Execution time for a single case is less than one second on the IBM 360/91.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - Capital cost calculations are based on the cost-model data developed for the CONCEPT program (NESC Abstract 498). A separate code OMCST (NESC Abstract 688) can be used to calculate nonfuel operation and maintenance costs.
9. STATUS - Abstract first distributed December 1973.
IBM360 version of ORCOST submitted March 1973, replaced by revision B July 1973,
replaced by ORCOST2 March 1976, sample problem executed by NESC May 1976 on an
IBM370/195.
10. REFERENCES - S. T. Brewer, L. C. Fuller, M. L. Meyers, L. L. Bennett and H. I. Bowers, ORCOST2 - A Computer Code for Estimating the Cost of Power for Steam-Electric Power Plants, ERDA 76-38, October 1975.
11. MACHINE REQUIREMENTS - 90K bytes
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 - ORNL environment subroutines IDAY, ICOMPARE, and TIME are supplied in Assembly language.
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 - Magnetic Tape Transmittal
Source decks (ORCOST2 2283 cards, IDAY 63 cards, ICOMPARE 39 cards, TIME 28 cards)
Sample problem (8 cards)
Reference report

17. CATEGORY - D

KEYWORDS - economics, capital, cost, charges, power plants, PWR reactors, BWR reactors, HTGR reactors, CONCEPT codes, OMCST codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - BECOM
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360/50, UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - BECOM is restricted to a 6 years' study.
6. TYPICAL RUNNING TIME - On the UNIVAC1108 50 studies can be done in less than a minute. On the IBM360 the sample problem requires about 30 seconds.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - This program is a modification of ALO-178 and ALO-251 transferred from the ALO-COSMIC collection.
9. STATUS - Abstract first distributed December 1973
IBM360 version submitted January 1973, sample problem executed by NESC
UNIVAC1108 version submitted January 1973
10. REFERENCES - Bruno D. Navales, BECOM, A Computer Program to Calculate Break-Even Point of Purchase vs Lease for Computing Equipment in the AEC, Sandia Laboratories Manual.
Bruno D. Navales, BECOM, A Computer Program to Calculate Break-Even Point of Purchase vs Lease for Computing Equipment in the AEC, Sandia Laboratories Manual, modified February 1971.
Bruno Navales, Purchase vs Lease Program Listing (BECOM) for IBM360/50, Sandia Laboratories Report, January 24, 1973.
Bruno Navales, Purchase vs Lease Program Listing (BECOM) for UNIVAC 1108 EXEC-8, Sandia Laboratories Report, January 23, 1973.
11. MACHINE REQUIREMENTS - 300K bytes of storage (IBM360)
12. PROGRAMMING LANGUAGE USED - COBOL
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360 (IBM360), EXEC8 (UNIVAC1108)
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
Bruno Navales
Sandia Laboratories
P O Box 5800
Albuquerque, New Mexico 87115
16. MATERIAL AVAILABLE - Restricted Distribution
Magnetic Tape Transmittal (360 version)
Source decks (360-1423 cards, 1108-960 cards)
Sample problems (360-97 cards, 1108-97 cards)
Control information (360-9 cards)
Load module BECOM (42 blocks)
Reference reports
17. CATEGORY - M
KEYWORDS - cost, economic analysis, equipment, procurement

10. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - INTEG/INSPEC
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - In INTEG, the discontinuous density function is integrated by the trapezoidal rule from time equals zero to time equals 1. INSPEC is based on the simulation of reactor operation as a Markov process. A vector of probabilities is successively multiplied by a transition matrix.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - INSPEC is limited to subsystems with no more than 7 safety circuits. The transition matrix can be made up as desired so that any intercorrelations between failures of circuits can be accommodated. In INTEG, failure rates of safety circuits are restricted to independence.
6. TYPICAL RUNNING TIME - The INTEG sample problem containing five problems, each with 3,000 steps of trapezoidal integration and with an average of 4.8 safety circuits, requires a total CPU time of 2 seconds on an IBM360/195, while the INSPEC sample problem with three safety circuits runs for 500 transitions with an indicated CPU time less than 2 seconds.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1973
IBM360 version submitted March 1973, sample problems executed by NESC
10. REFERENCE - L. M. Arnett, Quantitative Analysis of Reactor Safety, DP-1168, November 1968
11. MACHINE REQUIREMENTS -
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 decks (INTEG 143 cards, INSPEC 159 cards)
Sample problems (INTEG 28 cards, INSPEC 10 cards)
Sample problem output (INTEG 13 pages, INSPEC 2 pages)
Reference report
17. CATEGORY - G
KEYWORDS - reactor safety, reactor operation, simulation, MARKOV process

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - PLETHS
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
GE400 Time-Sharing
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - Concentrations for each point of a square grid are calculated by means of the plume model for atmospheric dispersion or (for low wind speeds) the puff model.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Calculations can be performed for any (nonreacting) gas or particulate matter. The resulting concentrations and isopleths are in parts per million (for gases of given molecular weight) or in micrograms per cubic meter (for any pollutant).
6. TYPICAL RUNNING TIME - Less than a minute is required with average connect time about 15 to 20 minutes.
7. UNUSUAL FEATURES OF THE PROGRAM - The particular advantage of the time-sharing program is that isopleths can be calculated for any combination of source strength and isopleth level, as well as any combination of wind speed, stability, and other meteorological conditions. Any book of tables is necessarily limited by size to a small set of cases.
8. RELATED AND AUXILIARY PROGRAMS - The time-sharing program is based on the isopleth-area code described in reference 1. This code also formed the nucleus of the PUFF code associated with the APICS system, reference 2.
9. STATUS - Abstract first distributed December 1973.
GE-400 Time-Sharing program received May 1973.
10. REFERENCES - L. A. Conley, E. J. Croke, A. S. Kennedy, R. F. King, J. E. Norco, J. J. Roberts, A. D. Rossin, and T. D. Wolsko, Isopleth-Area Tables, ANL/ES-8, October 1971.
J. J. Roberts, Editor, Chicago Air Pollution Systems Analysis Program. Final Report, ANL/ES-CC-009, February 1971.
Richard F. King, Time-Sharing Isopleth-Area Program, ANL/ES-13, September 1972.
11. MACHINE REQUIREMENTS - Code lengths are source, about 22,500 bytes, object, about 13,000 bytes, 3-bytes per 24-bit word.
12. PROGRAMMING LANGUAGE USED - GE-400 Time Sharing FORTRAN
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GSA Time-Sharing System
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -
15. NAME AND ESTABLISHMENT OF AUTHOR -
Richard F. King
Energy and Environmental Systems Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
16. MATERIAL AVAILABLE -

Reference report, ANL/ES-13, containing source listing, sample problem input and output information.

17. CATEGORY - R

KEYWORDS - air pollution, plumes, particles, gases, meteorology, PUFF codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - GEAR
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600,7600, IBM360,370
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The basic methods used are of the linear multistep predictor-corrector type. GEAR contains both the implicit Adams methods and the backward differentiation formulae, or the methods of C. W. Gear, as options, and is based on a program written by Gear.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Choice of either implicit Adams methods to order 12, or the backward differentiation formulae, also called Gear's stiff methods, to order 5 is allowed. The program presently is dimensioned to allow solution of systems of up to 20 first order differential equations. This limit can be increased by changing dimensions in subroutine DRIVE.
6. TYPICAL RUNNING TIME - Less than 1 minute is required to compile and execute the sample problem.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS - GEARB (NESC Abstract 661) for systems with a banded Jacobian, EPISODE (NESC Abstract 675), especially suited for systems with high-speed transients, and DE/STEP,INTRP (NESC Abstract 640).
9. STATUS - Abstract first distributed December 1973.
CDC6600,7600 version submitted July 1973, replaced by Edition B January 1975, replaced by Edition C March 1976, sample problem executed by NESC January 1975 on a CDC6600 and a CDC7600.
IBM360 version submitted September 1974, replaced by Edition B January 1975, replaced by Edition C March 1976, sample problem executed by NESC March 1976 on an IBM370/185.
10. REFERENCES - C. W. Gear, Numerical Initial Value Problems in Ordinary Differential Equations, Prentice-Hall, 1971.
A. C. Hindmarsh, Linear Multistep Methods for Ordinary Differential Equations: Method Formulations, Stability, and the Methods of Nordsieck and Gear, UCRL-51186, March 1972.
A. C. Hindmarsh, The Control of Errors in the GEAR Package for Ordinary Differential Equations, in Construction of Mathematical Software, F. N. Fritsch, Ed., UCID-30050 Part 3, August 7, 1972.
A. C. Hindmarsh, GEAR Ordinary Differential Equation System Solver, UCID-30001 Rev. 3, December 1974.
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 - 14,000 (octal) words to execute the test problem (CDC6600,7600), 60K 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 - The subroutines in the GEAR package are heavily augmented with comment cards. If GEAR is used on other machines, the

unit roundoff error, UROUND, may need to be reset. It is specified in a data statement 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.

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 -

Source decks (6600-1133 cards, 360-1176 cards)
Sample problems (6600-74 cards, 360-81 cards)
Auxiliary programs (6600-26 cards, 360-26 cards)
Sample problems output (6600-10 pages, 360-10 pages)
Reference report, UCID-30001 Rev. 3, and ACC Programming Note

17. CATEGORY - P

KEYWORDS - ordinary differential equations, numerical solution, initial-value problems, Adams method, GEARB codes, EPISODE codes, DE/STEP codes, INTRP codes

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - SPEAKEASY MU+ Level
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360,370,3033
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - The language syntax closely resembles that of mathematics. User-defined variables are classified as scalars, arrays, vectors, or matrices. Class-oriented operators simplify the language.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME -
7. UNUSUAL FEATURES OF THE PROGRAM - SPEAKEASY is an extensible library-directed processor. Available facilities include array algebra, complete matrix algebra, statistical packages, and assorted special functions. SPEAKEASY also offers HELP documents and TUTORIAL sessions.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1973.
IBM360 IOTA SF Level submitted November 1973, replaced by revised IOTA Level edition March 1974, deleted January 1975.
IBM360 MU+ Level submitted January 1979, sample problems executed by NESC February 1979 on an IBM360,370,3033.
10. REFERENCES - S. Cohen and S. Pieper, The SPEAKEASY-3 Reference Manual, Level MU, IBM OS/VS Version, ANL-8000 Rev. 2, August 1977.
G. Gordon, LECTURES ON SPEAKEASY, Communications Satellite Corporation-ANL Speakeasy Center Memorandum, August 1977.
B. Williams, The SPEAKEASY Example Documents, ANL-CEA Program Report, Spring 1977.
Installation Instructions for MU+ Level SPEAKEASY, ANL Memorandum, February 1979.
Notes on the SPEAK SOURCE PDS, NESC Note 79-25, February 26, 1979.
11. MACHINE REQUIREMENTS - A minimum of 130K of memory is needed for the MU080 processor, 190K for the MU150 processor, and 300K for the MU250 processor for the MU+ Level of SPEAKEASY.
12. PROGRAMMING LANGUAGES USED - FORTRAN IV (95%) and Assembler (5%).
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - OS/360
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - MU+ Level: SPEAKEASY is distributed on a standard-labeled tape containing 18 files, and is intended for use only on IBM360,370,3033 systems. Source decks are supplied (SPEAK SOURCE) only for those utility routines which may require modification for local implementation. Sixteen of the 18 files are partitioned data sets (PDSs), the remaining two contain machine-readable documentation.
15. NAME AND ESTABLISHMENT OF AUTHOR -
S. Cohen
Physics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
*Present address-Speakeasy Computing Corporation
222 West Adams, Room 849
Chicago, Illinois 60606

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (PDS SPEAK.SOURCE)
Load modules (PDSs SPEAK.MU090, MU150, MU260, LINKULES, DATAMANG, FORTLIB, UTILITY, VSCOPY)
Test data (PDSs SPEAK.EXAMPLES, TESTCASE)
Processor interface and initialization (PDS SPEAK.PROCLIB)
Auxiliary information (PDSs SPEAK.HELP, TUTOR, DOCUMENT; DATA)
Sample output (TESTCASE-25 pages)
Machine-readable documentation (SPEAK.MANUAL, HELPLIST)
Reference documents, ANL-CEA Program Report, ANL Memorandum, and NESC Note 79-25
17. CATEGORY - P
KEYWORDS - programming languages, numerical solution, libraries
18. SPONSOR - ERDA Division of Physical Research
Argonne National Laboratory

1. NAME OR DESIGNATION OF PROGRAM - ARC-XSEC1
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - IBM360
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - ARC-XSEC1 consists of four related modules - AJC007, NUI006, NUI001, and NUC001. The module AJC007 provides a group collapse of the multigroup XS.ISO data into a user-specified group structure and writes the binary interface data set XS.ISO2. NUI006 produces run-time modifications of isotopic cross section components of the card image data set A.NIP. The module NUI001 processes the material and composition level mixing data specified in A.NIP and produces mix tables as the binary interface data set B.HOMOG. NUC001 uses the mix tables of B.HOMOG to produce homogenized material and composition level cross section data sets in the binary interface data set formats XS.M.MIN, XS.M.ANI, XS.M.AUX, XS.C.MIN, XS.C.ANI, XS.C.AUX, respectively.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - The sample problem provided which consists of multiple operations, requires about 71 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. The homogenization capability, NUI001 and NUC001, is used to provide cross section data for each of the neutronics modules with communication via interface data sets.
8. RELATED AND AUXILIARY PROGRAMS - The neutronics paths of the ARC System utilize the capabilities provided by these modules. The ARC System environment is provided by ARC-SYSTEM (NESC Abstract 522). The BCD input processor module for the ARC-SYSTEM is ARC-NUI002 (NESC Abstract 533).
9. STATUS - Abstract first distributed December 1973.
IBM360 version submitted April 1973, sample problem executed by NESC.
10. REFERENCES - E. A. Kovalsky, J. Zapalka, H. Henryson, II, J. Hoover, and P. M. Walker, The ARC System Cross Section Homogenization and Modification Capabilities, ANL-7714, June 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.
B. J. Toppel, Supplemental Information, ANL Memo, 1973.
11. MACHINE REQUIREMENTS - 300K bytes with a 10,000 doubleword container (default) and 2 peripheral I/O devices
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 E. A. Kovalsky, J. Zapalka, H. Henryson, II,
J. Hoover, and P. M. Walker

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9700 South Cass Avenue
Argonne, Illinois 60439

16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (PDS ARC.XSOURCE)
Object modules (PDS ARC.XSEGLIB)
Linkage editor control statements (PDS ARC.XOVERLAY)
Load modules (PDS ARC.XMODLIB)
Control information (JCL IEHMOVE deck)
Sample problem (425 cards)
Libraries (XS.ISO.F1 and XS.ISO.F2)
Sample problem output (98 pages)
Reference reports
17. CATEGORY - L
KEYWORDS - multigroup, cross sections, data processing, group constants, ARC codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - MAPPER
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -
GE MARK III Time-Sharing
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION -
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM -
6. TYPICAL RUNNING TIME - 1 to 2 seconds are required for a typical problem.
7. UNUSUAL FEATURES OF THE PROGRAM -
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1973.
GE MARK III Time-Sharing program listing submitted August 1973.
10. REFERENCES - R. J. Di Prima, Manufacturing Program for Predicting Equipment Requirement (MAPPER), GEPP-103, 1973.
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - BASIC
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - GE MARK III Time-Sharing operation.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - The program uses the MARK III system plotting routine EZGRAF.
15. NAME AND ESTABLISHMENT OF AUTHOR -
R. J. Di Prima
Neutron Devices Department
General Electric Company
P. O. Box 11508
St. Petersburg, Florida 33733
16. MATERIAL AVAILABLE -
Reference report containing source listing, sample problem input and output information
Source program on paper tape (available upon request)
17. CATEGORY - M
KEYWORDS - management, manufacturing, production, forecasting
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - ENDFB2/GAND2/GFE2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1100
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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 last 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)
4. METHOD OF SOLUTION - GAND2 prepares fine group cross sections and scattering transfer array coefficient arrays for use in the GAF code using modified versions of the routines used to prepare GGC4 (NESC Abstract 298) data tapes as well as the GANDY code (NESC Abstract 341) for unresolved resonance region cross section generation. Pointwise resolved resonance region cross sections for use in the GAR and MICROX codes as well as the GAROL option of the GGC5 code are prepared using the PSEUDO code (NESC Abstract 292) to generate statistical resonances in the unresolved resonance region and the FSDPS code (NESC Abstract 216) to generate the cross sections from both the statistical resonances and the resolved resonance parameters. Cross section values in the thermal neutron energy range may be prepared for non-moderator nuclides (those nuclides for which no detailed scattering law data are given in file 7) using either a strictly pointwise calculation or an ultra-fine mesh averaging procedure using a neutron energy spectrum obtained by interpolation from an input spectrum.
 GFE2 is an extended special-purpose version of the GAF cross section preparation section of the GAND2 code. The extensions include the computation of P3 instead of P1 scattering transfer arrays and a high-speed, zero temperature, infinite dilution resolved resonance calculation via the INDER code (GA-7158).
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - ENDFB2 processes Files 1 through 7 of the current ENDF/B format
 GAND2 maxima include -
 - 20 ENDF/B materials processed in a single problem
 - 35 resonance levels on either side of the incident neutron energy
 - 1000 resolved resonances per isotope (375 per l-state per isotope in GFE2 version)
 - 500 energies per l-state per isotope for energy-dependant unresolved resonance parameters (lru=2, lrf=1 or 2)
 - 1740 groups for GAF
 - 5000 words per record on GAF data tapes
 - 2000 words per record on GAR data tapes
 - 10 temperatures per GAR problem
 - 10 isotopes per GAR problem
 - 800 energies (groups) in the thermal neutron cross section preparation section
 GFE2 maxima include -
 - 20 ENDF/B materials per problem
 - 375 resolved resonances per l-state (angular momentum state) per isotope
 - 375 energies per l-state per isotope for energy-dependant unresolved resonance parameters (lru=2, lrf=1 or 2)
 - 99 groups (limited by subroutine INDER and by transfer array accumulation in subroutine GADJ)
 ll=1 or 5 secondary energy distribution laws in File 5 cannot be processed in the present version of GAND2 and GFE2. Inelastic scattering is assumed to be isotropic in the center-of-mass system.

6. **TYPICAL RUNNING TIME** - ENDFB2 processing one material takes less than a minute. Total time is determined by the position of the material on the card-image tape. A full card-image tape (containing approximately 23,000 records) takes about 8 minutes to read.

GAND2 requires 15 minutes or less for a typical GAF or GAR problem, 1 minute for the thermal neutron cross section option.

5 minutes are required for a typical GFE2 problem.

7. **UNUSUAL FEATURES OF THE PROGRAM** - ENDFB2 writes the binary output tape using the UNIVAC special I/O routine NTRAN. If the number of tabular points for a given ENDF/B File 3 reaction type exceeds 2000, the reaction data is blocked into multiple records. Redundant inelastic scattering data is also eliminated.

The resolved and unresolved resonance calculations in GAND2 can treat processes involving neutrons of orbital angular momenta zero through three (s-, p-, d-, and f-wave interactions). The version of the PSEUDO code used in this program has been modified to allow 1 to 4 degrees of freedom for the distribution of fission widths and has been modified in GAND2 to operate from higher to lower energies for much greater speed in preparing 14,500 point GAR data for nuclides such as U235. A virtually unlimited (over 2 million) number of tabular energies may be used in the ENDF/B format File 3 data. This is achieved by breaking the ENDF/B File 3 data up into 2000-word blocks. A similar scheme is used to process the angular distribution data from an ENDF/B format File 4 without significant restrictions on the amount of input data.

The resolved and unresolved resonance calculations in GFE2 can treat processes involving neutrons of orbital angular momenta zero through three (s-, p-, d-, and f-wave interactions). A virtually unlimited (over 2 million) number of tabular energies may be used in the ENDF/B format File 3 data. This is achieved by breaking the ENDF/B File 3 data up into 2000-word blocks. A similar scheme is used to process the angular distribution data from an ENDF/B format File 4 without significant restrictions on the amount of input data.

8. **RELATED AND AUXILIARY PROGRAMS** - The binary ENDF/B format nuclear data tapes required by the GAND2 and GFE2 codes are prepared from cards or ENDF/B card-image tapes by the ENDFB2 code, which is similar to the DAMMET code (NESC Abstract 384). Output from the GAND2 code is intended for use in the GAFFAR code (NESC Abstract 316), the GAROL option of the GGC5 code, and MICROX code, and the WTRG code. Output of the GFE2 code is intended for use as input to the MAKE code which prepares data tapes (GAM type) for use in the fast sections of the GGC4 and GGC5 codes. These GAM-type data tapes are also used to prepare data tapes for use in the MICROX code.

9. **STATUS** - Abstract first distributed December 1973
UNIVAC1108 version submitted July 1973

10. **REFERENCES** - R. J. Archibald and O. R. Mathews, The GAF/GAR/GAND Fast Reactor Cross Section Preparation System, GAFFAR - A Program for the Calculation of Neutron Spectra and Group-Averaged Cross Sections, GA-7542, Vol. 1, 1968, and Errata, May 1968.

R. J. Archibald and O. R. Mathews, The GAF/GAR/GAND Fast Reactor Cross Section Preparation System, GAND2 and GFE2 - Computer Programs for Preparing Input Data for the GAFFAR, GGC and MICROX Codes from an ENDF/B Format Nuclear Data File, GA-7542, Vol. 11, March 1973, and Errata, February 18, 1974.

M. K. Drake (Ed.), Data Formats and Procedures for the ENDF/B Neutron Cross Section Library, BNL-50274, October 1970.

M. K. Drake, C. V. Smith, and L. J. Todt, Description of Auxiliary Codes Used in the Preparation of Data for the GGC-3 Code, GA-7158, August 1971.

S. C. Cohen and P. K. Koch, GANDY - A Computer Program for the Evaluation of Effective Cross Sections in the Unresolved Resonance Region, GA-8003, May 1967.

M. W. Dyos, Construction of Statistical Resonances in the Unresolved Resonance Region - The PSEUDO Code, GA-7136, May 26, 1966.

O. R. Mathews, FSDP3, A Computer Program for Computing Cross Sections from Resonance Parameters, GULF-GA-A12052, April 5, 1972.

D. Mathews, et al., GGC-5, A Computer Program for Calculation of Neutron Spectra and Group Constants, GA-8871, September 27, 1971.

J. Adir and K. D. Lathrop, Theory of Methods Used in the GGC-4 Multigroup Cross Section Code, GA-9021, October 1968.

P. Waltl and P. Koch, MICROX - A Two-region Flux Spectrum Code for the Efficient Calculation of Group Cross Sections, GULF-GA-A10827, April 14, 1972.

11. MACHINE REQUIREMENTS - 11,000 words for ENDFB2 program and data and a maximum of 4 magnetic tape units, 65K word available fast memory and 4 to 8 magnetic tape units plus 5 scratch files totaling about 1310K words in capacity for GAND2, 65K word available fast memory and 2 magnetic tape units plus 7 scratch files totaling about 1310K words in capacity for GFE2
12. PROGRAMMING LANGUAGE USED - FORTRAN V
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC8.
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - These programs use the UNIVAC NTRAN I/O routines, UNIVAC FORTRAN V procedure elements, as well as the INCLUDE and PARAMETER statements.
15. NAME AND ESTABLISHMENT OF AUTHORS -
D. R. Mathews and R. J. Archibald
General Atomic Company
P. O. Box 81608
San Diego, California 92138
16. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source decks (ENDFB2 790 cards, GAND2 9217 cards, GFE2 6228 cards)
Sample problems (ENDFB2 13 cards, GAND2 53 cards, GFE2 32 cards)
Reference report, GA-7542, Vol. II
17. CATEGORY - B
KEYWORDS - cross sections, neutrons, reactor kinetics, ENDF/B, data processing, GGC4 codes, GANDY codes, GAROL codes, GGC5 codes, PSEUDO codes, FSDP3 codes, GAFGAR codes, MICROX codes, WTEG codes, MAKE codes, DAMMET codes
18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - MATUS
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600,7600
3. DESCRIPTION OF PROBLEM OR FUNCTION - MATUS performs small-strain elastic analysis of three-dimensional solids
4. METHOD OF SOLUTION - The finite-element method is used, with eight-node trilinear isoparametric elements. The principle of virtual work is used to develop the stiffness equations. The stiffness equations are solved by a direct method (Crout's method) which takes advantage of the symmetry, bandedness, and sparseness of the stiffness matrix.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Problems with up to about 3200 nodes can be solved (with a central memory field length of 170,000 octal). Large bandwidths can cause overflow of data from extended core storage to lower speed disk storage which can greatly increase the running time of a problem.
6. TYPICAL RUNNING TIME - Running time depends on the problem size and the computer. The program runs about five times faster on the CDC7600 than on the CDC6600. The forward elimination (factorization) phase of the direct solution process is the most time consuming phase of a time-step. This forward elimination time (CP plus I/O time) can be estimated from the forward elimination time (in seconds) approximately equal to $1/c$ times the summation from 1 to n of $(bw(sub\ n))^2$ where $bw(sub\ n)$ is the bandwidth of row n of the stiffness matrix and n is the number of nodes. The constant c equals 2000 if the CDC6600 is used or equals 10,000 if the CDC7600 is used. If the maximum bandwidth is greater than the number of rows of the stiffness matrix that will fit in extended core storage (ECS), the running time will greatly exceed the estimate given above. With an ECS field length of 1,200,000 octal, problems with bandwidths up to about 162 can be solved without causing overflow from ECS to disk.
7. UNUSUAL FEATURES OF THE PROGRAM - The program has a temperature-dependent material property capability. Some critical loops in the forward elimination (factorization) part of the direct solution algorithm have been programmed in COMPASS assembly language in order to speed up the solution process. A restart option allows the user to save the factored stiffness matrix and to retrieve it in a later job in which the same problem is submitted with different loading conditions. The use of this option results in a considerable (80-95 percent) savings in run time, since it eliminates the necessity to re-generate the factored stiffness matrix.
8. RELATED AND AUXILIARY PROGRAMS - PEDCOM (ref 1) reads, processes, and checks the input data for MATUS. MESH3D (ref 3) can be used to automatically generate a finite-element mesh for MATUS. APACHE (ref 2) can be used to generate the temperature distributions and, also, to calculate nodal point values of stress and strain. PLOTZ (Appendix D of ref 1) can be used to generate deformed geometry plots and temperature, stress, and strain contour plots. PRINS (Appendix E of ref 1) can be used to compute principal stresses and strains at the centers of the MATUS elements. MATUS uses the Battis Environmental Routines (NESC Abstract 479).
9. STATUS - Abstract first distributed December 1973
CDC6600,7600 versions submitted May 1973
10. REFERENCES - D. N. Hutula and B. E. Wiancko, MATUS, A Three-dimensional Finite Element Program For Small-strain Elastic Analysis, WAPD-TM-1081, March 1973.
D. N. Hutula, B. E. Wiancko, and S. M. Zeiler, APACHE, A Three-dimensional Finite Element Program for Steady-state or Transient Heat Conduction Analysis, WAPD-TM-1080, March 1973.
D. N. Hutula and S. M. Zeiler, MESH3D, A Three-dimensional Finite Element Mesh Generator Program for Eight-Node Isoparametric Elements, WAPD-TM-1079, March 1973.
C. J. Pfeifer, CDC-6600 FORTRAN Programming - Battis Environmental Report, WAPD-TM-668, January 1967.
ACC No. R597 MATUS, Argonne Code Center Programming Note 74-1, July 1973.

ACC No R597 MATUS, Argonne Code Center Programming Note 74-10, November 1973

11. **MACHINE REQUIREMENTS** - The program was written for a CDC6600 or a CDC7600 with a central memory size of 64K and an extended core size of 512K. The actual amount of central memory and extended core used by the program depends on the problem size. The program requires a card reader, a line printer, a system disk, and 2 scratch disks. Also, a driver that allows writing-in-place is required for the 2 scratch disks.
12. **PROGRAMMING LANGUAGES USED** - FORTRAN IV and COMPASS
13. **OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED** - A description of the software environment and the hardware usage assumed by the program is contained in reference 4. In particular, the program is designed to run under the SCOPE 3.1.5 operating system on the CDC6600 and under SCOPE 1.1 operating system on the CDC7600.
14. **OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS** - MATUS is organized for overlay loading, whereby central memory is occupied at any given time by the main overlay (root) and a single primary overlay. There are five primary overlays. The root contains many of the FCHIP routines (ref. 4), including NEXT, which loads each overlay as needed. The root declares a blank common array of length one. If there are m words from the start of blank common to the field length and n words of text in the longest overlay, the storage space actually available for problem data is $m-n$ words. These $m-n$ words of blank common are dynamically allocated to accommodate the arrays needed for a particular problem. Extended core storage, also dynamically allocated, is used to store material properly tables, some large arrays, and, most importantly, as much of the stiffness matrix as is possible.
APACHE and MESH3D are similarly organized.
In APACHE the TRIO routines (a scratch I/O system) contain calls to MLOAD, which calls a PP subroutine, DD7. These are calls to a disk driver, which could not be included with this transmission.
In MATUS there will be an unsatisfied external called STPLAN. This is not used, and all calls on this routine may be deleted.
15. **NAME AND ESTABLISHMENT OF AUTHORS** -
D. N. Hutula and B. E. Wiancko
Battis Atomic Power Laboratory
Westinghouse Electric Corporation
Box 78
West Mifflin, Pennsylvania 15122
16. **MATERIAL AVAILABLE** - Restricted Distribution
Magnetic Tape Transmittal (2 tapes)
Source decks (MATUS 10,916 cards, MESH3D 6778 cards, APACHE 8309 cards, PEDCOM 3356 cards, PLOTZ 2328 cards, PRINS 876 cards, 7600 ECSRW routine 274 cards, 6600 TRIO routines 1438 cards)
Sample problems (MESH3D and APACHE 685 cards, PEDCOM 204 cards)
Reference reports, WAPD-TM-1081, WAPD-TM-1080, WAPD-TM-1079, and ACC Notes
17. **CATEGORY** - I
KEYWORDS - three-dimensional, finite element method, thermal conduction, PEDCOM codes, MESH3D codes, APACHE codes, PLOTZ codes, PRINS codes
18. **SPONSOR** -

1. NAME OR DESIGNATION OF PROGRAM - PELEN
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - CDC6600
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - For the mathematical model, the history is subdivided into a set of time increments and the geometry is subdivided into an assemblage of finite elements such that each element is a ring with a triangular cross section. Each finite element has at most a linear distribution of temperature and displacement specified by the nodal values. The field equations with the nodal values as unknowns are derived by variational principles for heat conduction and stress analyses. The solution is obtained by matrix inversion techniques.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Maxima of -
25 history intervals as input, where each interval can have
an arbitrary number of subdivisions
200 finite elements
6. TYPICAL RUNNING TIME - Running time depends on the complexities of the history input and number of finite elements. Approximately 2.5 seconds of computation time per time increment are required for 18 finite elements.
7. UNUSUAL FEATURES OF THE PROGRAM - PELEN has a minimum of geometry input data to generate the finite elements. It internally updates the geometrical configuration to include dimensional changes from the reference configurations.
8. RELATED AND AUXILIARY PROGRAMS - INPF, the Bettis input data package is part of the Bettis Environmental Routines (NESC Abstract 478). ECSFIL, the Bettis extended core storage file package is described in reference 2.
9. STATUS - Abstract first distributed December 1973
CDC6600 version submitted September 1973
10. REFERENCES - R. B. Stout, E. Duncombe, and J. K. Fischer, PELEN - A Computer Program to Analyze Axial and Radial Variations of Temperature and Deformation in Zircaloy-Clad Oxide Fuel Rods, WAPD-TM-1001(L), December 1971.
C. J. Plesler, CDC-6600 FORTRAN Programming - Bettis Environmental Report, WAPD-TM-668, January 1967.
J. J. Urbanik, ARF Description, September 1969.
11. MACHINE REQUIREMENTS - 140,000 octal words of core storage, a printer, and extended core storage units.
12. PROGRAMMING LANGUAGE USED - FORTRAN IV
13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED -
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHORS -

R. B. Stout, E. Duncombe, and J. K. Fischer
 Bellis Atomic Power Laboratory
 Westinghouse Electric Corporation
 Box 79
 West Millin, Pennsylvania 15122

16. MATERIAL AVAILABLE - Restricted Distribution

Magnetic Tape Transmittal
 Source deck (6086 cards)
 Sample problem (45 cards)
 Reference report, WAPD-TM-1001(L), and ARF Description

17. CATEGORY - I

KEYWORDS - two-dimensional, temperature, stresses, deformation, thermal conduction, finite element method

18. SPONSOR -

1. NAME OR DESIGNATION OF PROGRAM - TOPLYR2
2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE - UNIVAC1108
3. DESCRIPTION OF PROBLEM OR FUNCTION - 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.
4. METHOD OF SOLUTION - TOPLYR2 divides the water mass into an array of rectangular prisms of non-uniform depth where vertically averaged quantities are employed. The mathematical model employs an energy balance of temporal, convective, diffusional and source terms and a mass balance. The equations are transformed to a second-order finite-difference form and an alternating direction implicit scheme is used to compute the temperature field. The two-dimensional tridiagonal arrays produced by the ADI method are solved by Gaussian elimination. Provisions have been included in the program to accommodate non-uniform diffusivity. The energy source results from weather conditions and Newton's cooling law boundary conditions.
5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Subscripted variables are dimensioned at compilation time using the UNIVAC1108 procedure definition processor. Code instructions require relatively little storage. A typical river simulation problem with adequate geometric-time mesh involves about 10,000 decimal words of storage (instructions, blank common and data).
6. TYPICAL RUNNING TIME - For a typical 17 x 10 node spatial grid and 200 time-steps, 1 to 3 minutes are required depending upon problem complexity.
7. UNUSUAL FEATURES OF THE PROGRAM - To eliminate the possibility of any non-physically plausible temperature form entering into the analysis a scheme proposed by Hains is employed. The use of the Hains principle assures that the second law of thermodynamics is not violated. A default algorithm assigns a uniform diffusion coefficient to the flow field. Local depth and velocity are available for the user to construct a non-uniform diffusion coefficient matrix. Currently, an algorithm based on one-dimensional frictional flow is provided.
8. RELATED AND AUXILIARY PROGRAMS -
9. STATUS - Abstract first distributed December 1973
UNIVAC1108 version submitted June 1973
10. REFERENCES - D. C. Kolesar, J. C. Sonnichsen, TOPLYR2 - A Two-dimensional Thermal-Energy Transport Code, HEDL-TME-72-46, March 1972.
D. C. Kolesar, Mathematical Modeling of Thermal Plume Dispersion in a Receiving Water Body, presented at the Second Annual Thermal Power Conference, Washington State University, Pullman, Washington, October 1971.
A. J. Policastro, J. V. Tokar, Heated-Effluent Dispersion in Large Lakes, State-of-the-Art of Analytical Modeling ANL/ES-11 (1972) Part 1, Critique of Model Formulations, 1972.
TOPLYR2, ACC No. 599, HEDL Note, 1973.
11. MACHINE REQUIREMENTS -
12. PROGRAMMING LANGUAGE USED - FORTRAN V

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - EXEC2 or CSCX
14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS - Two versions of TOPLYR2 are available - one employs a constant diffusivity and the other a local depth and velocity dependent diffusivity. The latter version implements the empirical correlation.
16. NAME AND ESTABLISHMENT OF AUTHORS -
D. C. Kolesar and J. C. Sonnichsen
Hanford Engineering Development Laboratory
Westinghouse Hanford Company
P. O. Box 1970
Richland, Washington 99352
18. MATERIAL AVAILABLE - Magnetic Tape Transmittal
Source deck (1998 cards)
Sample problem (61 cards)
Reference report, HEDL-TME-72-46, and HEDL Note
17. CATEGORY - R
KEYWORDS - thermodynamics, water, velocity, temperature distribution, two-dimensional, mass balance, simulation
18. SPONSOR -