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Useful to Reactor Control System Engineering

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A Bibliographic File of Technical Report Abstracts
Useful to Reactor Control System Engineering

Revision No. 2, March 1, 1958

Francis P. Green

Information regarding all aspects of reactor control system engineering has not been readily available to technical personnel. As a result careful searches seldom have been made of project literature to determine previous work accomplished. This has led to much duplication of development effort. Often extensive effort has been required to locate details of existing reactor systems. The Reactor Controls Department has a responsibility for having accessible background data and references for any future Reactor Handbook writing commitments.

It is for the reasons just stated that the Department has compiled a punched-card abstract file of all pertinent classified and declassified technical reports primarily for the in situ use of the Department and AEC contract personnel. In addition to its primary function, under the time and personnel limitations of the Reactor Controls Department, a number of requests for report numbers can be handled upon receipt of specific subject code or category inquiries. Please bear in mind that the cataloguing limitations of any abstract apply to this file; it cannot replace the handbook for which it can act as reference.

Report abstracts from more than 40 AEC and foreign facilities, AEC contractors, and technical periodicals are represented, published throughout the years 1941 to 1958. Cards for current publications are placed in the file no later than six weeks after the abstracts appear in the Abstracts of Classified Reports.

The subject matter in the file is arranged in three principle divisions. The first division is entitled Reactor Control Philosophy. The treatises on general aspects of control philosophy as well as specific ones are included. Such subjects as safety criteria, reactor operation, reactor kinetics, power conversion systems, general reactor design parameters, and reactor maintenance are specific subtitles. The second division is simply labeled Reactor Types. The reports on all specific reactors conceived, whether built or abandoned, are located here. Subtitles in this division are categorized by several systems of reactor delineation such as primary purpose, homogeneity, sub-criticality, energy level, fuel, and description by locale. The third division includes an arbitrary grouping of the principle building blocks of the feed-back control loop; the reactor lattice Control Elements (rods, fluid levels and concentrations, curtains or cylinders, gaps, and dumps), the Control Actuators (motor drives, pumps, latches, relays, and experiment actuators), the Control Computers (block diagrams, transfer functions, servomechanisms, and simulators), and the sensory Instruments (radiation, process, and research experiment measurement).

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The Punched-card System

The use of punched-cards for tabulation of abstracts of both classified and declassified reports permits a drastic reduction in the search time for engineering information. This file, now containing over 3000 entries, is sufficiently complete and up-to-date to be consulted efficiently and is available for use in the Reactor Control Department offices at Oak Ridge National Laboratory by security-cleared personnel.

As with any system, a punched-card file has particular characteristics with which the user must become familiar, including the development of simple manual dexterity to make an efficient needle sort of the file cards. The indexes (Appendixes 2 and 3) to the subject code are compiled in categorical and alphabetical forms to permit two approaches to finding the code number. The alphabetical arrangement resolves the problem of synonyms. An index (Appendix 4) is also supplied to indicate the source of publication code.

Although this publication is marked "Unclassified" the cards will be classified in agreement with the documents being abstracted. In addition to the use of this code in a punched-card abstract program, it is hoped that it will supply individuals who wish to maintain a private file with an index more suitable to project literature.

A fundamental advantage of a punched-card is its ability to handle a number of index headings, rather than a separate card for publisher, each subject, publication date, and for any other desired aspect of a literature reference. Generally, one card is used to record each report. Another advantage accrues from the fact that the desired reference can be selected no matter how the cards are shuffled.

The punched-card adopted for this classification is the 5" by 8" McBee Keysort card using a single row of holes punched on all four edges of the card. (Refer to illustration). Indexing the appropriate combination of holes is done by clipping out the portion of the card between the hole and the margin, using a hand punch. Entries can be removed from the file by a mechanical operation using a sorting needle (Refer to Appendix 1). For example, when the sorting needle is inserted into hole #7 of a pack of cards, and the cards are separated and lifted out, the cards containing a notched hole #7 will drop. These cards that drop contain all of those being sought. The upper right corner of the card is cut off diagonally as an aid in keeping the cards right side up when needling. If the cards become turned, needling the upper right-hand hole will remove those requiring inversion. All declassified and unclassified reports can be selected from the file by needling the special hole indicated on the illustration, marked "Unclassified". To sequence a group of cards in any one index, needle from the right to left, and place dropped cards in front of the stack following each operation.

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Card selection is made by an interrelation of ideas rather than by searching for a series of single subject headings in turn. Several indexes are incorporated on a single card by allotting the upper edge to two indexes, one to the Source of Publication, and the other to the Year of Publication, and the bottom and left edges to the Subject. Two subject code groups are often punched on one card from the Subject index, thereby permitting, in some cases, a "false drop" (a card appearing with irrelevant information). The right-hand edge is reserved for any future index that might be desired.

In sorting, it is advisable to start with the criterion which will bring out the smallest number of cards in the first sort. The use of the basic premise that the recovery of information need not be complete and exclusive of all other information permits a considerable expansion in the information a given code system can supply. The searcher's needs are served if it recovers all the information he desires and excludes most of the other information in the file. Thus, if in a search of a 3000-card file he gets 100 cards of which 75 are wanted, or gets 10 cards of which 5 are wanted, it is not burdensome to select the 25, or 5, "false-drops", (irrelevant cards) for removal to the discard pile during evaluation.

Acquisition of a "Keysort Selector" now makes possible a factor of about six increase in sorting speed. One entire edge of the card can be searched simultaneously. This device permits extracting all cards containing one code number from the file in less than 10 minutes. A literature search for material specified by a half-dozen code numbers can be made, and a typewritten list of report numbers (and titles, in some cases) can be produced, all within one work-day.

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Appendix 1

HAND-SORTING TECHNIQUE

1. Remove from file group of cards 2" or less in thickness.
2. Needle hole desired, inserting needle to point no farther than 1" from handle.
3. Keep needle horizontal at all times.
4. Supporting cards loosely in left hand, rotate needle clockwise to "cramp" cards diagonally along needle.
5. Fan cards by pinching cards with left hand while rotating needle back to original position.
6. Release left hand and give cards several slight downward jerks with both hands.
7. Do not grasp falling cards tightly; hold left-hand in form of "U" to prevent cards from falling to front or rear.
8. If position to be sorted is near the left edge, rotate the handle downward to "cramp" cards instead of clockwise, and pinch at bottom. Other steps are the same.

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Appendix 2

CATEGORICAL SUBJECT INDEX

Revised to: March 1, 1958

Arranged in six principle categories:

1. Control Philosophy
2. Reactor Types
3. Control Elements
4. Control Actuators
5. Control Computers
6. Instruments

Abstract File Code

CONTROL PHILOSOPHY

1-8-17	General Philosophy of Reactor Control
1-8-18	Reactor Properties (Reactivity; Multiplication Factor)
1-8-19	Component Properties
1-8-20	Human Properties (Sensor and Motor Limitations)
1-9-17	Safety (Calculated Risk; Hazards; Limit Control)
1-9-18	Component Reliability (Power; Control; Safety circuit; Fuses)
1-9-19	Reactor Reliability (Lattice; Container)
1-9-20	Human Reliability (Senses; Operating Accidents)
1-9-21	Natural Disturbances (Lightning; Earthquakes)
1-10-17	Kinetics (Dynamics; Operation)
1-10-18	Start-up (Critical Experiment; Loading)
1-10-19	Fixed Level (Drift)
1-10-20	Change of Level (Poisoning; Boiling; Oscillation; Decomposition)
1-10-21	Shut-down (Scram)
1-11-17	Power Conversion Systems (Heat Transfer)
1-11-18	Heat Exchangers (Cooling Systems; Pressurizers)
1-11-19	Turbines (Rockets)
1-11-20	Ionizing Radiation-to-Electrical Conversion
1-11-21	Mass Transfer (Inhibitors)
1-12-17	Design Criteria
1-12-18	Total k_{eff} (Reactivity Coefficients, Danger Coefficient, Turning-Loss; Xe Override)
1-12-19	Elements controlled (Source, Fuel, Moderator, Absorber, Shadow Effect, Control Channel Selection; Seeding)
1-12-20	Consoles (Control Boards, Procedure Panel)
1-12-21	Economics

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Categorical Subject Index (Continued)

1-13-17 Maintenance
 1-13-18 Direct
 1-13-19 Remote (Manipulators)

REACTOR TYPES (Includes Progress Reports)

2-8-17 General Reactor Description based on Function
 2-8-18 Radio-isotope; Research
 2-8-18-29 Argonne Natl. Lab. (CP-2, CP-3', CP-5 or ARR, CP-6)
 2-8-18-30 Brookhaven Natl. Lab. (BNL-1, LMFR, BMR)
 2-8-18-31 Chalk River (NRU, NRX, NPD)
 2-8-18-32 European (GLEEP, ZOE, E.443, DIDO, BR-1, Downreay Fast)
 2-8-18-33 NRTS, Idaho (MTR, Borax-1, -2, -3, ETR)
 2-8-18-34 Los Alamos (LOPO, HYPO, SUPO (Water Boilers), Godiva,
 Clementine (LA Fast Reactors, JEZEBEL, POPSY)
 2-8-18-35 Los Angeles (WBNS, SGR, NPR, PPPE, NETC, LPR, PuP#30c)
 2-8-18-36 Oak Ridge Natl. Lab. (X, ORR)
 2-8-18-37 Other Sites (TTR, NRL Res., NTR, RIR, WTR, RER)
 2-8-19 Training
 2-8-19-29 National Laboratories (LITR, GCR or Aquarium)
 2-8-19-30 Universities
 2-8-19-31 Industrial (HEW-305, Pilito)
 2-8-20 Motive Power Production
 2-8-20-29 Land Application
 2-8-20-30 Naval, Military, Surface (CVR, LSR, or AlW, FER, D1G,
 A2W, F1W)
 2-8-20-31 Naval, Military, Submarine (STR-I or S1W, STR-II or S2W,
 SIR-A or S1G, SIR-B or S2G, S3W, S4W, SAR, SFR, or
 S3G, S4G, S5W, S1C)
 2-8-20-32 Naval, Commercial, Surface
 2-8-20-33 Aircraft, Manned (NJ-1, 2)
 2-8-20-34 Aircraft, Remote Controlled (Nuclear Rockets, Pluto)
 2-8-21 Systems Research
 2-8-21-29 Aqueous-cooled (Daniels, HRE, ISHR, BER, LAPRE-1, -2, EBWR,
 ALPR, BLWR, HARE)
 2-8-21-30 Gas-cooled (CP-7, HTRE, TRA-2, R-1, AC-100-A, AC-107, AC-110,
 XMA-1, LMF-GCR)
 2-8-21-31 Liquid-metal-cooled (ANP, ARE, ART, CFRE or Fireball, CCR,
 CANEL, PWAR-3)
 2-8-21-32 Organic fluid-cooled (SCWR, OMRE, NROE)
 2-8-22 Shielding Research
 2-8-22-29 Stationary (BSF, GTR, Watertown RR)
 2-8-22-30 Mobile (TSR, ASTR)
 2-8-23 Breeders (EBR or CP-4, KAPL, TBR, PBR, FBR)
 2-8-24 Converters (Hanford, Savannah River, UPR, PURR)
 2-8-25 Electric Power Production
 2-8-25-29 Multi-purpose (Heat or intermittent elec. tie-in)
 (LEO, HRT or HRE-2, SRE)
 2-8-25-30 Transportable (Package, APPR-1)
 2-8-25-31 Utility (PWR, PIPPA, Calder Hall)

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Categorical Subject Index (Continued)

2-9-17	Heterogeneous
2-10-17	Homogeneous (Slurry)
2-10-18	Circulating Fuel (Aqueous; Liquid Salts or Metals)
2-10-19	Circulating Moderator (Reflector)
2-10-20	Static Fuel and Moderator (ANP)
2-11-17	Sub-critical Assemblies (Exponential, Sigma Pile, Standard Piles)
2-11-18	Zero Power Piles (ZEEP, ZPR, R-1 Mockup, Model T, PPA, SAPL) Zephyr, SMR, PTR, PDP, LTR, ZEUS, DIMPLE)
2-11-19	Kinetics Test (SPERT-I, -II, -III, KEWB)
2-12-17	Description by Locale
2-12-18	U. S. Research (ANL, BNL, ORNL, etc.)
2-12-19	U. S. Production (Han., Aiken, etc.)
2-12-20	Canadian, other N. American
2-12-21	European (G-1)
2-12-22	Asian (U.S.S.R.)
2-12-23	Southern Hemisphere
2-13-17	Energy Level
2-13-18	Thermal (Cavity reactor)
2-13-19	Epithermal
2-13-20	Fast
2-14-17	Fuel
2-14-18	Natural U (Includes D ₂ O-Reactors)
2-14-19	Enriched U
2-14-20	Uranium 25, Pu 49
2-14-21	Thorium, U-23
2-14-22	Fusion (Enhanced Fission)
CONTROL ELEMENTS	
3-8-17	General Properties of Control Elements
3-8-18	Reactivity (Range, Temperature Coefficient, Fineness, Calibration, Barometric Coefficient)
3-8-19	Stability (Heat, Mechanical, Chemical, Radiation)
3-9-17	Rods (Control)
3-9-18	Shim
3-9-19	Safety (Plates)
3-9-20	Regulating
3-9-21	Liquid
3-10-17	Fluid Moderators (Reflectors)
3-10-18	Reflector Level
3-10-19	Safety Solutions
3-10-20	Burnout Poisons

Categorical Subject Index (Continued)

3-11-17 Fluid Fuels (Enrichment)
3-11-18 Metal Alloys and Salts
3-11-19 Aqueous Solutions

3-12-17 Curtains (Blankets)
3-12-18 Tapes
3-12-19 Drums (Cylinders)

3-13-17 Gaps

3-14-17 Other (Gas Concentration, Dumps)

CONTROL ACTUATORS (MECHANISMS)

4-8-17 General Selection Criteria

4-9-17 Motors (Drives)
4-9-18 Electric
4-9-19 Hydraulic
4-9-20 Pneumatic

4-10-17 Pumps (Blowers)
4-10-18 Level Control
4-10-19 Liquid Metals and Salts
4-10-20 Slurry

4-11-17 Latches (Energy-Storage Elements)
4-11-18 Electromagnetic
4-11-19 Mechanical

4-12-17 Research Experiment Actuators
4-12-18 Pneumatic
4-12-19 Hydraulic

4-13-17 Relays (Ratio)

CONTROL COMPUTERS

5-8-17 General Control System Principles
5-8-18 Control Schemes (Block Diagrams)
5-8-19 Differential Equations (General Transfer Functions;
Digital Computations)
5-8-20 Elec. Circuit Analogs (Heat Transfer, Transport Lag)

5-9-17 Servomechanisms
5-9-18 On-Off (Velocity, Position, Interlock)
5-9-19 Proportional (Velocity, Position, D.C., A.C.)
5-9-20 Tachometers
5-9-21 Position Indicators
5-9-22 Amplidynes
5-9-23 D.C. Amplifiers

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Categorical Subject Index (Continued)

5-10-17 Simulation (Electrical Analog)
5-10-18 (Heat Analog)

INSTRUMENTS (SENSORS)

6-8-17 General Instrument Test Equipment and Montage
6-8-18 Component Test, Mechanical (Latch)
6-8-19 Component Test, Electrical (Cables, Calibration)
6-8-20 System Test (Actuators, Radiation Tests)
6-8-21 Instrument Shields (Control Plugs)
6-9-17 Neutron Measurement
6-9-18 Source (Counters, Count Rate, Monitors, Fission Chambers,
 Scintillation Counters)
6-9-19 Delayed (Photo)
6-9-20 Level (Ion Chambers, Foil Detectors (In and Dy, N¹⁶-γ)
6-9-21 Logarithmic Devices (Period)
6-9-22 Thermopiles (Bolometers)
6-9-23 Photronic Cells (Scintillations Xtals.)

6-10-17 Gamma, Beta
6-10-18 Level (Compensated Chambers, Delayed)
6-10-19 Monitors
6-10-20 Cherenkov Detectors (Scintillation Spectrom); Beta Counters

6-11-17 Process (Coolant Systems)
6-11-18 Temperature, Pressure (Head), and Flow Rate, Level, Strain
6-11-19 Power Measurement
6-11-20 Density (Concentration, pH, Conductivity)
6-11-21 Isotope Build-up

6-12-17 Research Experiment (In-Pile, In-reactor)
6-12-18 Pile Oscillators (Modulators)
6-12-19 Reactivity (RMF-MTR) (Pilot Channel, Irradiation Facilities)
6-12-20 Component Properties Measurement (In-pile Loops)

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DOCUMENT PUBLICATION SOURCES

Report Number Code	Organization	Source File Code
AECD, AECU	Atomic Energy Commission	AE
AERE	Atomic Energy Research Establishment	AR
ANL	Argonne National Laboratory	AN
ANP	Aircraft Nuclear Propulsion Project	OR
APEX	General Electric Company	GE
	Atomics	AT
BMI	Battelle Memorial Institute	BM
BNL	Brookhaven National Laboratory	BN
C(), CO	Chicago Operations Office	CH
CF	Central Files, Oak Ridge National Lab.	OR
CNL, CL	Clinton (OR) National Laboratory	OR
CR()	Chalk River, Canada	CR
CU	Columbia University	MC
CVAC	Consolidated-Vultee Aircraft Corp.	CO
DC	General Electric Company	GE
DP	Dupont Corp.	DP
GEL	General Electric Company	GE
HW	Hanford Works	HW
IDO	Idaho Operations Office (Phillips)	ID
	Journal of Applied Physics	JP
	Journal de Physique et le Radium	JR
K	K-25	OR
KAPL	Knolls Atomic Power Laboratory	KA
KLX	Kellex Corporation	KL
LA, LAMS	Los Alamos	LA
Lex P, LP	Lexington Project (NEPA)	NE
LRL	Livermore Research Laboratory, California Research and Devel.	LI
M;A,B,BR,N	Miscellaneous AEC Contractors	MC
MUC,NP,NYO,TID		
MDDC,MDDU	Manhattan District	MD
MLM	Mound Laboratory	ML
Mon()	Monsanto Chemical Corp., O.R.	MO
N	Oak Ridge National Laboratory or Miscellaneous	OR MC
NACA	National Advisory Committee on Aeronautics	NC
NAA	North American Aviation	NO
NBS	National Bureau of Standards	NS
NEPA	Nuclear Energy for Propulsion of Aircraft, Fairchild Engine and Airplane Corp.	NE

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<u>Report Number</u> <u>Code</u>	<u>Organization</u>	<u>Source File</u> <u>Code</u>
	Nucleonics	NU
NYO	New York Operations Office, AEC	AE
ORNL, ORO	Oak Ridge National Laboratory	OR
	Physical Review	PR
PR	Chalk River, Canada	CR
	Proceedings of the Inst. of Electrical Engrs.	IE
PWAC	Pratt and Whitney Aircraft Corp.	PW
R	General Electric Company	GE
	Review of Scientific Instruments	RS
RH	Atomic Energy Commission	AE
Tec(), TPI	Chalk River, Canada	CR
TID	Technical Information Division, AEC	AE,AN,BN, LA,OR,WA
UCLA,UCRL	University of California, Radiation Laboratory	MC
WAPD	Westinghouse, Atomic Power Division	WA
WASH	AEC, Washington	AE
Y	Y-12	OR

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