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THE RADIATION SHIELDING INFORMATION CENTER
COMPUTER CODES COLLECTION
1963 - 1967

Betty F. Maskewitz and D. K. Trubey

The Computer Codes Section of the Radiation Shielding Information Center was formed in 1963 to provide computer tools directly to the individual scientist or engineer who performs radiation transport calculations. The code collection has now grown to 85 large computer code packages (listed in an appendix), and shipments to code users are averaging 1.3 code packages per working day. Other information services connected with computer codes are performed at the rate of almost three per day. Since most persons in need of RSIC services are engaged in government-connected work, the Center is funded by the U. S. Atomic Energy Commission, the Defense Atomic Support Agency, and the National Aeronautics and Space Administration. An analysis of the acquisitions and services of the Codes Section shows that the universities and foreign scientists also participate substantially in the information exchange.

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The activities described in this report are made possible by the cooperation of many people. We are grateful to the code contributors, without whom there would be no computer codes collection; to the report authors, who try to put into words all the information necessary to the understanding and successful use of a complicated tool; to the USAEC, to NASA, and to DASA, who provide financial support in the RSIC program.

It is a pleasure to acknowledge the support of other members of the RSIC staff. Mrs. Mildred Landay is responsible for the records of the RSIC Codes Section and supplied the statistics used in the report. Mrs. Vivian Jacobs processes requests directed to the Codes Section and sees that they are filled. Mrs. Hemma Francis, Mrs. Henrietta Hendrickson, and Miss Juanita Brown service the collection in all phases of checkout, packaging, and shipping.

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INTRODUCTION AND HISTORY

In the fall of 1962 the Radiation Shielding Information Center (RSIC) was established at the Oak Ridge National Laboratory to assist engineers and scientists in solving radiation transport problems. Originally funded only by the U. S. Atomic Energy Commission for reactor shielding, the scope of the Center has been enlarged to include accelerator shielding, shielding from nuclear weapons radiation (supported by the Defense Atomic Support Agency), and shielding from radiation encountered in space (supported by the National Aeronautics and Space Administration).

An important integral operation of the Center, begun early in 1963, is the collection, evaluation, and dissemination of digital computer codes. The shielding scientist necessarily makes use of large computers in solving problems of radiation transport in the design of shields. Before 1963, however, he had little experience in organized sharing of his code development efforts comparable to that of the reactor specialist who had such experience starting about 1956. Each shielding group developed its library of programs independently, causing duplication of effort. Since many of these codes represent a development investment of the order of \$100,000, duplication costs were considerable. But by creating a favorable climate for the exchange of computer codes, and an agency to accomplish this, it was apparent that a substantial amount of time and effort could be saved.

The RSIC computer codes collection began in early 1963 with the acquisition of three reels of magnetic tape on which were codes contributed by Nuclear Aerospace Research Facility (NARF), General Dynamics, Fort Worth, Texas, and United Nuclear Corporation, White Plains, New York. By July 1964, 22 code packages had been collected by the Center; 20 code packages had been shipped to requesters, 25 documents had been mailed, and 127 requests had been filled for miscellaneous services. Other activities of the staff included defining the scope of the work to be undertaken, searching the literature for codes of interest, building the library of documents describing computer codes, seeking out codes under development, and persuading installations to contribute their shielding codes to the collection.

STAFF

The RSIC Codes Section staff consists of four full-time employees, who are concerned with programming and with the hardware and software of computers, and three part-time employees, who do information processing. This staff works closely with several RSIC and other ORNL physicists and nuclear engineers who act in an advisory capacity.

SCOPE AND OPERATIONS

The scope of the RSIC Codes Section includes:

1. collecting computer codes and codes literature related to shielding against the radiations from reactors, accelerators, and nuclear weapons, and also the radiations in space;
2. checking out and making operable locally the above codes and running sample problems;
3. packaging the codes into comprehensive units;
4. writing and publishing abstracts of the code packages;
5. publishing information about the codes in the RSIC newsletter and in national journals;
6. publishing bibliographies of the selected codes literature;
7. filling requests for code packages;
8. answering inquiries about the codes literature, the codes, methods of calculations, etc.;
9. recommending codes for specific problems;
10. initiating and encouraging periodic participation in the Codes Section work by members of the shielding community;
11. holding seminar-workshops on calculational methods and computer codes when deemed advisable;
12. exchanging codes and cooperating in many other ways with other code centers, both domestic and international;
13. providing leadership in the development of standards and practices (documentation and programming) that will facilitate the exchange of computer codes; and
14. maintaining records and issuing reports of the activities of the Codes Section.

The term "code package" was coined by RSIC to describe a comprehensive collection of documents and computer material which enables the user to solve particular problems with a digital computer. In general, an RSIC "code package" consists of: (a) written material - reports, instructions, data sheets, listings of data and any other useful material; (b) computer materials - IBM card decks, or, more often, a reel of magnetic tape on which are written images of the IBM card decks containing the program (source and binary), sample problem input, libraries of data, and the BCD output from the sample problem. Not only is the main code included in the package, but also any auxiliary routine which has been made available.

When a code is to be placed in the RSIC collection, the contributor is asked to designate an individual who is familiar with the programming, operation, and data preparation to answer questions. If the code is very complex, or if several codes are being placed in the collection at a given time, RSIC requests that a briefing be given to members of the staff. This is best done when in the form of an informal workshop held at the contributing installation.

When codes are received, they are put into the RSIC routine checking process. After a code or a group of codes, has been fully processed, it is packaged, assigned a CCC number, and provided with an abstract.

The RSIC collection may include computer codes which, for various reasons, have restricted distribution. The restriction is explained in the published abstract and the code package is handled in whatever manner required.

The concept of the "live" code package is basic to the RSIC philosophy of serving the shielding community. When a code is packaged, lines of communication are kept open with the contributor and with users. Proposed corrections by users, after being verified by the original contributor, and additions and modifications are made to the code package as long as the program is of interest.

PUBLICATIONS

The RSIC Code Section has made use of several means of communicating information about the codes collection. The RSIC Newsletter regularly carries items concerning activities of the staff, corrections and modifications to existing code packages, new codes packaged, and accession lists of literature describing codes. The Newsletter is distributed to more than 800 subscribers.

A loose-leaf notebook¹ of abstracts of code packages assembled by RSIC was issued in 1965. Additions are made to the notebook as new abstracts are written. The notebooks have been issued to more than 500 interested individuals.

The collection of literature on shielding codes is a continuing activity. A bibliography of this literature² was issued in October 1966 to more than 500 people. An updated version³ of 700 entries is in press.

An article dealing with the codes collection was published in Nucleonics⁴ and from time to time information about the collection appears in Nuclear News. Members of the RSIC staff have been invited to speak at several universities and meetings.⁵

¹Betty F. Maskewitz, Abstracts of Digital Computer Code Packages Assembled by the Radiation Shielding Information Center, ORNL-RSIC-13 (1965).

²Betty F. Maskewitz, Betty L. McGill, and Jane Gurney, Bibliography of the Computer Codes Literature Examined by the Radiation Shielding Information Center, ORNL-RSIC-15 (1966).

³Betty F. Maskewitz, Vivian A. Jacobs, and Jane Gurney, Bibliography of the Computer Codes Literature Examined by the Radiation Shielding Information Center, ORNL-RSIC-15 (Rev.) (1967).

⁴D. K. Trubey, B. F. Maskewitz, and S. K. Penny, "Computer Codes for Shielding Calculations," Nucleonics, 24(8), 112-115 (August 1966).

⁵Proceedings of the Conference on the Application of Computing Methods to Reactor Problems, May 17-19, 1965, ANL-7050, pp. 133-137.

THE CODE COLLECTION

The computer codes collection continues to grow. As of July 1, 1967, 85 code packages had been assembled and made ready for distribution, with approximately 12 additional shielding codes in various stages of checkout and packaging. Members of the staff continue to seek out codes in the development stage and encourage new code development when there is a recognized need. Recipients of RSIC services have been pleased and we now find that contributions to the code collection are voluntarily made as compared to the hesitation observed at the beginning. Inclusion of a code in the RSIC computer code collection calls attention to the special knowledge of a specific shielding group and is becoming recognized as an asset.

INTERACTION WITH USERS

Requests to the RSIC Codes Section may come in a variety of forms but, in general, fall into the following pattern. A telephone call or a letter asks for information about available codes for use in solving a specific problem. In response, information about several codes may be sent to the requester and questions may be asked of him to further ascertain his needs. A second call or letter from the requester supplies additional information, and perhaps makes a more specific request. A recommendation is then made to him and a code package is shipped. Members of the RSIC staff "stand by" to "trouble-shoot" or advise as the requester is in the process of running the program on his computer.

Many variations to the above pattern are made. In some cases, the requester cannot run any available code on his computer and must develop his own. Occasionally, he comes to the Center to learn to use the codes he has requested. Many requests are for advice in connection with doing shielding calculations. Other special services include effecting the transition from one computer monitor system to another very different monitor system.

ANALYSIS OF ACTIVITIES

In the section which follows, numerical information is given which summarizes the activities of the Codes Section. The items tabulated are:

- number of code packages shipped,
- number of packages of information about codes shipped, and
- number of times members of the staff perform research for information or use a computer to get information to fill a request.

Services to the shielding community given by the RSIC Codes Section since its inception are detailed by chart in Fig. 1. Annual growth can be seen in Table 1 which shows the number of codes packaged and number of services performed per working day averaged over a fiscal year. The growth of the collection is also shown.

Table 1
Growth of Services by Year

Services Rendered by Codes Section	Fiscal Year			
	1964	1965	1966	1967
Number of code packages shipped per day	.08	.38	.96	1.26
Answers mailed to questions about specific codes per day	.10	.42	1.14	1.74
Miscellaneous services performed in connection with shielding calculations per day	.49	.70	.74	1.03
Number of Code Packages in the Collection as of the End of Each Fiscal Year	22	36	70	85

An Analysis of Those Served

Most of the codes in the depository (83.6 per cent) were contributed by domestic installations (Fig. 2). Foreign contributors, through an agreement between the United States Atomic Energy Commission and the European Nuclear Energy Agency (ENEA), accounted for the remaining. Services given by RSIC to the international shielding community were as follows: code packages disseminated - 87.5 per cent to domestic users; 12.5 per cent to foreign users. Other RSIC Code Section services were in the same proportion. It is interesting to note that foreign contributions exceed requests from RSIC.

Foreign Requests

An analysis of foreign requesters (Fig. 3) reveals the following. Of the total number of code packages requested, 52.2 per cent were shipped to governmental agencies, 14.5 per cent to technical universities, 5.8 per cent to private industry, and 27.5 per cent to the ENEA Computer Programme Library (ENEA CPL) at Ispra (Varese), Italy. At this time, RSIC records do not reflect requests filled by ENEA CPL. Since the USAEC-ENEA agreement was made in 1965, requests from the European shielding scientists are filled through ENEA CPL when feasible. Requests for information about shielding calculations and computer codes were filled as follows: 64.8 per cent for governmental agencies, 20.8 per cent for technical universities, 8.3 per cent for private industry, and 6.1 per cent for the ENEA CPL.

Domestic Requests

Within the United States an analysis of RSIC services renders the following information (Fig. 4). Code packages were distributed in the ratio: 86.5 per cent to governmental agencies or to private agencies for use on governmental contracts, 7.7 per cent to universities, and 5.8 per cent to private industry which had no obvious government contracts. Other RSIC services were analyzed as follows: 85.1 per cent to governmental agencies or contractors, 6.5 per cent to universities, and 8.4 per cent to private industry. The interest of universities in RSIC roles has increased considerably during the last fiscal year.

Fig. 1.
Chart, by Fiscal Year, of Number of Requests Filled
(RSIC Codes Section)

Fig. 2.
Source of Code Collection and Distribution
of Services (RSIC Codes Section)

Fig. 3.
Distribution of Services to Foreign Requestors
(RSIC Codes Section).

Fig. 4.
Distribution of Services to Domestic Installations
(RSIC Codes Section)

Governmental Agencies or Contractors

Figure 5 indicates the government agencies or contractors being served by the RSIC Codes Section. If all defense-connected requests are grouped,* they receive 48.3 per cent of all code packages shipped, and 45.6 per cent of other services; the AEC, 28.6 per cent and 29.4 per cent respectively; NASA, 22.6 per cent and 24.1 per cent; and OCD and TVA negligible amounts.

A percentage breakdown by government agency and contractors is shown in Fig. 6 and in Table 2.

Table 2
Distribution of RSIC Services to Government Agencies
and Contractors 1963-1967

Agency Served Directly or Through Contracts	Code Packages Shipped	Other Services Rendered
USAEC	28.6%	29.4%
NASA	22.6%	24.1%
US Air Force	23.3%	25.5%
US Army	10.3%	7.1%
US Navy	7.9%	8.0%
DASA (direct)	6.8%	5.0%
OCD	0.5%	0.8%
TVA	0.0%	0.1%

Description of "Other" RSIC Services

The "other services rendered" shown on the charts in this report represent the number of times a member of the staff fills a request by

*That is, requests from the military services, their contractors, or through DASA.

Fig. 5.

Distribution of Services to U.S. Government Agencies
Directly or Through Contractors

Fig. 6.

Distribution of Services to U.S. Government Agencies
Directly or Through Contractors (Defense Breakdown)

phone or by mailing out codes or information about codes. Often considerable time is spent in research in order to answer questions such as the following:

"Do you have a code we can use to solve the following problem?"

"X installation has sent us a proposal to do code development. Does a code already exist for calculations in this area?"

"Can you tell me where I can find data in the format required by this specific code?"

"I am trying to do a problem using this specific code and it is giving wrong answers. Will you look at my data?"

"I can't make the code package you sent to me work on my machine. Will you advise?"

"We think we want this specific code package but can't be sure. Will you send us more information?"

"May I come to visit and learn how to run this specific code?"

Workshops and Seminars

Members of the RSIC staff continue to seek new and more efficient ways to exchange information. The concentrated workshop, as a method of placing a computer code in the RSIC collection, has proved to be a practical and efficient one for transferring a great deal of information in a small amount of time. Members of the Codes Section staff were given a workshop-in-depth on a specific code at the originating installation on five different occasions during fiscal year 1966-1967.

The workshop concept has been extended, in several cases, to include a seminar for the purpose of evaluating and discussing the theory and application of the method inherent in a particular code in the collection.

In July 1965, a group of 80 people representing 45 domestic organizations and one foreign group attended the seminar-workshop, "O5R General Purpose Monte Carlo Neutron Transport Code System," held at ORNL. In April 1966, two members of the staff conducted a similar meeting for the European Nuclear Energy Agency Computer Programme Library at Ispra (Varese), Italy, with 36 people in attendance - 4 from the United Kingdom, 3 from Spain, 4 from France, 6 from Sweden, 7 from Germany, 5 from Italy, 2 from

Belgium, and 1 each from Switzerland, Japan, Denmark, Norway, and the Netherlands. In early May 1966, the Shielding Department, Centre D'Etudes Nucleaire (CEN), Fontenay-aux-roses, France, sponsored an all-French two-day seminar on "Monte Carlo Methods in Shielding" for the benefit of the visiting members of the RSIC staff and 33 participants from the CEN installations in France.

Fifty participants from 25 separate installations were in attendance at the "QAD, Kernel Integration Shielding Code" seminar-workshop, sponsored at ORNL by RSIC and presented by members of the N Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico, with the assistance of one member of the Shielding Group, NASA Lewis Research Center, Cleveland, Ohio. By enlarging the scope to include discussions of applications by other users of the code and of kernel integration as a method to design shields, much information was exchanged.

A seminar on "The Discrete Ordinates (S_N) Method for Radiation Transport Calculations," together with a workshop on the computer code ANISN was held in August 1967.

Cooperative Endeavors

RSIC staff members initiate, encourage, and assist in the development of standards and practices (documentation and programming) that will facilitate the exchange of computer codes. A member of the staff serves as an American Nuclear Society subcommittee whose purpose is to recommend practices in this area.

RSIC encourages periodic participation in its Codes Section work by interested members of the shielding community. This may be those who have an interest in a specific computer code which is not yet packaged and offer their services, or those who want to learn to use a code under supervision and contribute their services. Experience to date has demonstrated mutual profit from such cooperative effort.

With the encouragement of the USAEC, RSIC cooperates closely with the U. S. Code Center (USCC) at Argonne and ENEA Computer Programme Library (ENEA CPL) serving other OECD countries from Ispra, Italy. Nuclear codes, usually not applicable to shielding, are collected and disseminated

from Argonne in the U. S. A. In the event that a code is also packaged by Argonne and/or ENEA CPL, their abstract number is given in the RSIC abstract. Codes of interest are exchanged between the code centers and European requests for shielding codes are filled from the ENEA CPL. The cooperative agreement allows for personnel exchange, and a member of the ENEA CPL staff spent a month with RSIC in 1966. This cooperative agreement existing between the code centers was initiated so that the scientific community could be served more efficiently. It does not eliminate the need for open lines of communication between the individual shielding scientist and the information center.

With the growth in size and scope of the RSIC codes work, the need for efficient records systems became obvious. The time came when it was obvious that time of staff members must be allocated so that questions concerning statistics could be answered. Early this year, with the addition of a part-time staff member, an effort was initiated to fill this need.

SUMMARY AND CONCLUSIONS

The Computer Code Section, functioning as an integral part of the Radiation Shielding Information Center, provides an effective means of distributing previously developed calculational tools directly to the scientist and engineer. While not always in the exact form necessary to meet his needs, the available codes give him a starting point such that a relatively modest amount of additional development is required. Since each code represents a substantial investment of time and effort, large savings for the recipients are realized by avoiding duplication of effort. The practice of code exchange has now grown in the shielding field to the point where the initiation of large new systems is almost never required or undertaken.

The value of the Code Section, working closely with the technical personnel of the Center and the ORNL Neutron Physics Division, is clearly demonstrated when the recipients need technical advice. A code center, operating as a library, is not able to provide this information

service.. Consequently, it is our prediction that, in the future, there will be many information centers with an integral computer code collection.

The AEC information centers and many others are supported by the government on the premise that most of the clients are connected with government-supported work and function as part of a national information network. The analysis of RSIC services support this thesis with approximately 85 per cent of the service going to government connected installations. Service to universities is also substantial.

In summary, it is clear the activities connected with the computer codes collection result in substantial savings to the government. Although operating with the framework of an AEC laboratory, the Center also serves the shielding information needs of the Department of Defense and the National Aeronautics and Space Administration.

APPENDIX

LIST OF CODE PACKAGES, TITLES,
CONTRIBUTORS, AND PRIMARY REFERENCES

- CCC-1: 14-0 and 14-3
 KERNEL INTEGRATION CODE AND DATA CHECK - CALCULATED SOURCES DESCRIBED IN CYLINDRICAL COORDINATE SYSTEM, contributed by General Electric, Cincinnati, Nuclear Materials and Propulsion Operation.
 SAP-FAP, IBM 704 and 7090
 (Reference: XDC 59-2-16 and XDC 59-3-52)
- CCC-2: 14-1 and 14-3
 KERNEL INTEGRATION CODE AND DATA CHECK - INPUT SOURCES DESCRIBED IN CYLINDRICAL COORDINATE SYSTEM, contributed by General Electric, Cincinnati, Nuclear Materials and Propulsion Operation.
 SAP-FAP, IBM 704 and 7090
 (Reference: XDC 59-2-16 and XDC 59-3-52)
- CCC-3: 14-2 and 14-3
 KERNEL INTEGRATION CODE AND DATA CHECK - SOURCES DESCRIBED IN RECTANGULAR COORDINATE SYSTEM, contributed by General Electric, Cincinnati, Nuclear Materials and Propulsion Operation.
 SAP-FAP, IBM 704 and 7090
 (Reference: XDC 59-6-173 and XDC 59-3-52)
- CCC-4: 15-2
 MONTE CARLO CALCULATION - GAMMA-RAY SCATTERING IN AIR, contributed by General Electric, Cincinnati, Nuclear Materials and Propulsion Operation.
 SAP-FAP, IBM 704 and 7090
 (Reference: XDC 61-5-1 and DC 60-10-150)
- CCC-5: C-17 and R-29
 KERNEL INTEGRATION CODE AND DATA GENERATOR - FRUSTRA OF RECTANGULAR PYRAMIDS AND CYLINDERS, contributed by General Dynamics, Fort Worth, USAF Nuclear Aerospace Research Facility.
 SAP-FAP, IBM 704 and 7090
 (Reference: NARF 61-39T, FZK-9-170)
- CCC-6: L-63 and R-29
 KERNEL INTEGRATION CODE AND DATA GENERATOR - CYLINDERS, SPHERES, AND COMPLEX GEOMETRY, contributed by General Dynamics, Fort Worth, USAF Nuclear Aerospace Research Facility.
 SAP-FAP, IBM 704 and 7090
 (Reference: NARF 61-39T, FZK-9-170)

- CCC-7: NTC
MONTE CARLO HIGH ENERGY NUCLEON TRANSPORT CODE INCORPORATING CASCADE AND EVAPORATIVE PROCESSES, contributed by Neutron Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
FORTRAN/FAP, IBM 7090
(Reference: ORNL-3610)
- CCC-8: K-74
MONTE CARLO CALCULATION OF NEUTRON FLUX IN INFINITE MEDIUM FOR POINT ISOTROPIC SOURCES, contributed by General Dynamics, Fort Worth, USAF Nuclear Aerospace Research Facility.
FAP, IBM 7090
(Reference: NARF 60-8T, FZK-9-147)
- CCC-9: L-05
MONTE CARLO MULTIBEND-DUCT SHIELDING CODE, contributed by General Dynamics, Fort Worth, USAF Nuclear Aerospace Research Facility.
FAP, IBM 7090
(Reference: NARF 61-33T, MR-N-286 and NARF 62-13T, MR-N-297)
- CCC-10: C-18, R-35, and R-65
MONTE CARLO MULTILAYER SLAB GEOMETRY SHIELDING CODES, contributed by General Dynamics, Fort Worth, USAF Nuclear Aerospace and Research Facility and U. S. Army Tank-Automotive Center, Warren, Michigan.
SAP-FAP, IBM 704 and 7090
(Reference: FZK-134-3)
- CCC-11: SANE
MONTE CARLO SPHERICAL MULTILAYER GEOMETRY NEUTRON TRANSPORT SHIELDING CODE, contributed by United Nuclear Corporation, White Plains, Development Division - NDA.
FORTRAN-FAP, IBM 7090
(Reference: UNUCOR-633 and UNUCOR-634)
- CCC-12: SAGE
MONTE CARLO SPHERICAL MULTILAYER GEOMETRY GAMMA TRANSPORT SHIELDING CODE, contributed by United Nuclear Corporation, White Plains, Development Division - NDA.
FORTRAN-FAP, IBM 7090
(Reference: UNUCOR-633 and UNUCOR-634)
- CCC-13: ADONIS
MONTE CARLO THREE-DIMENSIONAL RECTANGULAR GEOMETRY SHIELDING CODE, contributed by United Nuclear Corporation, White Plains, Development Division - NDA.
FORTRAN-FAP/CODAP, IBM 7090 and CDC 1604
(Reference: UNUCOR-635)

- CCC-14: FMC-G
MONTE CARLO SIMULATION OF GAMMA-RAY LIFE HISTORIES IN A SOURCE-SHIELD CONFIGURATION, contributed by General Electric, Cincinnati, Nuclear Materials and Propulsion Operation.
SAP-FAP, IBM 704 and 7090
(Reference: APEX-706)
- CCC-15: FMC-N
MONTE CARLO SIMULATION OF NEUTRON LIFE HISTORIES IN A SOURCE-SHIELD CONFIGURATION, contributed by General Electric, Cincinnati, Nuclear Materials and Propulsion Operation.
SAP-FAP, IBM 704 and 7090
(Reference: APEX-706)
- CCC-16: 18-0, 18-1 and Auxiliary Routines
MONTE CARLO SIMULATION OF NEUTRON AND GAMMA-RAY LIFE HISTORIES IN REACTOR-SHIELD ASSEMBLIES, contributed by General Electric, Cincinnati, Nuclear Materials and Propulsion Operation.
FORTRAN-FAP, IBM 7090
(Reference: XDC 61-1-91, GEMP-272)
- CCC-17: 05R
GENERAL PURPOSE MONTE CARLO NEUTRON TRANSPORT CODE, contributed by Neutron Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
FORTRAN-FAP/CODAP, IBM 7090 and CDC 1604
(Reference: ORNL-3622)
- CCC-18: 05-0
ANISOTROPIC POINT SOURCE CODE - SINGLE SCATTERED GAMMA RAYS IN INFINITE HOMOGENEOUS MEDIUM, contributed by General Electric, Nuclear Materials and Propulsion Operation, Cincinnati, Ohio.
SAP-FAP, IBM 704 and 7090
(Reference: XDC 50-8-218)
- CCC-19: 09-0
ANISOTROPIC POINT SOURCE CODE - SINGLE SCATTERED NEUTRONS IN INFINITE HOMOGENEOUS MEDIUM, contributed by General Electric, Nuclear Materials and Propulsion Operation, Cincinnati, Ohio.
SAP-FAP, IBM 704 and 7090
(Reference: APEX-533)
- CCC-20: TRIGR
MONTE CARLO GAMMA-RAY PENETRATION CODE - PLANE GEOMETRY, contributed by TRG, Incorporated, Melville, New York, and Aeronautical Research Laboratories, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio.
SAP, IBM 704
(Reference: WADC 59-771)

- CCC-21: MORTIMER
KERNEL INTEGRATION CODE - TWO-COMPONENT ANALYSIS FOR SNAP
SHIELD GEOMETRIES, contributed by Atomics International, Canoga
Park, California.
FORTRAN-FAP, IBM 7090
(Reference: NAA-SR-9327)
- CCC-22: MAC (A)
NEUTRON GAMMA-RAY ATTENUATION CODE - SPINNEY (REMOVAL-DIFFUSION)
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Plants, AEC, Frankfurt, Germany, and European Atomic Energy
Community-EURATOM, Joint Nuclear Research Center, ISPRA Establish-
ment, Italy.
FORTRAN, IBM-7090
(References: KERNENERGIEANLAGEN Bericht No. 116 (ORNL-tr-610),
EUR 2152.e, and ENEA Computer Programme Library, Abstract No.
006)
- CCC-23: MAVRAC
MODEL ASTRONAUT AND VEHICLE RADIATION ANALYSIS CODE, contri-
buted by Northrop Space Laboratories, Hawthorne, California,
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Air Force Base, Ohio.
FORTRAN, IBM 7090
(Reference: NSL 63-159)
- CCC-24: CARSTEP
TRAJECTORY AND ENVIRONMENT CODE - ELECTRON AND PROTON FLUXES
IMPINGING ON SPACECRAFT IN ORBIT, contributed by Northrop
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NUCLEAR WEAPON DETONATION, contributed by Research and Technology
Division, Air Force Weapons Laboratory, Kirtland Air Force Base,
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FORTRAN, CDC 1604
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- CCC-26: GRACE-II
GAMMA-RAY KERNEL INTEGRATION DOSE RATE AND HEATING CODE
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FORTRAN, IBM 7090-4, CDC 1604
(Reference: NAA-SR-4649)
- CCC-27: ACT II
ACTIVATION GAMMA-RAY SOURCE STRENGTH CODE, SIMPLE GEOMETRY,
FINITE DILUTION, contributed by Westinghouse Electric Corporation,
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FORTRAN, IBM 7090-4
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FISSION PRODUCT INVENTORY CODE, contributed by Lockheed-Georgia
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RATES IN LIQUID HYDROGEN - SLABS AND CYLINDERS, contributed
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- CCC-30: MARTY-N
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MONTE CARLO NEUTRON TRANSPORT CODE SYSTEM, contributed by Technical
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(Reference: TO-B 63-82, RRA-N58, RRA-N59, RRA-N57, RRA-N520, RRA-N519,
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- CCC-45: TORG
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- CCC-46: OGRE
A GENERAL-PURPOSE MONTE CARLO GAMMA-RAY TRANSPORT CODE SYSTEM, contri-
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CCC-46A: FORTRAN II and FAP, IBM 7090.
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CCC-46C: FORTRAN IV, IBM 360/50 and 360/75.
CCC-46D: FORTRAN IV, IBM 7090.
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- CCC-47: LEP
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 FORTRAN and FAP, IBM 7090.
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- CCC-48: QAD
 KERNEL INTEGRATION CODE SYSTEM, contributed by Los Alamos Scientific Laboratory, N Division, Los Alamos, New Mexico. QAD-HD and QAD-P5A were contributed by NASA Lewis Research Center, Shielding Analysis Section, Cleveland, Ohio.
 FORTRAN II (QAD-P5), FORTRAN IV (all versions), IBM 7090 and 7094.
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 PROTON PENETRATION CODE, contributed by Lockheed-Georgia Company, Nuclear Analysis Department, Marietta, Georgia.
 FAP (LPPC), FORTRAN II and FAP (LMFC, LSSC, LIGHT, MSGAM), FORTRAN II (NCON), FORTRAN IV and MAP (FLARE), IBM 7090 and 7094
 (Reference: ER-6643, ER-7777)
- CCC-52: LEBE
 ELECTRON BREMSSTRAHLUNG CODE, contributed by Lockheed-Georgia Company, Nuclear Analysis Department, Marietta, Georgia.
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- CCC-70: CHARGE
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FORTRAN II, IBM 7090
(Reference: Informal notes)

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CCC-85: MOMDIS and MOMGEN
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