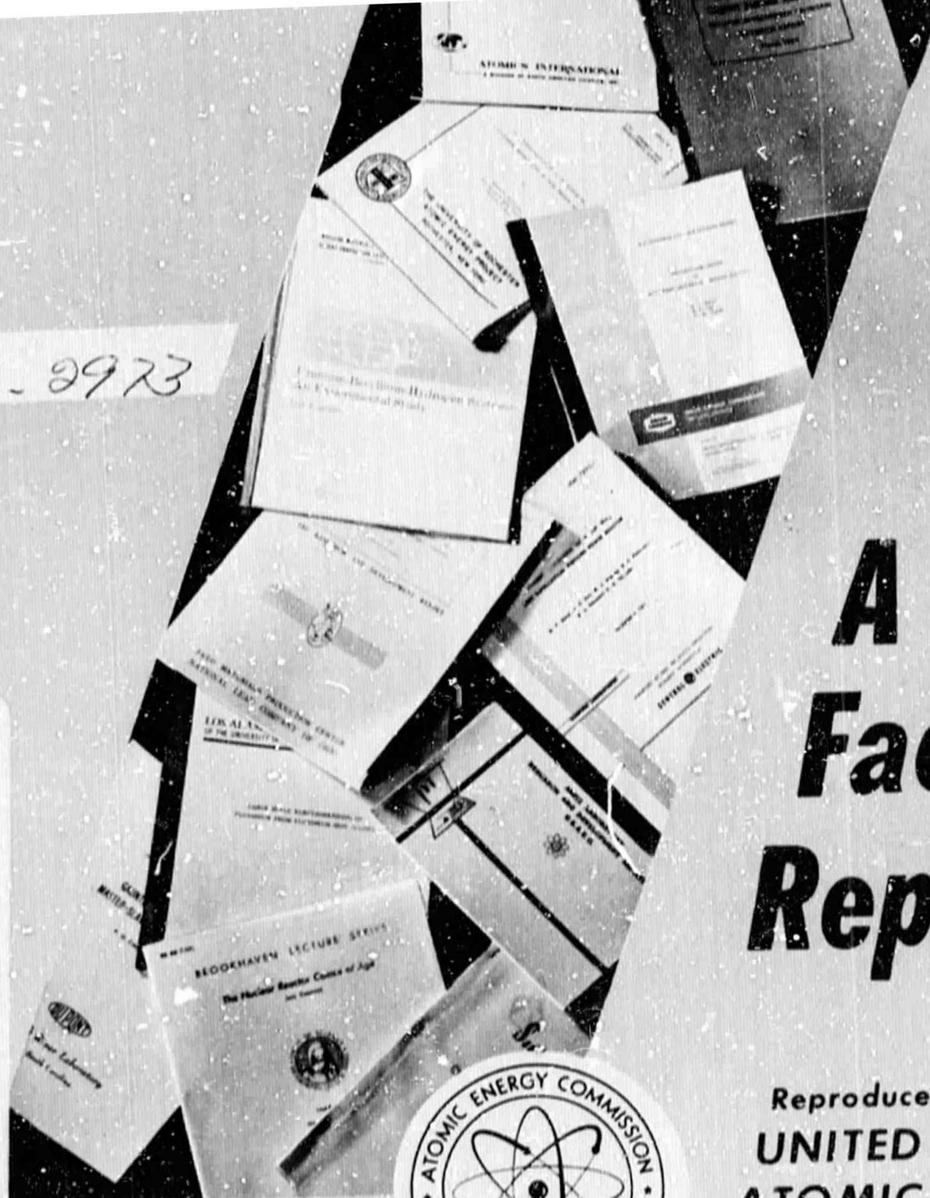

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Neutron Physics Division

THE INFORMATION ANALYSIS CENTER CONCEPT AS DEVELOPED BY THE RADIATION SHIELDING INFORMATION CENTER IN ITS COMPUTER CODES ACTIVITIES

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ABSTRACT

In implementing the information analysis center concept of acquiring, analyzing, and synthesizing a body of information, the Radiation Shielding Information Center (RSIC) packages and distributes computer codes. These codes, used for calculating radiation transport, solving related problems, or processing needed data, are used by scientists and engineers in research or shield design work for government and industry. A description is given of the objectives, scope, recent accomplishments, and auxiliary activities of the RSIC Computer Codes Center. A brief summary of the available codes is also given.

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THE INFORMATION ANALYSIS CENTER CONCEPT

To fully understand the Radiation Shielding Information Center,[1] it is necessary to define the information center concept. Panel No. 6 (Information Analysis and Data Centers) of COSATI (Committee on Scientific and Technical Information of the Federal Council for Science and Technology) has adopted the following definition.[2]

"An Information Analysis Center is a formally structured organizational unit specifically (but not necessarily exclusively) established for the purpose of acquiring, selecting, storing, retrieving, evaluating, analyzing, and synthesizing a body of information in a clearly defined specialized field or pertaining to a specified mission with the intent of compiling, digesting, repackaging, or otherwise organizing and presenting pertinent information in a form most authoritative, timely, and useful to a society of peers and management."

The overall idea of the information center was strongly endorsed in the Weinberg Report,[3] which emphasizes:

"... knowledgeable scientific interpreters who can collect relevant data, review a field, and distill information in a manner that goes to the heart of a technical situation are more help to the overburdened specialist than is a mere pile of relevant documents. Such knowledgeable scientific middlemen who themselves contribute to science are the backbone of the information center; they make an information center a technical institute rather than a technical library. The essence of a good technical information center is that it be operated by highly competent working scientists and engineers - people who see in the operation of the center an opportunity to advance and deepen their own personal contact with their science and technology."

It may be noted that each definition implies critical examination - the material collected by the Center is filtered through the human brain, analyzed, and placed in context. The answer to a question addressed to the Center is a composite of the literature and the expert's judgement based on an analysis of the questioner's needs. Therefore, it is essential to the technical institute concept that the information center focus on a specialized area, that it be placed in a large multi-purpose laboratory where active work in the field is going on, and be manned by a technical staff suited to the role of scientific middleman.

OBJECTIVES AND SCOPE - RSIC CODES CENTER

The Radiation Shielding Information Center (RSIC) functions within the Neutron Physics Division (NPD), Oak Ridge National Laboratory, which has long been engaged in shielding and radiation transport research. This research can be traced back to early work in nuclear submarine (cir. 1950) and nuclear powered aircraft (cir. 1953-61) programs, applications requiring high performance shields. Currently, the Division is engaged in shielding research applicable to reactors, including Systems for Nuclear Auxiliary Power (SNAP) and fast-breeder reactors, to radiation from weapons, accelerators, and to radiation encountered in space.

Shielding research and design require the use of large high-speed computers and complex computer codes which are both tools and by-products. Since many of these codes represent a development investment of the order of $100,000, duplication costs can be considerable. By creating a favorable environment for the exchange of computer codes, and agencies to accomplish this, it is apparent that a substantial amount of time and effort can be saved. The effective use of computers is promoted when the scientist-programmer can make use of existing tools without modification or as a base for developing new ones. Therefore, the Codes Center is an integral part of RSIC's information processing activities.

Means of Support, Clientele, and Staffing

Funded by the U. S. Atomic Energy Commission (USAEC), National Aeronautics and Space Administration (NASA), and Defense Atomic Support Agency (DASA), RSIC's services are free to scientists and engineers engaged in shielding work.

TABLE 1

Percentage Distribution of Services

USAEC*	27.5%	Universities	11.0%
DASA*	20.9%	Private Firms	10.1%
NASA*	18.5%	Foreign	11.2%
Other Govt.	0.8%		

Table 1 shows the percentage distribution of RSIC services. Since, to a large extent, the universities and private firms are doing their research and development under contract, with government funds, it is estimated that about 85% of RSIC services are for government-related work. Our funding agencies operate under the guiding principle of "permitting and encouraging the dissemination of scientific and technical information so as to provide that free interchange of ideas and criticism which is essential to scientific progress."[4,5] We feel that it is essential for this free interchange and sharing within the scientific community that RSIC promote a spirit of cooperative good will, free from commercial considerations.

The basic RSIC staff includes 2 physicists, a mathematician, a secretary, 3 computer-programming specialists, one full-time and 3 part-time information specialists. In addition, RSIC is able to call upon other NPD personnel in their special areas. Currently carrying technical assignments are 5 scientist-engineers who give part-time to RSIC and

*Agencies or their contractors

1-1/2 computer-facility-connected mathematician-and-information-system-programmers. Of the approximately 12-man-years accounted for above, about half (6) are devoted to the code center part of RSIC operations.

In implementing the information center concept, information is continually sought in the areas of calculational methods and the development of computer codes for computing radiation transport. The literature is surveyed and information about all nuclear codes is collected, since the concepts incorporated in nearly all such codes have a bearing on radiation problems. Literature dealing with radiation transport is studied closely and the computer codes which seem generally useful are acquired for the collection.

Scope and Operations of Code Center

The scope of the RSIC Codes Center includes:

1. collecting computer codes and codes literature related to shielding against the radiations from nuclear reactors, accelerators, and nuclear weapons, and that encountered in space;
2. checking out and making operable locally and using the acquired codes to run the sample problems;
3. packaging the codes into comprehensive and logical units;
4. writing and publishing abstracts of the code packages;[6]
5. publishing information about the codes in the RSIC Newsletter and in technical journals;[7,8]
6. publishing bibliographies of the selected codes literature;[9]
7. filling requests for code packages;
8. answering inquiries about the codes literature, the codes, methods of calculations, and related matters;
9. recommending codes for specific problems;
10. initiating and encouraging periodic participation in the codes center work by members of the shielding community;
11. holding seminar-workshops on calculational methods and computer codes when new and important developments are available;
12. acquiring, checking-out, and packaging data sets useful in connection with the shielding codes;

13. exchanging codes and cooperating in many other ways with other code centers, both domestic and international;
14. providing leadership in the development of standards and practices (documentation and programming) that will facilitate the exchange of computer codes; and
15. maintaining records and issuing reports of the activites of the codes center.

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. The user is encouraged to, and often does, feed back into the center the results of his conversion and/or modification/extension efforts.

CURRENT STATISTICS

The extent of the code center activities can be visualized by noting the following statistics for the 12 months of 1969.

Improvements Made to the Computer Code Collection

34 additional codes were packaged (an increase of 35%).

24 code packages in the collection were updated, several of which included major modifications and extensions to the program.

11 new hardware versions of existing code packages were fed back into RSIC by installations where conversions were made.

10 data library sets were collected and packaged. Improvements were made to the documentation in each of the data sets.

Services to the Shielding Community by the Code Center

1200 letters of request were logged into the Center - over 100/month, resulting in more than 2900 separate actions required to satisfy the requests.

628 separate code packages were shipped, including full documentation.

113 abstracts of code packages, or computer lists of programs were mailed.

37 instances in which only the updated material was sent.

317 instances in which staff members spent considerable time in trouble-shooting specific codes as a requester was learning how to use the codes, including advice concerning his input preparation.

192 instances in which time was spent in assisting the requester to solve his problems - general advice and counsel.

182 instances in which assistance was given in the selection of the computer code to fit the requester's problem, his computer, and his capabilities.

307 separate miscellaneous service requests that were filled.

Cross Section Work and Data Library Collection

In order to use computer codes to solve radiation transport problems, one must have libraries of cross sections. With the development of the USAEC Evaluated Nuclear Data File (ENDF), there is now a standard format. RSIC is working closely with Brookhaven National Laboratory's National Neutron Cross Section Center (NNCSC) and the Cross Section Evaluation Working Group (CSEWG) Shielding Subcommittee in the furtherance of the needs of the shielding community. In 1969 there were 36 separate transactions in which RSIC staff members assisted in cross section data handling - running CHECKER, etc.

In addition RSIC now packages and distributes documented data sets (such as multigroup P_8 angular expansion data libraries) which are needed as input to various shielding codes. A total of 234 separate shipments of these data sets were made in 1969.

The Seminar Workshop

Members of the RSIC staff continue to seek new and more efficient ways to exchange information. The concentrated workshop, which began as a method of informing the RSIC staff when a new computer code is placed in

the RSIC collection, has proved to be a practical and efficient one for transferring a great deal of information to a large number of potential users in a small amount of time. The workshop, which teaches users how to apply a certain code, has been extended, in several cases, to include a seminar for the purpose of evaluating and discussing the theory, state-of-the-art, and application of the method inherent in the particular code. Leading experts are invited to present papers which are collected, edited and published as a state-of-the-art report. Monte Carlo techniques, kernel integration, and discrete ordinates[10] calculation methods and computer codes have been subjects treated in the past.

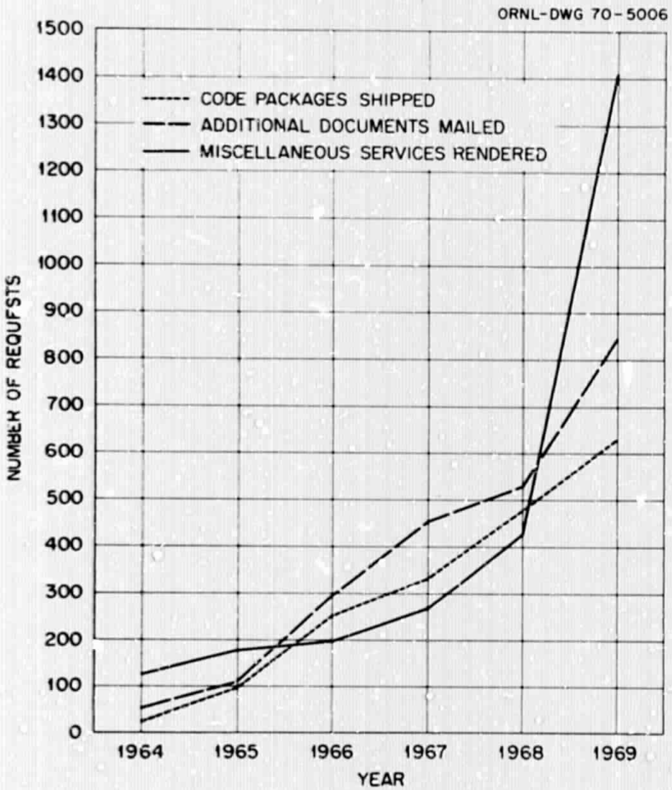
Two seminar-workshops were organized by RSIC in the year 1969.

(A) Theory and Operation of the Electron-Photon Transport Program, ETRAN. A total of 53 persons attended from 24 installations.

(B) A Review of Multigroup Nuclear Cross Section Preparation - Theory, Techniques, and Computer Codes. There were 124 persons from 57 separate installations, including 7 foreign countries, who attended. The papers were published as a state-of-the-art report.

Growth of Services to Users

The work of the RSIC codes center got underway in mid-1963 with only a few shielding codes, written in assembly language for the IBM 704. Annual growth may be seen in Figure 1 and in the following Table (2). The total number of requests filled in each category was averaged over the number of workdays within that year.



Chart, by Year, of Number of Requests Filled by RSIC Code Center 1964-1969.

FIGURE I

TABLE 2

Annual Growth of Services - RSIC Code Center

Average Number /Workday	Year 1964	1965	1966	1967	1968	1969
Code Packages Shipped	0.08	0.20	0.38	0.96	1.26	2.5
Answers to Specific inquiries about Codes	0.10	0.25	0.42	1.14	1.74	3.3
Miscellaneous Services Performed in Connection with Shielding Calculations	0.49	0.55	0.70	0.74	1.03	4.8
Sum of Requests Handled on an Average Day	0.67	1.0	1.5	2.84	4.03	10.6

FEEDBACK FROM USERS

The scientist-engineers served by RSIC vary in background and experience, both in shielding research and design and in the use of computers. The general shielding community is small compared to other scientific groups, and it is possible for RSIC to establish a secure line of communication with much interaction. There are still the sophisticated shielding experts who give as much as they take from the information store. There are also those who explain that they want to learn all about shielding calculations while standing on one foot! RSIC staff members attempt to serve both adequately. A special effort is made on requests from university faculty or students. By this means, RSIC serves as an extension of the classroom or university laboratory.

"If you convert this code version to any other computer, please let us know. If you find errors in the programming, or if you make modifications you feel might be helpful to others, we will appreciate your calling it to our attention. We will be grateful if you will put us on your routine distribution for any reports you may write in connection with this code package or its use. We also ask you not to forget to reference the original documentation in such report writing.

The usefulness of the RSIC Code Center depends on the cooperation of the research scientists who serve and are served by it. When you know of new and interesting code development, we will appreciate your calling it to our attention. We also ask you to put RSIC on your distribution list for all shielding research reports and code descriptions originating at your installation."

The above two paragraphs are written and mailed with each code package and many of the requesters take them quite seriously. In at least 69 instances, new hardware versions have been returned from users after having requested the original package from RSIC. The popular Monte Carlo and discrete ordinates computer code packages have been converted to run on as many as seven different hardware configurations.

The best feedback is represented by the following excerpts from letters received recently.

"We have converted the MORSE code to run on the UNIVAC 1108 and have added several changes. Basically, we have found MORSE to be a very usable and powerful Monte Carlo tool, the variety of variance-reduction options being especially useful. Excellent agreement has been found between MORSE and the discrete ordinates code 1DF. For your information, I enclose a list of the changes we have made to MORSE and several improvements we feel could be made. We will be pleased to release our version to you." (WHS, SAI, 4/70).

"We appreciate the opportunity to have access to the facilities and services of RSIC. Under the NERVA program, the development of a nuclear rocket reactor has required highly specialized techniques to accurately predict the nuclear radiation environment, involving the design and analysis of radiation shielding as well. RSIC services have been used extensively to obtain needed nuclear analysis, data processing, and shield design and analysis computer codes. We are now able to make a contribution to the Code Center. We are preparing to send to you APROPOS, SATURN, MAP, SCAP, and new versions of KAP, NAGS, and GAMLEG." (RS, WANL, 4/70).

"I wish that we were in the position to be sending you more codes, but I do not see that possibility in the near future. I will just have to beg from you and be a user for awhile." (WEE, BHI, 4/70).

"I hope that you will find this code to be a useful addition to the RSIC Code Collection. I have always found the Radiation Shielding Information Center to be an invaluable source of shielding data and codes, and I am pleased to be able to reciprocate in a small way for all the help you have been to me in the past. It is always a pleasure to deal with RSIC, not only because it is the only complete 'shielder's repository,' but also because of the spirit of enthusiastic cooperation and the willingness to provide services beyond the minimum required. In my capacity as leader of Task Force 1 for the CSEWG Shielding Committee, I look forward to a cooperative relationship with RSIC in the distribution and maintenace of cross-section data and codes. In this regard, I have already referred Norman Holden of KAPL to you for a copy of PHOXE. I am sure your Code Collection will be a valuable aid to him and to the Naval Reactor people in general, as it was to me at the Bettis Laboratory." (DJD, LASL, 4/70).

THE CODES COLLECTION

Most of the codes in the RSIC collection incorporate a certain way of solving the Boltzmann transport equation or use the results of such solutions. Some codes calculate dose rates while others calculate energy spectra and angular distributions as well. The most generally used methods are: attenuation kernel integration, Monte Carlo, discrete ordinates, and removal-diffusion. Currently, Monte Carlo and discrete ordinates are most popular for research, and kernel methods for design.

The neutron and gamma-ray transport codes are used for nuclear reactor, shelter, radioisotope, and neutron generator shielding. The energy range considered is generally less than about 15 MeV.

The charged-particle transport codes were designed to solve shielding problems connected with spacecraft design or with transport in simple geometries. The most powerful method is Monte Carlo but it may be the most difficult to apply.

In addition to codes used for neutron, gamma-ray, and charged particle transport, the collection includes cross-section libraries and codes for processing cross sections, calculating fission product inventories, and analyzing neutron activation detector data to determine spectra.

Several of the RSIC code packages actually represent coding systems. These are represented in the collection by prototypes, which are not necessarily useful in themselves but which achieve generality in that they are designed to be easily changed. Such code systems are most useful to the research worker who will invest a great deal of time and effort in learning to use the system.

A summary of the current codes collection has been published[8] and is reproduced as Appendix B. Additional summary data are given in Table 3.

TABLE 3

Computer Code Packages Available from RSIC

CCC No./ Code Name	Contributor	Computer*	Radiation Type	Method	Geometry	Ref.	Comments
CCC-116/TRECO	NASA-G	(A) IBM 360/75 (B) CDC 6600	p,e	Numerical integr.	3-dimens.	1,2	Integrates earth radiation belt flux along satellite orbits
CCC-117/BETA	ART	IBM 7090	e,Brems.	Monte Carlo	Complex	3	Uses importance sampling throughout.
CCC-118/SIGMA	MD-A	IBM 7090	p,e	Kernel integr.	Complex	4	Computes space radiation dose inside space vehicle, uses CCC-70/CHARGE data.
CCC-119/ELBA	NASA-MSFC	IBM 7090	e,Brems.	dE/dx	Slab	5	Computes electron and Bremsstrahlung dose behind aluminum slab.
CCC-120/ SPACETRAN	ORNL-N	IBM 360/75	n,γ	Numerical integr.	3-dimens.	6	Computes dose at detector points due to leakage from cylindrical surface.
CCC-121/SABINE	EURATOM	IBM 360/75	n, sec.γ	Spinney	1-dimens.	7	Particular attention paid to energy transfer in removal source.
CCC-122/RAD 2	GGA	IBM 7090	fp	Numerical		8	Computes fission-product activity distributions, decay chain any length. Designed for gas-cooled reactor problems.
CCC-123/XSDRN	CTC,ORNL-N	IBM 360/75	n	Discrete ordinates	1-dimens.	9	Designed to flux-weight cross sections, has extensive data library.
CCC-124/KDLIBE	GE-N	GE 635	n,γ	Kernel integr., Spinney	Complex	10-12	Incorporates CCC-48/QAD, NRN-like code, and others into system
CCC-125/RSAC	PPC	IBM 7044	γ	Kernel integr.	Infinite cloud	13	Computes dose from release of fission products to atmosphere.
CCC-126/ADOP	CTC	IBM 360/75	n,γ	Discrete ordinates	1-dimens.	14	Designed to optimize shields using CCC-82/ANISN
CCC-127/MORSE	ORNL-N	(A) CDC 1604 (B) IBM 360/75	n,γ	Multigroup Monte Carlo	Complex	15	Uses same cross-section format CCC-82/ANISN.
CCC-128/O5R	ORNL-N	(A) CDC 1604 (B) IBM 360/75	n	Monte Carlo	Complex	16-18	Revised version of CCC-17/O5R.
CCC-129/ TWOTRAN	GIA,LASL	(A) CDC 6600 (B) IBM 360/75	n,γ	Discrete ordinates	2-dimens.	19,20	Coarse-mesh and Chebyshev convergence accelerations, general anisotropic scattering, positive spatial difference scheme.
CCC-130/DTF69	SL	CDC 6600	x,γ	Discrete ordinates	1-dimens.	21	Special version of CCC-42/DTF-IV for X-ray transport.

*Computer for which versions are available.

TABLE III REFERENCES

1. NASA SP-3024 (1966)
2. NSSDC 68-02 (1968)
3. AFWL-TR-68-111 (1968)
4. DAC-60878 (1967)
5. NASA SP-169, p.529 (1968)
6. ORNL-TM-2592 (1969)
7. EUR 3636.e (1967 and Addendum (1969)
8. GAMD-6519 (1965)
9. ORNL-TM-2500 (1969)
10. GESP-226 (1969)
11. GEMP-456 (1966)
12. GEMP-599 (1968)
13. IDO-17151 (1966)
14. CTC-INF-941 (1969)
15. ORNL-CF 70-2-31 (1970)
16. ORNL-CF 69-8-36 (1969)
17. ORNL-3622 (1965)
18. ORNL-3856 (1966)
19. GA-8747 (1968)
20. LA-4058 (1969)
21. SC-RR-69-739 (1969)

CODE CONTRIBUTORS

ART	ART Research Corp., Los Angeles, Calif.
CTC	Computing Technology Center, Union Carbide Corp., Oak Ridge, Tenn.
EURATOM	EURATOM Joint Nuclear Research Center, Ispra (Varese) Italy
GE-N	General Electric Co., Nuclear Systems Programs, Cincinnati, O.
GGA	Gulf General Atomic, San Diego, Calif.
LASL	Los Alamos Scientific Lab., Los Alamos, N. M.
MD-A	McDonnell Douglas Astronautics Co., Western Div., Huntington Beach, Calif.
NASA-G	NASA Goddard Space Flight Center, Greenbelt, Md.
NASA-MSFC	NASA Geo. C. Marshall Space Flight Center, Huntsville, Ala.
ORNL-N	Oak Ridge National Lab., Neutron Physics Div., Oak Ridge, Tenn.
PPC	Phillips Petroleum Co., Atomic Energy Div., Idaho Falls, Id.
SL	Sandia Laboratories, Albuquerque, N. M.

CONVERSION

Factors to be Considered

Most of the new codes are written in FORTRAN IV, which makes them n- ly machine independent. With a little work, one can fairly easily make them operable on several of the large computers. However, there are problem areas in conversion, and the following are mentioned briefly.

The handling of information - input, output, string manipulation, string comparison, and character representation - can be a problem because of hardware and software differences. In terms of hardware, the greatest trouble is caused by different word lengths and structures. For example: the CDC 1604 and CDC 3600 operate on the basis of a 48-bit word; the CDC 6600, a 60-bit word; the IBM 7000 series, the UNIVAC series, and the GE series, a 36-bit word; and the IBM 360 series, a 32- or 64-bit word.

The differences between word lengths and structures cause problems in converting programs of precision-dependent calculations. Since computers differ in the number of bits per word, they must differ in accuracy of the results. This is most obvious in computations where convergence is sought. The use of double precision on the less accurate machines will usually solve the problem.

Character representation can also be a problem externally with the use of magnetic tapes and punched cards. RSIC has access to both IBM 026 and 029 keypunches and must have the facility for going from one to the other.

Another possibility of difficulty is concerned with the computer operating environment - hardware and software. Considerations must include the amount and type of core storage (available fast and slow memory), the number of tape drives available, the number of disks, and even the availability of peripheral equipment. Sometimes it takes cleverness to get around su i problems. From a software standpoint, the problems can be more subtle. Differences between compilers, between linkage editors, between systems libraries, between control cards, and particularly whether or not core is initialized cause headaches. However, none of these are insurmountable.

Conversion on a Cooperative Basis

The RSIC staff routinely converts computer codes written for other hardware to the IBM 360/75/91 when the problems are no more complicated than those mentioned above. However, the more time-consuming changes required by non-standard programming techniques, or those designed for unusual compilers or FORTRAN dialects, are beyond the manpower capabilities of the staff. If the computer code is of interest to the shielding community in general, an effort is made to influence possible users and funders to undertake conversion. At the same time, it is sometimes possible to point out useful extensions or modifications that should be made.

An example will demonstrate the possibilities.

In the UNC-SAM series of Monte Carlo transport codes, a technique called "masking" (or "packing") is used, in which two or more variables are stored adjacent to each other within the same physical word. This is good programming practice for the CDC computers, for which the UNC-SAM codes were originally written, but a prohibiting factor in conversion to other hardware. Since there were several IBM 360 installations interested in using the codes, conversion was deemed justifiable. A potential user was encouraged to convert the series. After 2 man-months, spread over a calendar year, an IBM 360 code package was returned to RSIC. The conversion is done once, and the several installations profit from it.

To use the UNC-SAM series of codes requires an extensive library of cross sections in a unique format. To ensure the availability of the latest data, a government agency was encouraged to give support to a programming effort to develop a linkage with the ENDF/B data format. This will soon become a part of the UNC-SAM code packages, increasing the value of a powerful tool for use in shielding research.

More recent contributions to the Code Center have been deliberately designed to run on different computers. The Experimental Analysis Group, Nuclear Radiation Design Department, NERVA project, Westinghouse Astronuclear Laboratory, write their computer programs in FORTRAN IV, check them out initially on the CDC 6600, make them operable on the IBM 360/75 and run test cases alternately between the two computers until the results agree within word length possibilities. Then, with a change of control cards and data statements, the test cases are run on the UNIVAC 1108. The end results are computer codes easily adapted to new computer environments.

Throughout these developments, the RSIC role of "sc... ific middleman" is clearly observable.

STANDARDS

The American Standards Association has encouraged efforts to establish standards "for the purpose of promoting a high degree of interchangeability of programs for use on a variety of automatic data processing systems."[12] Subcommittee ANS-10, manned by members of the Mathematics and Computation Division of the American Nuclear Society, exists to make recommendations and establish guidelines as an aid to program interchange. A report has been published[13] and further study is in progress.

Is there a standard? The programs which give RSIC the least trouble are those written for the FORTRAN IV compilers by a programmer who wanted to be able to exchange the code and had some idea of what could cause problems.

The current tendencies of government contractors to include provisions in contracts involving computer code development for placing their work within the public domain (code centers) has brought about progressive changes. RSIC receives many calls from code developers asking advice on both programming techniques and documentation. Contracts for software development should always include consideration for compatibility with existing systems. The use of local dialects of FORTRAN and unique compilers should be discouraged. They have no place in the effective use of computers in the nuclear industry.

RSIC is also concerned with benchmark problems. The benchmark, as defined by the American Nuclear Society Standards Subcommittee on Shielding (ANS-6) is a well-documented standard configuration defining a radiation transport problem for which reliable solutions exist. Several such problems and solutions have been published.[14] They are especially useful in testing computational methods.

A similar effort, in which RSIC is involved, has been undertaken by the CSEWG Shielding Subcommittee. In this case, benchmark experiments are sought by which ENDF/B reference data used in computer codes are tested. Comments on the conceptual problems involved in attempting to test data, calculational methods, computer codes, and integral experiments simultaneously have been published.[15]

A LOOK TO THE FUTURE

Manpower

RSIC is organized to carry the current workload effectively. However, it can be noted that the growth curves (Figure 1) continue in an upward direction. By keeping procedures simple and service prompt, the Code Center manages to keep the requester's good will. But, maintaining the status quo in a technical institute is not progress. Initiation and origination are essential. With a limited clerical staff there is always the danger of diverting technical staff members to perform routine clerical functions in order to give the required services. The more efficiently the information center functions, the greater and more valuable the service becomes, and the end result is economically sound. But, additional manpower is needed. RSIC could well use an additional full-time mathematician programmer to aid in checking out and evaluating a current backlog of 45 computer codes now in process, 17 pending updates to existing code packages, and 31 additional codes expected to come into RSIC in the near future. An additional secretary-clerk would be a big help. With an additional scientist, RSIC could exploit to a far greater degree the available computer codes to produce the useful engineering data which is continually being requested. With more work than can be handled, the output per dollar spent is maximized, but the total output is limited.

Travel

There is no comparable substitute for personal interaction in information gathering. An RSIC visit to an installation where there is considerable shielding interest can accomplish far more than months of surveying the literature and endless correspondence or telephone calls. Attendance by the RSIC technical staff at meetings of the American Nuclear Society, or other technical meetings, is vital. The value of the new avenues of scientific communication resulting from information-gathering RSIC foreign travel is clearly seen; yet when budgets are tight, travel money is always tighter. For those engaged as scientific middlemen, travel is often a basic essential of the job and should be budgeted in the same fashion as for the use of the computer or for the purchase of microfiche. In other words, essential travel activity as a part of the job activity should be viewed entirely differently from that of routine attendance at conventions. RSIC travel activities are considerably curtailed by current budget restrictions, resulting in an increased workload to perform the usual functions.

Future Developments

Although government-supported information dissemination has suffered more than its share of budget cutting, we foresee an emerging national (and international) information network. One will be able to interrogate the system and get quickly in contact with the cognizant information analysis center, no matter what the technical problem.

The Radiation Shielding Information Center, in its maturation, is becoming more of a data center. With powerful codes available, the limitation now to the effective use of computers is the adequacy of the basic input data. Therefore, more attention is being given to this problem and also to sifting data available in the literature. The goal is to make transport results more readily available, often for computer analyses, rather than merely listing potentially helpful documents as RSIC is now able to do with its computer-based information retrieval system. These reference data are needed to assist in moving shielding from *physics research* to *engineering design*.

CONCLUSION

In the period since 1963, the Radiation Shielding Information Center has demonstrated the value, in a particular technical area, of operating a computer code center as an integral part of an information center. Since computer calculations are such an integral part of a shielding engineer's work, computer code exchange has become, in general, the most important function of the Center. As a result, no scientist need repeat others' work, but can use directly computer codes developed by others or proceed to advance the state-of-the-art.

As a corollary, it has become necessary for the Center to undertake considerable effort in producing the required input cross section data. This work has been particularly useful to the many groups who cannot mount a large scale cross section effort.

With the daily interaction between RSIC and the shielding scientist working in the field, it becomes increasingly obvious that the Code Center, as a scientific middleman, performs a valuable function in the effective use of computers in the nuclear industry.

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APPENDIX A

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THE RADIATION SHIELDING INFORMATION CENTER
A TECHNICAL INFORMATION SERVICE FOR NUCLEAR ENGINEERS *

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The Radiation Shielding Information Center (RSIC) at Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA, is a technical institute serving the international scientific community. It serves those engaged in research and development for the design of shields that provide protection from biological and physical damage due to penetrating, ionizing radiation.

The Center is sponsored by the United States Atomic Energy Commission (USAEC) under contract with the Union Carbide Corporation and is also supported by the National Aeronautics and Space Administration (NASA) and the Defense Atomic Support Agency (DASA). In serving the interests of these agencies, RSIC is concerned with the shielding of radiation from nuclear reactors, nuclear weapons, radioisotopes, accelerators, and radiation present in space.

1. The Information Analysis Center Concept

RSIC is one of 28 information analysis centers sponsored by the USAEC, a dozen of which are located at Oak Ridge [1]. Like RSIC, many of them were founded about 1963 as a result of recommendations made by a panel of the President's Science Advisory Committee [2]. The panel was headed by Dr. Alvin M. Weinberg, ORNL Director, and the report is generally identified by his name. The Weinberg report dealt with the problem of the ever expanding amount of information being generated today (the so-called information explosion) and made recommendations for alleviating the general problem.

One of the suggestions of the Weinberg report was that more and better specialized information centers are needed. These are neither technical libraries nor documentation centers but rather consist of information analysis activities designed to collect, organize, evaluate, compress, and disseminate information in a specialized field. A center is built around trained, experienced technical specialists and is located where the relevant science is flourishing. The handling of actual data may or may not be done; a data center being a special type of information center. The types of output can vary greatly but include: specialized journals, review articles, bibliographies and abstracts of literature (carefully indexed or sorted), compilations of data, personalized conferring regarding specific problems, current awareness notification of published literature (selective-dissemination-of-information or SDI), newsletters, and computer programs. Some activities are not quite so tangible; these would include catalytic functions and leadership in effecting better information exchange.

2. RSIC Modus Operandi

The Radiation Shielding Information Center functions within the ORNL Neutron Physics Division which has long been engaged in shielding and radiation transport research. This research can be traced

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