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INFORMATION CENTERS AT THE OAK RIDGE NATIONAL LABORATORY

(A Study in Diversity)

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ABSTRACT

The information centers currently operating or about to be established at the Laboratory are reviewed. The factors involved in the creation of the centers and the range of the available services are discussed, mentioning some of the problems thus far encountered in their operation.

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INFORMATION CENTERS AT THE OAK RIDGE NATIONAL LABORATORY

(A Study in Diversity)

Introduction

Many attempts have been made by the technical community to cope with the ever-increasing volume of technical information which is rapidly approaching the level of saturating the individual scientist and engineer. Abstract journals, monographs, and specialized reviews of a given field are useful tools for coping with the voluminous output of technical information. Another tool, the information center, while not exactly new, has gained considerable importance during the last ten years. The concept received authoritative support from a panel of the President's Science Advisory Committee on Science Information*. It is stated in the report: "The Panel sees the specialized information center as a major key to the rationalization of our information system. Ultimately we believe the specialized center will become the accepted retailer of information, switching, interpreting, and otherwise processing information from the large wholesale depositories and archival journals to the individual user. The Panel therefore urges that more and better specialized information centers be established."

The Panel also recommended to the scientific community that centers be organized at technical institutions and not as an adjunct of general libraries or of publishing ventures. This philosophy was followed in the establishment of centers at the Oak Ridge National Laboratory, attempting to make each center a part of a group actually working in a given, clearly defined field of science or technology.

Assigning the supervision of a center to persons active in the field brought with it automatically a great diversity in the methods of operation. This in itself is not a disadvantage; while a certain amount of standardization is necessary, it is desirable to let the experts in the various scientific and engineering fields follow practices best suited for their own endeavor. The methods used for storing and retrieving the information, preparing bibliographies and answering questions vary considerably from one center to another without any noticeable loss of efficiency.

* Science, Government and Information; the Responsibilities of the Technical Community and the Government in the Transfer of Information - a report of the President's Science Advisory Committee by the Panel on Science Information, A. M. Weinberg, Chairman; The White House, January 10, 1963.

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It should be kept in mind that organization of technical information for efficient storage and rapid retrieval is a relatively new field, which at present undergoes a tremendous growth. New equipment is brought out frequently and therefore it is impossible to rely on time-tested, universally accepted systems.

Establishment of the Centers

It is of interest to compare the method of creating the centers. At ORNL, as doubtless also at many centers throughout the country, two chief driving forces seem to have acted in the establishment of formal information centers: assistance to journal editors and the need to help workers in suddenly emerging, new technological or scientific fields.

A surprisingly large number of centers were initiated in order to fulfill the needs of journal editors. As a result of the variety of the fields represented at the Laboratory, the technical employees assumed responsibility for editing diverse publications such as quarterly review journals sponsored by AEC, regular primary publications supervised by technical societies and the new breed of express "letters" journals. The editor and his staff had to keep up with the flood of information reaching them and therefore had to organize the material passing through their desks. This was especially important in the case of the review journals as their main duty is evaluation of the current technical literature and the preparation of state-of-the-art reports. It was therefore quite natural that the two AEC-sponsored quarterly journals provided a "nucleus of crystallization" for two of the large information centers at the Laboratory.

The quarterly "Nuclear Safety" published detailed reviews in its field and therefore, a great variety of reports and journal publications, covering many technical fields, reach the editor. Organization of these papers formed the basis of the information center. The situation was quite similar in case of the recently started "Isotope and Radiation Technology". The journal is edited by the Isotopes Development Center formed at the Laboratory, the duties of which encompass research, production and teaching functions. Application of isotopes involve also several technical and engineering fields and the systematic arrangement of the material lent itself naturally to the creation of an information center.

Among the technical society journals connected with information centers one should mention "Nuclear Science and Engineering", of the American Nuclear Society, although in this case the correlation was not as direct as in the previously mentioned cases. The Radiation Shielding Information Center shares with the journal the field of technical interest and joint supervisory personnel. Similar correlation exists also between the Information Center for Internal Exposure and the "Health Physics" Journal published by the Health Physics Society. The editor of the

"Journal of Applied Physics" and "Applied Physics Letters" is in overall charge of the Research Materials Information Center*. In this manner, both the information centers and the journals profit by having resources available to them which would not be the case without this close contact between the two fields of technical information activity.

The need to study the rising flood of publications in relatively new fields represents another important factor in the establishment of the centers. So, the mass of experimental data on level schemes gained new meaning after the experts of the Nuclear Data Center scrutinized the values culled from the literature and organized them in such a way as to allow new insight into the nature of the nucleus. Their work was essential to the theoreticians who developed the shell model of the nucleus. Charged-particle reaction cross-section values became much more useful and more conveniently available to workers who were able to find evaluated data and corrected curves and did not have to search through a number of original documents to find the needed value.

Organization of the Centers

It is the management's intention that information centers be established only in fields in which the Laboratory has a special competence, as evidenced by the research work carried out. No attempt will be made to prepare bibliographies or to make special searches in fields the Laboratory does not carry out intensive work, except as a preliminary study for a new local project. The information centers are supervised by one of the ORNL research divisions and are, at least partially, staffed by active research workers whose main job assignment includes carrying out theoretical or experimental studies in a given field. In order to be able to evaluate critically the information presented in the literature, it is deemed highly desirable that the individuals involved in this process have actual working experience in the field. Thus, each of the centers is backed up by the combined experience of the division; their colleagues are available as consultants, even though they may not be formally assigned to the center.

As a result of this variety in supervision, the actual operational methods of the centers are quite dissimilar. A slight loss of efficiency is considered a small price to pay for the gain in the originality and competence of the centers. Chemists, physicists, and engineers have different educational backgrounds and varying temperaments; what is suitable for the other might be completely unacceptable at least on individual grounds for the other. The divisional management is relied upon to make sure that this permissive method will yield generally acceptable results. In addition, a coordinator has been appointed** who is responsible for the review of the activities of

* The offices of these two journals will be moved away from ORNL but this does not weaken the argument concerning their influence.

** In the person of the writer.

the centers on behalf of management, striving to keep them informed about each other's activities and about new developments in the field of information handling.

In view of the variety of the background of the centers, the storage and retrieval tools used also cover the whole gamut of possibilities; no attempt is made to force uniformity. The equipment and the personnel depend on the field. Where the number of papers published per year is relatively small, a single individual usually is assigned as a part-time duty to read the publications of interest; the material is kept in form of "extract" or "abstract" on ordinary file cards; the simplicity and adaptability of this system which is very widely employed at Battelle Memorial Institute's information centers, was found very useful even by one of the largest ORNL centers - the Nuclear Safety Information Center. On the other hand, the managers of the Isotopes Information Center, the interest of which is centered on the reorganization of the published literature, attempting to systematize the data according to specific isotopes and their use in a given industry, found the Termatrex "Peekaboo" system of great help for this work. The Radiation Shielding Information Center personnel, being neutron physicists, are accustomed to carry out computer calculations and therefore it was natural for them to make considerable use of the computer for organizing their material. Computers are also used to a great extent by the Charged-Particle Cross-Section Data Center. The Research Materials Information Center takes advantage of a recently developed microfilm retrieval system, designated as Miracode, of the Recordak Company.

The Nuclear Data Group which until recently was a separate, National Academy of Sciences supported, entity in Washington, D. C. organized its own library-type holdings because it did not have a convenient access to the needed material; later, at ORNL it was found useful to continue this practice. The group subscribes to about 40 journals which cover a large percent of the data of interest to the nuclear data field. The Engineering Data Collection, which handles a large blueprint collection, makes use of aperture cards.

At present, groups and individuals who intend to submit a proposal for starting a new center are studying various storage, retrieval and general organizational methods before selecting the best suited for their purpose. For this reason, visits have been made to leading information centers throughout the country and representatives of other centers were invited to visit the Laboratory and to present talks.

Description of the Centers

Nuclear Data Project

Systematic collection of nuclear data was started in Chicago on the Manhattan Project, continued at Oak Ridge and at the National Bureau of Standards. For the past 12 years, a nuclear data group has been

sponsored by the National Academy of Sciences - National Research Council under contract with the AEC. In January, 1964, this group moved from Washington to the Oak Ridge National Laboratory where it is part of the Physics Division.

The aim of the Group is to collect and analyze information on nuclear level properties such as energies, moments, transition probabilities. The data reported in the world literature are first collected, organized, and studied by a physicist who tries to understand the reasons for discrepancies and to construct a plausible level scheme; his conclusions are reviewed by others in the Group. The scheme finally presented on the Nuclear Data Sheets, based on data on masses, half-lives, parity, magnetic and quadrupole moments, branching ratios, reaction products, etc. represents the consensus of several analyst-compilers. All experimental results, whether or not consistent with the final scheme, are included on the Sheets. Comments call attention to discrepancies in the data and give reasons for various choices made in order to construct the final scheme.

The graphic and numerical material is made available to the scientific community in a convenient, replaceable form on a subscription basis. The periodic publications include "Nuclear Data Sheets", "Nuclear Theory Index Booklets", and "Nuclear Data Tables".

The activities of the Group require a determination of the values actually measured by the author; very often, it is not always quite clear what data have been derived from previous publications of other authors. The resolution of the instrumentation used, the materials used for the measurement or background which interfere with the radiation are often responsible for the discrepancies in the literature.

Thus, the analyzed material is an important research tool; the information was used as the basis for many theoretical studies.

Charged-Particle Cross-Section Data Center

This Center, which is also under the supervision of the Physics Division, continues an activity started at the Los Alamos Scientific Laboratory in 1955, aimed at the compilation of nuclear cross sections for charged-particle induced reactions. Information on elements from hydrogen to chromium were published at Los Alamos; the current work attempts to complete the cycle by collecting information on elements from manganese to uranium; at the same time, material needed for the revision of the first portion of the compilation is collected. An up-to-date listing of published charged-particle cross sections is maintained for use by members of the Laboratory and interested outsiders.

The first volume of the series ("Nuclear Cross Sections for Charged-Particle Induced Reactions, Mn, Fe, Co") was completed in June, 1964

and was included in the material presented by the U. S. Delegation at the Third Geneva Conference. The second volume is completed and will be published in the near future.

The staff consists of experimentalists who spend about one-half of their time on data compilation and evaluation. Their output which presents existing data in a compact and integrated form, is a valuable tool for experimental and theoretical nuclear physicists, especially for those involved in optical model analyses of existing nuclear cross sections for charged-particle-induced reactions. Inconsistencies between several sets of data are often responsible for the immediate start of new series of measurements.

The volume of data to be compiled is steadily increasing because many new tandem Van-de-Graaff accelerators and cyclotrons, which accelerate a wide variety of ions, were placed in operation during the recent years, increasing the energy range over which cross sections for charged-particle-induced reactions are measured.

The "best values" of the cross sections for charged-particle-induced reactions are presented in graphical form with the grid lines reproduced; the data are also given in tabular form for all charged-particle-induced reactions, including heavy ions, at all energies of the form A(x,y)B where $M_x \geqslant$ one nucleon mass. Reactions involving mesons in the exit channel are not included.

Bibliographies for several special types of measurements, which are not included in the graphical format, e.g., energy spectra, angular correlations, and relative cross-section data are also compiled.

Isotopes Information Center

It has been stated that radioisotopes are the most important scientific tool to have appeared since the microscope. Organization of the rapidly accumulating publications involving radioisotopes is the chief purpose of the Isotopes Information Center which was established at the Laboratory about two years ago. At present, it is still in the preliminary planning and building stage and will not be in full operation for another year.

The scope of the Center embraces all phases of science and technology of radioactive and stable isotopes, with the information being collected from the open journals and from the report literature. The reports are of considerable interest, since the information often is not otherwise available.

In addition to scientists, the users of the Center include persons primarily interested in the application of isotopes in industry; therefore the information is organized according to individual isotopes and general areas of application. From time to time, specialized bibliographies covering a specific technological field or

important isotope will be published. Members of the Center also act as editors of the AEC quarterly review journal, "Isotopes and Radiation Technology", which has been the major output of the Center. Others include the bibliography of ORNL reports on isotopes and special brochures on the production of specific isotopes.

In order to identify the material, approximately 600 publications are routinely scanned; also included are several abstract journals, including Nuclear Science Abstracts, Excerpta Medica, Public Health Engineering Abstracts, Review of Metals Literature, Refrativnyi Zhurnal, etc. A large number of the publications are abstracted in NSA, but many additional industrial and agricultural applications which are out of scope for NSA fall within the scope of the Center, so must be covered separately. Close cooperation has been established with a specialized group at the Library of Congress to help with the foreign literature.

Each document is studied and indexed by a staff member; the system is organized in such a fashion as to retrieve information, rather than documents. The currently used file card indexing will soon be replaced by a Termatrex system.

The IIC is part of the Isotopes Development Center, organized to coordinate the research efforts on isotopes at the Laboratory.

Nuclear Safety Information Center

While the other information centers are restricted to a relatively clearly defined field of science or technology, the Nuclear Safety Information Center, of necessity, must cover a wide territory, cutting across various disciplines; the responsibility for the collection and dissemination of carefully evaluated nuclear safety information assigned to it by AEC requires the collaboration of experts with varied background.

At the present time the activities of the Center cover the following areas: (1) containment of nuclear facilities; (2) fission product release, transport and removal; (3) meteorological considerations; (4) nuclear instrumentation control and safety systems; (5) radioactive effluent control, monitoring, movement and dosage; (6) reactor transients, kinetics and stability. It is planned to cover additional areas at a later date, after the initial programs are well established.

A professional ORNL staff member serves as the part-time chairman of the activities carried out in each of these areas*. The individuals

* In at least one case, the services of an outside expert have been secured. In general, it is expected that outside assistance will be obtained in areas in which the Laboratory has no special competence.

maintain offices at the Center but continue their usual research activities within their own divisions. They evaluate material themselves or assign it to others, maintaining a close contact with the literature of their field. They are supported by the director, the associate director and the full-time local staff of the Center; in addition, the handling of the numerous documents is facilitated by a close working arrangement with the Document Section of the Y-12 Technical Library, located next door.

The essential information extracted from the documents is stored on filing cards; key words are used for indexing. This system allows rapid access under each of the key subjects. Arrangements are being made to process this information by a special IBM 7090 code which will permit the automatic preparation of periodical bibliographic lists or the conduct of special searches.

One of the chief purposes of this Center is to act as a consultant to the Division of Reactor Development of AEC; in addition, it will advise interested technical persons on radiation safety questions. Publication of the AEC Quarterly Review Nuclear Safety is also a function of some members of the Center which is part of the Reactor Division of the Laboratory.

Research Materials Information Center

Specific, up-to-date information about the availability and the quality of high-purity research specimens is of considerable interest to solid-state research workers who often encounter difficulties in finding a source of supply for a needed high purity material. Although a large number of materials are produced by commercial, private, university, and government laboratories, the published literature seldom includes a detailed description of the methods used for their preparation, assay and ultimate purity. The Research Materials Information Center was organized to fill this need acting as a central agency on the availability, methods of characterization, and properties of high-purity inorganic research materials such as metals, alloys, semiconductors, refractory and insulating compounds, lasers, masers and other optical materials, and magnetic materials.

Data on the purity and the availability of these materials and on the methods used for the determination are collected by means of a questionnaire sent to researchers and to the commercial producers.

A card is assigned to every material brought to the attention of the Center; any time an improved or changed material or a new source is added to a card, the information is checked against the names in the file on requests. If the new material fits the request specifications, the requester is notified of the source. "Feedback" from the users helps to evaluate the validity of the purity claimed by the supply

source. The inverse file of research materials that are not available but are desired by various investigators is also an important tool, as it indicates newly emerging fields of research.

Structural materials, electronic devices, radiation effects, radioactive and stable isotopes are not included (with the possible exception of their use in analytical methods) because they are sufficiently well covered by other information centers.

The abstracts and papers pertaining to the preparation, characterization methods and properties of the materials are cross-indexed and stored in the Recordak Miracode system, incorporating a 16-mm microfilm camera and a searcher-viewer.

The key terms selected from a thesaurus containing more than 300 terms is imposed on the film of the document; the machine scans the coded film and stops at each document that has been coded as containing information pertinent to the question. The machine can be instructed to print out copies of the first pages of all documents, thus compiling bibliographies of the desired fields; it can be used also for browsing. The present collection is about 13,000 documents.

The Center, which is under the supervision of the Solid State Division, publishes newsletters and bibliographies and maintains a close, direct contact with researchers in the field.

Radiation Shielding Information Center

Originally, the Center was organized to cover the field of low-energy shielding, restricting the collection of shielding information to problems related to reactors and radiochemical plants; more recently, the areas of weapons shielding and protection against high-energy radiation encountered in space and near accelerators have been included.

The chief operational component of the Center is a computer-oriented information retrieval system which contains abstracted and categorized shielding information obtained through surveys of pertinent books, journals, and reports and an archival microfiche file containing the analyzed literature. In order to facilitate the input, coordinators have been appointed at laboratories at which a considerable amount of shielding work is carried out.

The Center's services will consist in answering inquiries, issuing bibliographies of shielding information, writing critical reviews and state-of-the-art reports, and issuing compilations of useful data. An important byproduct is the evaluation of digital computer codes, developed throughout the country for shielding calculations. These codes are examined at the Laboratory and are made available to the technical community.

The Center is supervised by the Neutron Physics Division, members of which (in addition to the regular staff) collaborate closely in the evaluation of the material collected.

Information Center for Internal Exposure

This Center which is a part of the Health Physics Division assembles and interprets data related to the radiation dose received from internally deposited radionuclides. The material is obtained from project literature, open publications on the metabolism of radionuclides in various animals and man, and also from data on accidental intake of radionuclides by humans and therapeutic studies on radionuclides. Personal correspondence with members of the subcommittees on internal dose of the International Commission for Radiological Protection and the corresponding National Committee is an important source for new data.

The purpose of the Center is to evaluate the experimental data for inclusion in the appropriate ICRP and NPRP handbooks as a nationally and internationally accepted maximum permissible concentration value. The work involves the establishment of mathematical metabolic models which allows one to correlate the body dose with the maximum permissible values in the environment (air, water, food, etc.). The data obtained from the papers must be used to construct such a model. A large portion of the information consists of fragmented data; it is the duty of the Center to extrapolate these data to humans, or at least to make "best guesses", reducing the still existing uncertainties in the maximum permissible values. The data are often extracted from papers describing experiments carried out for a different purpose; this is the case in particular of medical papers. For this reason, indexes cannot be completely relied upon but papers even remotely related are carefully scanned.

The proposed MPC values are calculated for continuous exposure; this again requires special mathematical handling of the experimental data, because most studies relate to a single intake. Usually, only cases in which the animals are not harmed by the exposure are considered; this requirement makes it necessary to evaluate carefully any data obtained from studies concerned with biological effects of radiation.

The nature of this work requires collaboration between several specialists; the staff includes a "mathematical biologist". Indeed, persons collaborating include mathematicians, biologists, health physicists, and chemists.

Atomic and Molecular Processes Information Center

This group is about to be established formally at the Thermonuclear Division, where the information available in the field of atomic and molecular collisions has been systematically collected and organized

for the last four years. Users of the material include workers in plasma physics, astrophysics, optics, laser and maser research, magnetohydrodynamics and nuclear physics. The main purpose of the Center is to prepare future editions of the data collection, first published in 1964 and provide for its extension into neighboring areas which might be of interest. Currently, data are collected in the fields of electron-heavy particle, heavy particle-heavy particle and photon-heavy particle reactions, together with surface interactions and interactions of electric and magnetic fields with excited atoms or ions. The energy range is very broad: from thermal energies to several Mev.

The individuals connected with the Center will spend only about one-fourth of their time in data handling, continuing their own experimental or theoretical research during the rest of the time. Several storage and retrieval systems are being considered by the Center; quite probably, a computer-oriented system will be adopted.

Liquid Metals Information Center

In view of the broad interest of the Laboratory in liquid metals, establishment of a "mission oriented" center is strongly supported by the Laboratory. At present, work is in progress at ORNL on the analytical chemistry of liquid metals, thermophysical property determinations, materials compatibility, heat transfer, fluid flow, and engineering aspects of component development, including the design of pumps, valves, heat exchanger, etc. A great body of experience has been accumulated at the Laboratory through the operation of large liquid-metals systems.

The interest of the Laboratory in this activity dates from 1948; the first two editions of the authoritative Liquid Metals Handbook were prepared by a Laboratory staff member who retains his interest in this area of research.

A recent study by the Battelle Memorial Institute, carried out at the request of the Division of Technical Information of AEC, revealed that increasingly large numbers of papers are published in the field of liquid metals which are important in several areas of science and technology. The report's authors concluded that the establishment of a center would be of great benefit to both researchers and system developers; up to now, no final decision has yet been reached in this matter.

If responsibility for the Center is assigned to ORNL, it is proposed to place it under the supervision of the Reactor Division, where a large amount of pertinent work is currently being carried out. It is planned to collaborate with existing activities in this area, such as the abstract journal on high-temperature liquid-metal technology, edited under the auspices of the Brookhaven National Laboratory, in order to make use of all the available talent. Rather than

only collecting data, the proposed Center would also act as a consultant on the design and the operation of liquid-metal handling installations.

Criticality Data Center

Engineers and scientists working in widely varied fields, such as reactor design, chemical and metallurgical processing of the fuels, transportation and storage of fissile materials must use criticality data for reasons of safety. Safe and economic specifications of processes for chemical and metallurgical treatments of fissile materials and for their transportation and storage must be established from the rather formidable amount of available data describing critical parameters of the three most abundant fissile isotopes. Relevant data are continuing to be generated, as they have been over an extended time, in a number of laboratories, both in this country and abroad. It is considered necessary to assemble these data which presently are recorded fragmentarily in laboratory progress reports issued by the various originating laboratories. In addition to the mere collection of the data, the results must be collated in order to make them more generally applicable to safety problems.

Limited effort has been expended in the past to achieve the above aims. The ever increasing quantity of information and of its potential usage now requires a more systematic and adequately organized endeavor. To achieve this, a Criticality Data Center has been proposed, to be staffed by a small group of responsible individuals who are experienced in both the production of the data and its application, and are acquainted with the presently active programs and the individuals responsible for them.

The expected output of the Center is typified by a recently published AEC report*. It is expected that this document will be extended through frequent revisions and by addenda to incorporate existing uncorrelated data and the results of future measurements.

The Center will be administered by the Neutron Physics Division.

Accelerator Information Center

The main interest of this Center, sponsored by the Electronuclear Division, consists in the maintenance of a highly selected document collection on the design, structural, and performance aspects of accelerators throughout the world. By the very nature of the subject matter, the literature in this field is limited and its source is not always

* TID-7028, "Critical Dimensions of Systems Containing U^{235}, Pu^{239}, and U^{233}", compiled by H. C. Paxton, J. T. Thomas, D. Callihan, and E. B. Johnson.

predictable; therefore, great reliance is made on personal contacts, internal reports, and unpublished information. In addition, design reports and specifications are collected by sending questionnaires to the operators of the known accelerators in the world.

The main output of the Center is a Directory of Accelerators which is recognized as the authoritative compendium of the field. The unique original document collection is of great help to persons engaged in the design of new accelerators.

In collaboration with other laboratories, staff members associated with the Center are active in the organization of specialized national and international conferences in the field of accelerators and assist in the preparation of the transactions of these meetings.

Engineering Data Collection

This information center maintains reference and loan files of engineering data consisting of engineering drawings and related documents; manufacturers' drawings, spare parts lists, operating manuals, technical handbooks, specifications, standards, current engineering journals, classified document file point, a limited collection of unclassified documents, and manufacturer's catalogs and handbooks.

The Center maintains files on standards and specifications from federal and industrial sources and major standardization groups, together with ORNL building construction specifications. The collection of manufacturers' and suppliers' catalogs is continuously updated. A special file has been organized on manufacturers' data on equipment and facilities installed at the Laboratory. This file is used to distribute the information needed for the operation and maintenance of the equipment. It includes warranties, drawings, specifications, operation and maintenance manuals, and other applicable manufacturers' data, furnished by the vendor in accordance with engineering specifications or requisitioners requirements.

Engineering drawings originated by the General Engineering and Construction Division or transmitted from other divisions or contractors are filed in a fireproof vault and are indexed for fast retrieval. A unitized microfilming program of all engineering drawings is in the planning stage. All current drawings and backlog drawings which have a reference value will be transferred to aperture cards and will be cross indexed. The system will allow to provide customer service from the microfilm by means of prints made on a diazo printer.

Drawing reference service will be provided by decks of cards distributed to using areas. A reader-printer and a duplicard reproducer will be available in the customer service area. Drawing lists will be provided as required by machine print out from a slave deck of cards maintained by the Mathematics Division.

The Center is supervised by the General Engineering and Construction Division.

Space Materials Properties Information Center

This Center was established by the Reactor Division as consultant to the Sandia Corporation to collect and critically evaluate data on the thermophysical, mechanical, and chemical properties of a limited group of materials of importance in aerospace nuclear safety considerations. The materials being studied include (1) SNAP system fuels such as the isotopes of Sr, Ce, Cm, Po, Pu, and U and their compounds, (2) reactor system fuels such as $UZrH_x$, and (3) refractory encapsulating metals such as W, Nb, Mo, Ta, etc., and special alloys such as Hastelloy-N, Haynes-25, etc.

The primary effort of the Center is a survey of both the open and project literature, tabulation of the data in loose-leaf form (on yellow sheets to emphasize the preliminary nature of the compilation), critical evaluation of the data, and finally publication of recommended "best" values (on white sheets).

The accumulated data are transmitted immediately to the sponsor for current use in aerospace nuclear safety calculations; they are also closely examined at ORNL in order to uncover gaps in the needed knowledge and provide a rational basis for recommending experimental programs. As a part of this latter function, the Center assesses the facilities and capabilities of physical property laboratories throughout the United States and critically considers all existing techniques for measuring these properties.

Because of its special nature, the Center can only answer inquiries submitted by individuals or organizations approved by the sponsoring agency.

Nuclear Instruments Information Center

Establishment of such a Center within the Instrumentation and Controls Division is currently under consideration by the Division of Technical Information of AEC. The field to be covered by the Center will encompass instruments used for the detection of particles and the associated equipment.

Water Desalination Collection

The water desalination studies which represent an important activity of the Laboratory cover several engineering and scientific fields.

The Central Research Library of the Technical Information Division assembled a large body of reports and articles of interest to the Water Research Program. For the time being, the material is only accumulated and is not critically evaluated.

Nuclear Chart

The well-known Trilinear Chart of Nuclides, prepared under the supervision of the Technical Information Division, has been repeatedly brought up-to-date by the publication of new data sheets to be pasted on the chart. A large report and reprint collection including more than 30,000 items has been assembled during the preparation of this chart. As it was decided not to issue a new revised edition of the chart, the material has been transferred to the Nuclear Data Project.

Photographic Reference Collection

The more than 100,000 photographs of equipment and buildings taken at the Laboratory are maintained in the Laboratory Records Department of the Technical Information Division in an easily accessible form for the use of researchers and engineers for the purpose of assisting them in the preparation of reports. The material in the associated slide collection is an excellent tool for the preparation of oral presentations.

Range of Services

The above description of the centers indicates to a certain extent the variety of users and the depth of coverage. The primary function of the Isotope Information Center is to encourage the use of isotopes by assisting industrial researchers in the selection of the isotopes most suited for their problem. In addition, they have the responsibility to provide information in this field to the public at large, on behalf of AEC.

On the other hand, the Space Materials Information Center selects its materials according to the needs of a single sponsor and makes its collection available only if the approval of the sponsor has been obtained. The Engineering Data Collection and the Photographic Reference Collection, by their very nature, are of little interest to persons outside of ORNL, while the Research Materials Information Center serves scientists scattered in many government and university laboratories; it has little to offer to the public at large.

It should be emphasized that in principle (with the previously mentioned exception) services of the centers are available to qualified users without restriction. The formal output of the centers, newsletters, and bibliographies are distributed through the usual channels and may be obtained directly from the center in question. The publication of the Nuclear Data Project are available on a subscription basis through a commercial publisher.

Cooperation Between the ORNL Centers

Although the centers are supervised by the research divisions, active in their field of interest, steps have been taken to ensure that they cooperate closely with each other. During the monthly meetings, talks are presented by information specialists from other laboratories, attempting to make them aware of advances in the ever-growing field of information retrieval technology.

In order to reduce the overlap and to eliminate gaps an even closer contact is maintained between centers interested in similar areas. A specific paper might be in principle covered by the Radiation Shielding, the Isotope, the Nuclear Safety, or the Research Materials Information Centers. As a result of this cooperative effort, it is now understood that, e.g., the Nuclear Safety Information Center will not cover shielding or criticality problems; the Isotope Information Center will allow the NSIC to collect information in the field of handling of isotopes in hot cells or problems arising from a release of radioactive materials. The Research Materials Information Center will not gather data on pure isotopes; problems on criticality are, of course, within the purview of the Criticality Data Center. The important point is that if one of these centers receives a question in a field in which it does not maintain coverage, the operators know whom to consult in order to obtain the desired information.

The information centers organized at a large, multipurpose laboratory, such as ORNL, profit, of course, by the active research programs carried out in their field of specialization and by the presence of experts who can be called upon for technical assistance. In addition, advantage is taken of the many services rendered by the Technical Information Division. Rather than ordering themselves, the information centers obtain the needed reports, books, and other materials and services through the services of the procurement coordinator. The coordinator is a librarian with a thorough knowledge in the use of reference and bibliographic tools and understand the work processes of the various section of the library and of other departments of the Technical Information Division. The records kept indicate that during the first nine months of the year over 2,200 formal requests were processed; in addition, assistance was rendered in many minor areas.

Availability of the many services of TID and the expert staff of the libraries greatly facilitates the operation of the centers. These services are charged to an overhead account and not to the centers.

Collaboration with National and International Organizations

After a period of rapid growth, information centers in the United States reached a certain level of maturity, and organizations aimed at the improvement of collaboration between them start to exert a

strong influence on the services rendered. Most of the ORNL centers have been established relatively recently and therefore are able to profit from the existence of these coordinating agencies. Contacts have been made with the two major government agencies, the National Referral Center for Science and Technology, operated by the Library of Congress and the National Standard Reference Data Program of the National Bureau of Standards.

The first-mentioned agency acts as the "information desk" for the persons submitting queries in the field of science and engineering. The ORNL centers are included in the registry of groups providing specialized information functions and are thus a part of the national communication network. The National Standard Reference Data System is charged with the accumulation and critical evaluation of quantitative data. This function is to be carried out by centralized coordination at the National Bureau of Standards, and decentralized operation across the country. Some of the ORNL centers are expected to be formally designated as being specifically responsible for the collection and the critical evaluation of data in their field of interest.

It is hoped that a similar close collaboration will be maintained with the AEC and DOD-supervised information groups.

At the initiative of workers at the Battelle Memorial Institute*, the Laboratory is actively collaborating in the organization of a meeting of information center operators. It is expected that a continuously updated directory of information centers throughout the country will be an important byproduct of this and the probable subsequent meetings.

International cooperation between individual centers is in a less formalized state. In addition to the various exchanges of data collections, tapes, and other materials resulting from intergovernmental agencies, direct, personal contacts between information center managers and their foreign counterparts or individual scientists was found very useful. This type of cooperation does not rely on official documents and does not involve exchanges of funds; rather it is based on the helpful activity of individuals or groups who realized some benefit from the material supplied by a local center and find it mutually profitable to collaborate in the collection of otherwise difficultly available data and helping with the evaluation.

This system, recreating to a certain extent the historical method of communication between scientists, is very useful for providing an extensive coverage of the field. Quite naturally, it works both ways; several ORNL scientists serve as consultants and helpers of information centers located elsewhere.

* Which compiled "Specialized Science Information Services in the United States", published by the National Science Foundation.

Evaluation of the Centers

Several methods have been proposed for judging the value of a given information center to the scientific community. It is difficult to provide an exact standard to check the "productivity" of the center; the output can be counted and totalized but the resulting number - although giving a superficial estimate of the activity - is not more reliable than the practice of promoting an individual facility or staff member on basis of the number of articles published in a given time period or the number of citations of his papers in a citation index.

Data are currently accumulated on the number of queries processed by a center; the formal publications, such as bibliographies or compilations are, of course a part of record. Care should be taken also not to compare two otherwise unrelated information centers on the basis of these figures; the diversity of their nature is especially marked in this respect. The duty of a compilation group is to organize the critically evaluated material, making the collection conveniently available to all potential users, and keeping the data up-to-date by frequently issued revisions. In this case, a large number of queries is an indication that the desired goal was not reached. On the other hand, centers providing expert opinion of specific, usually engineering, problems cannot properly anticipate the nature of the problems to be solved and must rely on questions submitted orally or by mail.

The number of questions received depends also on the publicity concerning the center. Up to now the ORNL centers have not been widely used except in a few special cases. Care was taken not to overpublicize them too early at a stage of their development when they were not yet able to cope with a flood of queries. Now that a number of centers have reached a mature stage, steps will be taken to bring them to the attention of Laboratory personnel and of the scientific community at large.

One method for estimating the usefulness of the center is direct contact with the users. This has been applied by at least one of the centers: persons who used the services were asked by a questionnaire to express their opinion about the quality of the material received in answer to their queries. The users remarks were gratifyingly satisfactory; at the same time, this feedback pointed out areas in which improvement was desired.

Budgeting

Under the conditions of operation of the ORNL information centers, a clear assignment of costs is not always feasible. The estimated annual costs of the centers do not always reflect the full expenditure because, as mentioned above, a certain portion of the cost is

absorbed by the general services rendered by the Technical Information Division. Occasionally, especially in the case of small or newly organized centers, the sponsoring division might provide temporarily secretarial and other special services. In other cases, the cost of operating the center is included in the budget of the division and does not appear as a special entry.

The cost of operating the various information centers, as estimated by the Budget and Programming Office is given below:

Research Materials Information Center	$ 40,000
Nuclear Safety Information Center	125,000
Accelerator Information Center	45,000
Charged-Particle Cross-Section Data Center	57,000
Radiation Shielding Information Center	110,000
Information Center for Internal Exposure	100,000
Isotopes Information Center	150,000
Nuclear Data Group	260,000
	$887,000

The services of the Technical Information Division performed for the various centers are estimated to cost approximately $87,000. This amount will be distributed as overhead and the only cost to be charged directly will be overtime, unusual activities and work performed for outside parties.

There is very little information available in the literature on the detailed cost of input, storage, and retrieval operations of information centers. During a special symposium on cost at a recent meeting of the American Documentation Institute, widely varying figures were reported as cost estimates for abstracting and indexing a scientific article: the figures quoted ranged from about $2 to $15. It is planned to study the "unit operations" of information centers, establishing a common denominator as far as possible. The foregoing discussion already indicated the difficulties involved: the level of sophistication varies greatly; in some cases the original information is completely transformed, while in others it is simply more conveniently retrieved. Perhaps the largest amount of transformation is carried out in the Nuclear Data Group; their Data Sheets represent a compaction of volume at the ratio of about 1 to 40.

In Conclusion

The reasons for starting an information center are the same that motivated Beilstein, Gmelin, or Mellor to undertake the monumental task of bringing order in an all-engulfing flood of literature. These pioneers saw that their self-assigned task exceeded the capabilities of a single individual and strong organizations sprung up to lighten the load.

Even in more recent years, many information centers started from the private file card collection of an individual scientist. Currently, the duty is twofold: help to compress the literature and, whenever possible, evaluate the data critically, hoping to find new correlations.

Most of the ORNL information centers have now passed their stage of organization and are ready to serve the scientific and technical community. It is hoped that they can justify their existence by lightening the load on the research worker who otherwise would be forced to wade through voluminous publications in order to obtain data needed for his work.

Information Center Coordinator, F. Kertesz, Technical Information Division

Information Center	Sponsoring Division	Head
Accelerator Information Center	Electronuclear	F. T. Howard
Atomic and Molecular Processes Information Center	Thermonuclear	C. F. Barnett
Charged-Particle Cross-Section Data Center	Physics	F. K. McGowan
Criticality Data Center	Neutron Physics	A. D. Callihan
Engineering Data Collection	General Engineering and Construction	C. E. Burchsted
Information Center for Internal Exposure	Health Physics	R. S. Bernard
Isotopes Information Center	Isotopes	P. S. Baker
Liquid Metals Information Center	Reactor	R. N. Lyon
Nuclear Data Project	Physics	K. Way
Nuclear Instruments Information Center	Instrumentation and Controls	C. J. Borkowski
Nuclear Safety Information Center	Reactor	W. B. Cottrell
Photographic Reference Collection	Technical Information	N. T. Bray
Radiation Shielding Information Center	Neutron Physics	S. K. Penny
Research Materials Information Center	Solid State	T. F. Connolly

Information Center	Sponsoring Division	Head
Space Materials Information Center	Reactor	H. W. Hoffman
Water Desalination Collection	Director's	K. A. Kraus

Procurement Coordinator - Jo G. Sharp, Technical Information Division

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