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U.S. DEPARTMENT OF COMMERCE / National Bureau of Standards

MATERIALS INFORMATION PROGRAMS

An Interagency Review of Federal Agency Activities on Technical Information about Materials

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Office of Standard Reference Data — Office of Information Activities — Office of Technical Publications — Library — Office of International Relations — Office of International Standards.

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[1] Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D.C. 20234.

[2] Located at Boulder, Colorado 80302.

MATERIALS INFORMATION PROGRAMS
An Interagency Review of Federal Agency Activities on Technical Information about Materials

Proceedings of a Conference
held at the National Bureau of Standards
Gaithersburg, Maryland
April 16 and 17, 1974

Edited by

S. A. Rossmassler

Office of Standard Reference Data
National Bureau of Standards
Washington, DC 20234

Sponsored by
Interagency Council for Materials

Organized by
Working Group on Materials Information and Data

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FOREWORD

The Conference on Materials Information Programs was held on April 16 and 17, 1974, at the National Bureau of Standards, Gaithersburg, Maryland. It was planned, with sponsorship by the Interagency Council for Materials (ICM), as an interagency review of Federal agency activities on technical information about materials. The program was organized by the ICM Working Group on Materials Information and Data. Members of the Working Group are identified on the following page. The intent of the review was to develop a common awareness, among operators and sponsors of information activities, of opportunities to help each other solve problems and to improve their services to users.

The papers in these Proceedings are presented, for the most part, as submitted by the authors in the form of camera-ready copy. New work assignments for some of the authors interfered with the submission of their texts, and caused unfortunate delays in the present publication. On behalf of the ICM Working Group, the Editor apologizes for this situation. Some agency reorganizations which occurred after the Conference have led to archaisms in the text, not readily correctable. Readers should have no difficulty in substituting ERDA for AEC, and in making similar adjustments as needed.

Appreciation is extended to the NBS Office of Information Activities, especially Mrs. Sara Torrence and Miss Jo Ann Lorden, for the meeting arrangements. Mrs. Helen Johnson, of the NBS Office of Standard Reference Data, prepared the pre-conference material and handled financial matters. Mrs. Mary Schlager of the same Office prepared the final text of the Proceedings.

S. A. Rossmassler
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I. Introductory Session

Chairman: S. A. Rossmassler
National Bureau of Standards

Welcome Address to Attendees of Materials Information Programs Symposium, April 16, 1974

E. Horowitz

I want to welcome you to the National Bureau of Standards on behalf of Dr. Richard W. Roberts, the Director of NBS and Dr. John D. Hoffman, the Director of the Institute for Materials Research. On my own behalf, as Chairman of the Interagency Council for Materials, and as Deputy Director of the Institute for Materials Research, I am very pleased to open this Conference on Materials Information Programs in the Federal Government.

In announcing this conference, Dr. Rossmassler stated that materials information and data have assumed a position of greater importance than ever before in the total materials cycle because of the increasing demand for more materials, more reliable materials, better performing materials, and safer materials -- at a time of current materials shortages and when forecasters are predicting the age of the materials-limited society.

The program has been arranged to provide a review of Federal agency activities on materials information and data and is a major undertaking of the Interagency Council for Materials Working Group on Materials Information and Data. This conference is in accord with the original charter of ICM which states that it "will provide forums for the discussion of materials-related issues and promote cooperation and coordination among Federal agencies with materials programs." ICM, which was established in 1971 by Dr. Edward David when he was Science Advisor to the President, traces its origin to the Coordinating Committee for Materials Research and Development which was set up in 1959 under the Federal Council for Science and Technology. If we go back to the minutes of the meetings of CCMRD, we find that materials information and data figure prominently in the discussions and deliberations of the committee members. This interest was continued by the Interagency Council for Materials and led to establishment of the Working Group on Materials Information and Data less than a year ago.

This review will serve a number of important objectives. We will all come away better informed of the programs on materials information in other agencies. We will see more clearly those areas where, by working together, we can accomplish more than by going it alone, and perhaps where greater utilization can be made of existing facilities and resources. The proceedings of this conference can serve as an important source document on materials information activities in the Federal Government and should be useful to the materials managers and directors as well as policy-makers. I commend all those on the Working Group for Materials Information and Data for planning and arranging this conference. It is a fine example of government departments and agencies working together to solve materials problems. My special thanks also to the speakers and conferees for taking the time to participate in this very useful and unique meeting.

The National Significance of Materials Information

Franklin P. Huddle
Congressional Research Service
Library of Congress
Washington, D.C.

The management of scientific and technical information, an endless frontier, has its roots in the emergence of Homo sapiens, and in the achievement of symbolic communication. Computers have enlarged the human capacity for management of information. Materials management--which means the management of information about materials--is bound up with energy needs, environmental quality and our national economic health. National programs for materials information expanded greatly during the 1950's, and many current information programs have resulted from those early efforts. Present interest is focusing on national materials policy, programs for technology assessment, and a better definition of today's materials information needs.

Materials information, management, policy, national programs, technology assessment, energy, environmental quality.

I have four topics to discuss. First, the opportunities that lie before us into the next century in the proper management of scientific and technical information. Second, the social importance of materials science and engineering. Third, some historical recapitulation about materials information management since 1950. And fourth, an account of some recent developments to strengthen our national posture in the important subject this symposium was convened to address.

I. The information function seems to me the next great frontier. Possibly, it is so vast and intractable that it will remain forever a frontier. As Vanever Bush called it: "the endless frontier." Whether finite or infinite—and I am inclined to share the latter view--the information function is perhaps the greatest challenge yet to confront mankind.

How can we rationalize, bring order and rationality to, man's knowledge of his universe? That is the cosmic question. The nation that best answers this question will exercise world leadership in the 21st century. The way this leadership will be attained is by a step-by-step process.

Step One will be a development of sound information theory in which the relations of every fact to every other fact are accurately recorded and made accessible.

Step Two will be the development of means for the identification of users of facts, on a preferential basis, so that those persons and institutions best able to use particular facts and clusters of facts are quickly assured their possession.

Step Three will be the devising of institutions to apply the capabilities developed under Steps One and Two.

Step Four, less obvious but of great importance in maintaining a continuity of excellence in information management, will be the establishment of an institution to detect flaws and erosion or decay in the national system of information management and to correct or arrest them.

Step Five, also of great importance and difficulty, will be the elimination from the system of outworn, obsolete, and superseded facts and clusters of facts; the replacement of unsound structures of information with better structures.

I state this concept of a national objective with the thought that it can provide a framework within which the myriad of elements of information management can be coherently organized toward a unified national purpose.

The history of information management began with the emergence of Homo sapiens as the dominant species on our planet. Communication and concerted action and transmission of tribal behavior are not unique to man: they are evident in schools of fish, the flight of birds, the protective behavior of herds of herbivores. But man's achievement of symbolic communication enabled him to achieve a subtlety and detail of communication unattainable by the other animals. Written symbols could convey intelligence to persons remote in space or time. They could store information beyond the human capacity to retain. They could be subjected to verification or correction from one person to another. Bodies of written information could be enlarged by succeeding generations. By means of the priceless tool of the printed symbol man progressed.

Then, starting about 1950, man invented the electronic brain. Since then it has become increasingly apparent that the human capacity for the management--the collection, storage, retrieval, manipulation, and dissemination--of information has no necessary limits in quantity or scope. The technology is available for total information management. All that remains to be done is for man to apply this technology systematically and rationally, by assembling the hardware and software, devising the taxonomies of knowledge, and organizing the human institutions to manage and use the product.

To be sure, there still remain a few gaps. Our computers need to be able to scan and record pictorial patterns and recognize them when they see them again. Our data banks need further compression. We need to teach them learning processes so that they can discard what is incorrect or superfluous. A better marriage of microfilm to the computer is needed.

But most of all, the human mind and the computer both need to learn how to work in closer harmony.

One of the great unanswered questions is whether there are functions that man's brain can perform that are inherently impossible to the computer. So far there is no record of a computer printout that said "Dammit--I goofed!" Nor has a computer responded to a question with its own question: "Why do you want to know that?" Nor is there any record of a computer bursting out enthusiastically with "isn't that a great problem?" "What a beautiful solution!" or: "This doesn't make sense to me either." Or--even more to the point--"I don't like the direction we're taking." The computer brain cannot tolerate radioactivity or heat, but we have yet to hear one say "ouch!"

Some of these responses would be easy to program. Others would not. But as we and the computer progress together, I am sure we will teach each other how to cooperate more closely, to share the work, and possibly to share even the frustrations of defeat and blind alleys.

Meanwhile, what shall we do about the management of information? As we search for ways of improving our systems of intelligence in 1974, how can we at the same time move positively toward goals a century in the future?

II. The subject of this conference is Materials Information Systems. I have already made the case, I hope, that information management is central to human development. No less is it important that man learn to improve his management of materials.

No matter where we look, we find that materials provide the opportunities and the obstacles to human progress. In the field of energy, for example, every alternative to fossil fuels as the source of heat, light, and motive power calls for innovative materials technology. Every proposed technology to improve our efficiency in the use of fossil fuels is materials-limited.

The national quest for environmental quality is another case in point. Pollution itself is nothing more nor less than materials mismanaged. Threats to human health from toxic materials in commerce are evidence of our want of knowledge about the materials in everyday use.

The economic challenges of Japan and Germany come not from any inherent skill or resources, but from a better management of knowledge of the production, fabrication, and design of everyday implements and devices--using materials more skillfully than we. Compelled by their own deficiencies, they have planned ahead, designed more attentively to human needs, learned to recyle materials more completely, and developed more effective techniques of basic materials processing from lower grade ores. All these achievements were based ultimately on technical information, much of which came from the United States. Thus, we have relinquished our superiority in the use of industrial materials and at the same time have allowed ourselves to be surpassed in the management of materials information. While insisting that we should be second to no nation in our military strength, we have permitted a deterioration in the industrial skills needed to earn the taxes to support this military strength as well as to provide the technology to sustain it.

In the short term, we have passed, this winter, through the traumatic experience of an insufficiency of petroleum. The certainty that we will be unable to afford previous profligate consumption of imported petroleum has not yet struck home. Nor have we yet grasped the equal truth that material abundance is a thing of the past. The buyers' market for tin, nickel, chromium, manganese, cobalt, and bauxite is inexorably turning into a sellers' market. We must pay for what we need, and we will be in competition with many other developed nations in what we buy. What we have to sell must be better and cheaper, if we are to compete for sales in order to have the wherewithal to compete for materials.

In this future competition, our management of materials will be the decisive element. And to manage materials effectively requires our best use of materials information.

III. Back in the late 1950's, and up to 1963, the institutions for the management of technical information in materials were mainly funded by the Department of Defense. That agency sponsored the Defense Documentation Center, the Titanium Metallurgical Laboratory--precursor to the Defense Metals and Ceramics Information Center, the Electronic Materials Information Center, the Plastics Technical Evaluation Center, and the Thermophysical Properties Research Center.

During my stint in ODDR&E, I developed a "grand design" for an interlocked set of four materials centers, on metals, polymers, ceramics, and composites. I had in mind an experiment under which one of these would be managed by a not-for-profit, one by a military field establishment, one by a university, and one by a private industrial corporation. This experiment would serve the double purpose of advancing our management of materials information while at the same time it would reveal the strengths and weaknesses of four different kinds of management. I left the Department of Defense with my grand design only half completed. We had set up the metals center at Battelle and Plastec at Picatinny Arsenal; we had obtained funding support for a ceramics center which the Air Force agreed to manage; but the composite materials center never really got underway, and the ceramics center was coupled in with DMIC at Battelle.

You might be interested in some of the background that led to this burst of activity in materials information management in the late 1950's.

One element was a report of a program in the Soviet Union that was about to centralize the management of all technical information. This was the "All-Union Institute of Scientific and Technical Information." A PSAC panel at the time, headed by Bill Baker of Bell Labs, recommended against any such center in this country, but urged a great increase of attention to the information function on a decentralized basis, with the support of the National Science Foundation.

Another element was the enormous expansion, at the time, of DOD support for materials research and development. It had become evident to the R&D leadership in the Department that every advanced weapon system in development or in concept was constrained in achievement of required levels of performance because of the limitations of materials. The limitations included jet engine hot spots, leading edges of supersonic aircraft, ablating surfaces of reentry vehicles, jetovators and rocket nozzles, the joining of titanium, and many other strategic and tactical requirements. As we tripled or quadrupled our expenditures for materials R&D, we were particularly concerned that R&D results should become promptly available to users. We were distressed, for example, to learn that after all our efforts to support a refractory metal sheet rolling program, the designers of the B-70 were content to use tool steel in sheet form for leading edges. It was evident that a closer coupling of high performance materials and engineering design was needed.

As the funding of materials R&D began to fall off somewhat, in the later 1960's, it seemed evident to me that an even larger effort was needed in the management of materials information. As the R&D product becomes more scarce, efficiency of its use grows in importance. But in practice, we reduced our effort in information management, consolidated our institutions, and began to apply the principle of making them self supporting through user charges.

Our original concept had been that information management was most important to exploit rapidly advancing technologies. The information needed analysis and evaluation by experts, so that information centers should also be operating research laboratories. We wanted to collect not only research findings but also the practical experience of materials engineers in industry, so we insisted that our information center personnel should go on the road from time to time, to pry data out of the engineers' little black books. We distinguished between useful information and published literature; we were concerned with the former rather than the latter. We believed, in short, that a knowledgeable scientist or technologist could read a report and pick out what was new and important in it; rather than building files of documents, we wanted to build files of up-to-the-minute information. Moreover, these files could be used to prepare valuable state-of-the-art reports in rapidly advancing fields. Our main concern, in short, was not with the building of large information repositories but with expediting the flow of useful new information into use.

IV. My fourth topic concerns where we stand today. When the Office of Technology Assessment began gearing up its program of studies, one of the four or five major areas it decided to concentrate on--with the approval of the Technology Assessment Board--was materials. In the process of formulating its program in materials the first topic to be taken up by OTA was materials information management.

Emilio Q. Daddario, Director of OTA, wrote president M. Eugene Merchant of the Federation of Materials Societies, asking the Federation to "undertake a survey of existing institutions providing the kinds of U.S. materials information services, with an appraisal of the services provided with respect to scope, quality, accessibility, completeness, and adequacy, relative to national need."

Mr. Daddario considered it "significant" that the Henniker Conferences on national materials policy in 1970 and 1972 "... stressed the need for a national materials inventory ... and called for legislation to support such a program ...." Then his letter continued:

"The need for a strong national program to generate, manage, and make accessible materials information and data appears to be well documented. The question from the point of view of the Office of Technology Assessment is whether this issue merits priority attention among the various claimants for OTA consideration. How urgent is it that action be taken to strengthen all or some particular aspects of materials information management in the United States, and what priority attention should be assigned to the various categories of such information? Among the categories we have in mind are the following:

"New science and technology in materials discovery

Patterns of technology of materials use

New science and technology of materials in application

Physical occurrence of minerals

Quantities and location of waste materials

Technology of waste recycling

Latent technology of substitution

Foreign data on materials supply and demand

Characterization of materials properties

Interactions of materials and energy

Interactions of materials and environment

Interactions of materials and the national economy

"A sense of urgency is communicated to this broad problem, first, by the current energy shortage and the important relationship to it of the availability of energy materials in the ground and materials aspects of new energy technologies; second, by the ongoing concern for the environment with its implications for disposal versus recycling of waste materials; and third, by the emergence of present and prospective shortages of numerous mineral and petrochemical materials with all the industrial and economic consequences that such shortages imply."

In response to the OTA invitation, the Board of Trustees of FMS agreed to undertake this task and delegated it to Dr. Jack Westbrook of the General Electric Company, and Chairman of the FMS Committee on Materials Information. Dr. Westbrook, Dr. John Wachtman, and Gene Merchant subsequently met with Director Daddario and his staff to develop the format for the study. The plan adopted was for the preparation of a questionnaire to be sent out to some 7500 materials scientists and technologists dealing with every aspect of materials information. The responses to the questionnaire would be machine coded and tabulated, in order to develop statistical information about the subject. In addition, they would be analyzed by Dr. Westbrook's Committee for qualitative information. From these two operations, a report would be prepared.

It was agreed that a report would be completed, at least in draft, in time for presentation on the opening day of the third Henniker symposium on national materials policy, to be held at New England College, August 11-16, 1974.

At this conference it is also planned that two parallel task forces will conduct workshops on national materials information policy. The terms of reference of their task are set forth as follows:

TASK ONE

THE MANAGEMENT OF MATERIALS INFORMATION

What can be done to improve the availability of pertinent, timely, reliable, and adequate information in all aspects of the materials life cycle to those who need this information in the conduct of materials programs, projects, application, and policy formulation?

Rationale

Decisions on the management of materials depend on the collection and analyses of many kinds of information. Global management of materials implies many kinds of information from many countries. Many systems of materials information have been established, such as the Canadian resources inventory, the ACS and ASM abstracts, journals, technical evaluation centers, translations, critical tables, standards and specifications, materials characterization, alloy tables, process data, state-of-the-art reports, corrosion and deterioration data, and reports of materials research completed and in progress. The volume of all these data is increasing at an exponential rate. Access to needed information is becoming more difficult, even while the literature becomes more abundant and duplicative.

Questions

1. What technical information should be available to users?

2. Is it possible to approach on a systematic basis the problem of consolidating and codifying materials data and information?

3. How can this body of knowledge be structured for storage, analysis, and access for retrieval to be more efficiently responsive to established consumer needs?

4. What methods of information management could ensure the international compatibility and exchange of materials information?

5. What first steps would be most cost/effective toward a global system for materials information management?

6. What would be a reasonable and feasible set of long range goals for materials information management?

7. Where should the initiative be located for a positive program in this field?

I hope that the findings of your ICM Conference here at the National Bureau of Standards will be made available to the "Henniker III" conference. I earnestly solicit your help in obtaining the fullest possible responses to the FMS inquiry for the OTA. And, of course, I hope that some of those here today will be able to attend the Henniker Conference to carry further the evolution of a sound and strong national policy for materials information management.

Conclusion

There is much to be done, not only in the short range to restore the industrial and technological superiority of the United States, but to build toward the preservation of this superiority in the next century.

Among the questions I hope this symposium will come to grips with are these:

Who should pay the costs of information management?

How can the social and economic value of information services be demonstrated?

How can the computer be sensibly incorporated in our information systems?

How can the information content of individual papers or deposited units be increased?

How can the information storage bank be purged of obsoletes? and,

How can the volume of papers be reduced without reducing information content?

For the longer range future, I hope that we can revive in the National Science Foundation the program started back in the 1950's by Bert Adkinson to build a sophisticated understanding of the theory of scientific information management. We need a better rationale for what we are trying to do.

I hope, also, that we can learn to solve the problems I identified at the outset of my paper: to learn how the users of facts can be better coupled with the purveyors of facts. Not least of our problems is the circumstance that our technical schools and universities too often take for granted that information flow is a natural function that needs no attention. I submit that users of information need to be trained quite as much as do those who collect and disseminate it.

A national system of information management may or may not be appropriate for this individualistic nation. But surely there is unity to all scientific knowledge about our universe. There is a unity in our knowledge about materials. We must build a unity also into the institutions that manage that knowledge.

Our skills in the laboratory, in the design of new technologies, and in our industrial processes lag behind what we ought to be capable of, because we have not designed the institutions and systems to bring needed information to the user.

There will always be room for improvement in any human endeavor. But I can think of no one field where improvement in our performance can have as consequential results for the public benefit as in the management and efficient use of materials information.

II. U. S. Department of Agriculture Session

Chairman: Mary B. O'Hara
Forest Service

Review of Agriculture Information Program
Materials Information in the Forest Service

John I. Zerbe*
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Development and dissemination of wood and other forest products materials has been a major function of the Forest Service from its beginning in 1876, almost a century ago. An early report by Dr. Franklin B. Hough discussed wood use in railroad ties, fuel, paper-making, and charcoal, together with naval stores and tannins obtained from wood.

This first report preceded a long line of publications which cover all aspects of forest products materials production, processing, and usage, as well as physical and chemical characteristics. Technology transfer is also accomplished through forest products specialists in the State and Private Forestry Arm of the Forest Service and by participation of research scientists in public information forums and, in some cases, consultations with individuals and small groups.

An example of a comprehensive coverage of wood as a material is Agriculture Handbook No. 72, the "Wood Handbook." This has been a good seller at the Government Printing Office, and the most recent 1955 edition has been sold out for several years. Many requests are on hand for a new edition which will be out during the next year. Another extensive treatment of wood as a material is the two-volume work, "Utilization of the Southern Pines," by Dr. Peter Koch of the Southern Forest Experiment Station, Agriculture Handbook No. 420.

An example of the State and Private Forestry work in disseminating information on forest products is a program for showing sawmill operators possibilities for using research results to gain greater efficiency in their conversion of logs to lumber. In this effort, called the Sawmill Improvement Program, about 200 sawmills have been studied to demonstrate how production output from a given quantity of raw material may be higher through the use of better machinery, such as scanners and computers, and better quality control, leading to more accurate sizing of logs and reduction of waste in sawing and planing the finished product. Programs such as this can

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Keywords: AIDS; bark; forest products; glues and gluing; information service; lumber; mechanical properties; paper; pulp; timber; wood; wood products

be pilot projects of what might be done. It is possible, for example, that the application of new technology could significantly raise the number of board feet produced from one log.

An example of a research service function to disseminate information is the fulfillment of many requests for identification of wood specimens as to botanical species. It is not too difficult for the layman to separate oaks from walnut or cherry; but, identification of an obscure tropical species often requires a scientist with specialized knowledge and wide experience.

Person-to-person contact and consultation programs are effective in transferring technology on a limited scale, but affordable broad scale coverage is, of course, dependent on publication. Cataloging and classifying publications so they are more readily identifiable and accessible to the potential user is a field in which we have limited experience, but one in which we are making good progress through the work of Mary O'Hara and specialists working with her.

To simplify the selection of publications, we have various lists such as "List of Available Publications of the United States Department of Agriculture," "List of Forest Service Publications by Subject," "List of Publications of Interest to Architects, Builders, Engineers, and Retail Lumbermen," "List of Publications on Wood Chemistry," "List of Publications on Wood Preservation," "List of Publications on Fire Performance," and "List of Publications Relating to Wood Finishing Subjects." We can provide these lists to people who are interested in these publications.

Another aid in simplifying searches for forest products materials publications by title and keywords in titles is a so-called "KWIC" index. This keyword in content index contains keywords from titles arranged alphabetically in printed columns. In addition to the keyword, each printed line contains the remainder of the title up to a total of 60 characters and spaces.

Retrieval of publications by authors is facilitated by an author card file index.

Our next step is to abstract Forest Service research publications and provide for an automated retrieval system of titles and abstracts. We are working with the Atomic Energy Commission to incorporate our information into their operating system. International dissemination will probably be handled through AGRIS, which is a new effort being sponsored by the Food and Agriculture Organization of the United Nations.

Another Forest Service scientist is cooperating with the Forest Products Research Society in expanding an existing information system.

Called AIDS, for Abstract Information Digest Service, it covers published information on wood as a material and solid wood products throughout the world, with emphasis on North America. A part of the system is a detailed abstract of items published in English. Abstracts are from journals and university and government publications, books, and U.S. and Canadian patents. Foreign language publications are usually included in the system by title only.

Retrieval of AIDS titles and abstracts is through computer access or microfiche indexes. Abstracts disclosed by a search are available for purchase.

The AIDS information system covers subject matter in the following 23 areas:

1. Hardwood and Softwood Lumber
2. Treated Wood Products
3. Construction and Decorative Plywood and Veneers
4. Hardboard, Insulation Board, Particleboard, and Molded Products
5. Pulp and Paper
6. Furniture, Dimension Stock, Turned Stock, Millwork, Cabinets, and Fixtures
7. Wood Engineering, Mechanical Properties, Laminated Construction, Engineered Structures, and Mechanical Fastening
8. Residential and Commercial Construction
9. Pallets and Containers
10. Tropical Woods
11. Bark and Residues
12. Production Management and Quality Control
13. Economics, Financial, and Research Management
14. Marketing
15. Timber Production
16. Drying and Storage
17. Glues and Gluing
18. Milling and Machining
19. Finishing and Overlaying
20. Pollution Abatement and Control
21. Biology
22. Chemistry
23. Physics

We believe that extension of computerized information retrieval systems will be effective in providing needed forest products information to the industrial user as well as the researcher. In addition, we regularly develop publications of broad general interest. An example of such a publication is a Current Information Report on the Outlook for Meeting Future Timber Demands. This consumer-oriented publication is a very brief abstract of a much larger publication which is developed periodically. With abstracts such as this we feel that we are getting our story across, but we look forward to doing a better job in the near future.

The Current Research Information System (CRIS) as a Source for Materials Information in the Agricultural and Allied Sciences

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U.S. Department of Agriculture
Washington, D.C.

The Current Research Information System (CRIS) is described as an available source for project summary information on current research on agricultural and related materials. An overview of the system is provided and a characterization is given for features relating to system inputs, the nature and size of the data base, information sources, the user population, and types of output generated. Summaries of the results of selected searches provide indications as to level of effort for research on properties of food and non-food products, in terms of scientist man years and number of projects, by field of science and agricultural commodity. The form and content of the CRIS Standard Technical Printout are illustrated, and user instructions for requesting CRIS searches are detailed.

Agricultural materials, agricultural research, biological properties, chemical properties, engineering properties, food products, information retrieval systems, management information systems, materials, non-food products, physical properties, research information

The Current Research Information System (CRIS) as a Source for Materials Information in the Agricultural and Allied Sciences

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Overview. The Current Research Information System (CRIS), established by the U.S. Department of Agriculture in 1966, is designed to serve basically two purposes: to improve communications among scientists with regard to research presently underway; and to provide more effective management information on the total research programs of the State agricultural experiment stations and the U.S. Department of Agriculture (1)[1]. Specifically, CRIS is a computer-based retrieval system that provides technical and management information about on-going and recently completed research conducted by the six USDA research agencies, the State agricultural experiment stations at 53 locations, and 30 forestry schools and other cooperating institutions, including the colleges of 1890 and Tuskegee University. The system services mainly research scientists and research administrators at these institutions, as well as other Federal agencies and certain other governmental agencies and organizations. Systems outputs include both narrative summaries or abstracts of individual research projects, and financial and manpower information that indicates level of research effort by program, location, problem area, or by type of administrative division or subject category.

Input. Input consists of both technical and management information for each research project at the work-unit level. Technical input includes, for example, title, objective, plan of work, investigators' names, performing institution, department, and location. Also included as input are classification data describing the subject matter of the research by percentage of effort

* Technical Information Specialist
1 Figures in parenthesis indicate the literature references at the end of this paper

according to plant or animal commodity, resource, and field of science, and by activities and problem areas that are keyed to the Department's long-range programs in agricultural research. Other special categories, such as pollution, health, or poverty-related, are coded and weighted by means of percentages if applicable. Progress made during the course of the most recent annual or semi-annual reporting period, and citations to publications generated during the same period are also included as input. Management information entered for each project includes the amount of money allocated from each source of funds and manpower allocations by type of manpower--scientist, professional support, technical and clerical support. The start to termination date of each project normally runs from three to five years, so that three to five financial and progress updates are processed for each project during the life of a work-unit.

Output. Products are varied, ranging from standardized formats carrying narrative project write-ups, to customized summaries of funds and manpower, totaled and sorted by subject, organizational division, or otherwise as specified by the user. Most outputs are provided on demand and are based on a master file of active and recently completed projects. However, a number of recurring reports are generated annually, including the "Inventory of Agricultural Research," which is issued yearly as a publication by the U.S. Department of Agriculture (2). Retrospective searches of previously terminated projects, including progress and publications from prior years, are also made available on special request.

Nature and Size of the CRIS File. CRIS maintains an average of approximately 26,000 active and recently completed projects on the master file annually, with purging performed at completion of yearly financial and progress updates. Subject coverage includes: soils, land, water and related natural resources; all plant and animal commodities, including those raised for food, feed, and fiber; fish and wildlife; trees and forest products; and human and man-made resources, communities, and institutions. Fields of science represented include all the biological and agricultural sciences, the physical sciences, economics, sociology, psychology and related. While activities and problem areas are oriented toward applied and developmental aspects, a significant portion of the total effort is on basic research. Retrievals are based on Boolean logic, using both keyword and classification searches, alone or in combination. Added capability permits the use of percentages or weights in conjunction with classification searches. At the present time, over 500 broad subject classification codes, some 14,000 individual keywords and over 100 data elements are available for use as search parameters.

CRIS as a Source for Materials Information. Broadly viewed, agricultural materials occur in the form of raw commodities, processed products, or natural or man-made resources. These include: crop and animal commodities in their natural state; processed farm and forest products in marketable or consumable form; soils, land and water; supplies and equipment; agricultural pollutants; crop and animal wastes; and the entire range of agricultural chemicals such as fertilizers, pesticides, and growth substances. Virtually every phase of the agricultural production, distribution and marketing cycle involves some aspect of materials performance and properties.

The value of information about characteristics and properties of agricultural materials is addressed by Mohsenin (3) in his book on this subject:

> Modern agriculture has brought about the handling and processing of plant and animal materials by various means such as mechanical, thermal, electrical, optical and even sonic techniques and devices. Despite these ever increasing applications, little is known about the basic physical characteristics, and properties of these materials. Specific heat and other thermal characteristics, electrical conductivity and dielectric constants, light transmittance characteristics, and such mechanical properties as stress-strain behavior, resistance to compression, impact and shear, and coefficient of friction are a few examples of these unknown properties. A knowledge of these properties should constitute important and essential engineering data in design of machines, structures, processes and controls; in analyzing and determining the efficiency of a machine or an operation; in developing new consumer products of plant or animal origins; and in evaluating and retaining the quality of the final product. Such basic information should be of value not only to engineers but also to food scientists and processors, plant and animal breeders, and other scientists who may exploit these properties and find new uses. To understand and appreciate the need for information on physical properties of plant and animal products...

To illustrate the nature and size of the CRIS file in selected areas of materials research, the results of two searches on properties of food and non-food products are summarized in Tables 1 and 2. These show the results of broad classification searches for all projects classified to CRIS Activity 5400 (Chemical and physical properties of food products) and CRIS Activity 5600 (Chemical and physical properties of non-food products). Level of effort for FY 73 is shown by scientist man years (SMY's) committed to each of these activities by commodity and field of science. The total number of current projects (FY 73 and new) is also given for each commodity and field of science.

Table 1 shows that for research in the physical sciences on properties of food products, level of effort in terms of FY 73 SMY's was about the same for deciduous fruit and tree nuts (33 SMY's) and dairy products (32 SMY's). Following in order by SMY's in the physical sciences are: poultry products; citrus and subtropical fruit; vegetables and wheat; soybeans, food (general) and cottonseed; potatoes; swine, peanuts and corn; fish and game; and beef. A total of 252 SMY's for FY 73 was committed for research in the physical sciences with over 700 current projects classified to properties of food products.

For research in the physical sciences relating to properties of non-food products, Table 2 shows that 173 SMY's, or 69% of the level of effort for FY 73 on this activity was committed to cotton (93 SMY's) and trees and forest products (80 SMY's). A total of 172 current projects was retrieved from the search on these two commodities, which represents 57% of all projects resulting from the search. Following in order by level of effort are: oilseeds and oil crops; sheep and wool; miscellaneous and new crops; clothing and textiles; and forage, cottonseed, and soybeans. The total of 250 SMY's for FY 73 represents the combined level of effort on chemical and physical properties of non-food products, with a corresponding total of 300 current projects for this activity.

It should be noted that the summaries of the results of these searches do not reflect the total CRIS file on materials research nor do they characterize all the system's output capabilities. Further searching would be necessary to explore other areas concerned with materials research, such as that dealing with characteristics and properties of soils, water, fertilizers, pesticides, pollutants, wastes, and so on. A recent search, for example, retrieved on the basis of keywords containing the term, "properties" -- "rheological properties," "thermal properties," "electrical properties," "mechanical properties," etc. -- indicates that close to 1,000 current projects, covering all activities, commodities, fields of science and problem areas, are contained on the master file. This, together with indications based on in-house indexes,

TABLE 1 Level of Effort and Size of File for Projects Classified to CRIS Activity Code A5400 -- Chemical and Physical Properties of Food Products

General Commodity	FY 73 Scientist Man Years by Field of Science: Chemistry	Biochemistry & Biophysics	Engineering	Physics	Physical Sciences Combined	Other	Current Projects
Deciduous fruit & tree nuts	10	17	6	-	33	8	70
Dairy Products	15	16	1	-	32	6	73
Poultry	14	11	4	-	29	5	67
Citrus & subtropical fruit	11	10	2	-	23	4	29
Vegetables	11	8	3	-	21	11	88
Wheat	11	10	-	-	21	2	40
Soybeans	14	1	-	-	15	1	23
Food, general	6	7	1	1	15	3	48
Cottonseed	9	2	4	-	15	-	12
Potatoes	5	4	2	-	11	3	25
Swine	2	7	-	-	9	4	52
Peanuts	7	1	1	-	9	1	16
Corn	6	1	2	-	9	3	21
Fish & game	2	2	1	-	5	3	21
Beef	4	-	-	-	4	6	66
Subtotal	127	97	27	1	252	60	651
Other	10	6	3	-	19	6	76
Total	137	103	30	1	271	66	727

TABLE 2 Level of Effort and Size of File for Projects Classified to CRIS Activity Code A5600 -- Chemical and Physical Properties of Non-Food Products

	FY 73 Scientist Man Years by Field of Science						
General Commodity	Chemistry	Engineering	Physics	Biochemistry & Biophysics	Physical Sciences Combined	Other	Current Projects
Cotton	63	14	16	-	93	1	53
Trees & forest products	26	40	12	2	80	31	119
Oilseeds & oil crops	16	1	-	-	17	3	16
Sheep & wool	4	3	1	2	10	-	3
Miscellaneous & new crops	8	-	-	-	8	-	3
Clothing & textiles	4	1	1	1	7	3	39
Forages	4	1	1	1	6	3	2
Cottonseed	6	-	-	-	6	1	6
Soybeans	6	-	-	-	6	-	6
Subtotal	137	60	30	6	233	42	247
Other	10	3	-	4	17	15	53
Total	147	63	30	10	250	57	300

search histories, and user interaction, suggests that the CRIS system could serve as an available source for information on materials research.

Example of the Standard Technical Printout. In conjunction with the two selected searches described above, one particularly relevant project by Mohsenin and Morrow, titled "Physical Properties of Agricultural Materials," was retrieved. This project is shown in figure 1 to illustrate the form and content of the CRIS Standard Technical Printout. This form of output provides the title, investigators' names, performing department, institution, location, objective, approach, keywords, and the most current progress. Although no publications were cited during the last progress reporting period shown (January 1973 to December 1973), a retrospective search of this project retrieved the previously noted reference, "Physical Properties of Plant and Animal Materials." The narrative in this work-unit is informative and indicated a wide range of materials being studied, such as small grains, corn, vegetables, soybeans, fruit, forage and meals. Materials range from fluid foods and wastes to solid feed and food products.

Request Procedure. CRIS services are provided at no charge to all USDA and State experiment station personnel, forestry schools, and certain other institutions and colleges which provide input to the system. Other qualified users include the Federal agencies, and certain state agencies, private institutions, and foreign governments. The method for requesting searches is preferably by means of a request form which solicits information regarding both general and detailed narrative statements as to subject coverage and type of information desired. Requests may also specify period covered, extent of narrative desired, nature of financial and manpower information, or sort sequence. User supplied keywords are solicited, as well as indications as to the particular subject classifications that may be relevant. Classification categories are obtained from the CRIS "Manual of Classification of Agricultural and Forestry Research" (4) which is also used as a guide for preparing CRIS inputs. For those not having access to the request form or the manual, a request may be submitted in letter or narrative form that provides as much detailed information as possible, both as to subject matter and type of information desired. For those needing only the narrative project summary, it is only necessary to request that the output be provided in the form of a Standard Technical Printout. Requests should be addressed to: Director, Current Research Information System, U. S. Department of Agriculture, Washington, D.C. 20250.

AD-357 (4-71)

U.S. DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH SERVICE
RESEARCH WORK UNIT/PROJECT ABSTRACT
CURRENT RESEARCH INFORMATION SYSTEM

CRIS ID. NO. IH1004
DATE 11 APR 1974

	START DATE	TERMINATION DATE
MATERIALS TESTING	01 JAN 1971	31 DEC 1974

ACCESSION NO.	WORK UNIT/PROJECT NO.	CONTRACT/GRANT/AGREEMENT NO.	AGENCY IDENT.
0058730	PEN01901	HATCH	CSRS PEN

LOCATION	PERFORMING ORGANIZATION
PENNSYLVANIA STATE UNIVERSITY UNIVERSITY PARK PENNSYLVANIA 16802	AGRI ENGINEERING

INVESTIGATORS
MOHSENIN N N MORROW C T

TITLE
PHYSICAL PROPERTIES OF AGRICULTURAL MATERIALS

OBJECTIVES:
Study physical properties of agricultural products and by-products which are significant in production, handling, processing and utilization.
APPROACH:
Physical properties (shape, size, density, volume, surface area, porosity, permeability) and mechanical properties (resistance to mechanical damage, energy requirements for size reduction, compressional and expansion characteristics, aero- and hydrodynamic properties, frictional characteristics) will be determined and related to various aspects of production, breeding, storage, and processing of agricultural materials. Materials will range from fluid foods and wastes to solid feed and food products.
KEYWORDS:
AGRICULTURAL-PRODUCTS BY-PRODUCTS PRODUCTION HANDLING PROCESSING UTILIZATION MECHANICAL-PROPERTIES STORAGE FEED FOOD MATERIALS-HANDLING MATERIALS WASTE MECHANIZATION PHYSICS RHEOLOGY PHYSICAL-PROPERTIES ENGINEERING
PROGRESS REPORT: 73/01 73/12
Air permeability and coating methods were used to determine specific surface of barley, beans, buckwheat, corn, lentil, peas, rye, sorghum, soybean, wheat. Such data are useful in heat treatment, drying, and cooling of these grains. Heat transfer studies in apple showed limitations beyond which present theories will not be applicable in air or water cooling of apples. A composite material consisting of fiberized alfalfa hay, ground corn, soybean meal, and edible binding agents was developed as a convertible structural material useful in manufacture of packaging containers. With the exception of tensile strength, mechanical properties compared favorably with those of corrugated cardboard. Results suggested a need for different fabrication technique to form master containers intended for conversion after shreddings into other usable materials. A meat analog was developed using egg albumen-soy fiber and silastic rubber-cotton thread to determine if the textural characteristics of natural meat can be duplicated. Results indicated feasibility of stimulating meat texture by controlling fiber density and orientation. This information should be useful in improving the textural characteristics of synthetic meats. Development of a computerized information storage and retrival system on physical properties of agricultural materials was completed. The system is being expanded and updated and is expected to serve as a national service for this type of information.
PUBLICATIONS: 02 ADDITIONAL PUBLICATIONS
NO PUBLICATIONS REPORTED THIS PERIOD.

FIGURE 1 Example of the CRIS Standard Technical Printout

If this information is reproduced, published, or quoted, credit must be given to the project leader and the organization conducting the research. For progress reports, it must be clearly stated that the information reflects only the results obtained during the period specified and final results are subject to the completion of the investigation.

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(1) Turnbull, J., "Current Research Information System, USDA's Newest Development in Information Retrieval," AGRICULTURAL SCIENCE REVIEW, Vol. 5, No. 3 (1967), 30-33.

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(3) Mohsenin, N.N., PHYSICAL PROPERTIES OF PLANT AND ANIMAL MATERIALS, Vol. I: STRUCTURE, PHYSICAL CHARACTERISTICS AND MECHANICAL PROPERTIES, New York: Gordon and Breach (1970), 734 pp.

(4) U.S. Department of Agriculture, MANUAL OF CLASSIFICATION OF AGRICULTURAL AND FORESTRY RESEARCH, Rev. II, Jan. 1973, 171 pp.

How the Extension Service-Land Grant University-ARS-USDA Information Exchange Functions

Ovid Bay
Extension Service
U.S. Department of Agriculture
Washington, D.C.

The USDA Office of Communication is directed by Claude Gifford and Chief of the Publications Division is Nelson Fitton, USDA, Washington, D.C., 20250, (202-447-6623). Fitton and his staff can tell you if USDA has a publication on the material or subject you are researching.

Extension editorial staffs at the national and state levels are key people in the Extension Service-Land Grant information exchange system. They can tell you what information Extension has on a specific subject or material. (A list of State Extension Editors is attached.)

The information staff of the Agricultural Research Service consists of a national staff with Robert B. Rathbone, Director, USDA, Washington, D.C., 20250, (202-447-4433). The four regional information officers are:

Northeast Region: Alice Shelsey, Agricultural Research Center, Beltsville, Maryland 20705 (301-344-3530)
North Central Region: Bob Enlow, 2000 W. Pioneer Parkway, Peoria, Illinois 61604 (309-673-5988)
Southern Region: V.R. Marcley, POB 53326, New Orleans, Louisiana 70153 (504-527-6708)
Western Region: W.J. Whorton, 2850 Telegraph Avenue, Berkeley, California 94705 (415-486-3350)

If you are looking for research information on cotton, contact the Southern office; on corn, the North Central office; on wool, the Western office, etc. For any subject or commodity, you can start with the national office, of course, which coordinates the publications and data from all four regions.

Keywords: Agricultural Research Service; agriculture; extension service; information services; land grant university

How the Extension Service-Land Grant University-ARS-USDA Information Exchange Functions

Ovid Bay*
Extension Service
U.S. Department of Agriculture
Washington, D.C.

This brief background may help you understand how research data and information from the scientists at the Land Grant Universities in each State, members of the staff of the USDA Agricultural Research Service, and other scientific organizations and groups is retrieved and used by the Extension Service.

In 1862, President Lincoln signed the Land Grant College Act authored by Justin Morrill which established a Land Grant University in each State with low tuition fees to allow more American youth to attend a university.

In 1875, Connecticut established the first Agricultural Experiment Station. Later legislation authored by Col. William Hatch in 1887 made possible the national Federal-State cooperative program in agricultural research.

In 1914, our nation created a new and unique system of education called the Cooperative Extension Services when it passed the Smith-Lever Act. It was based on the belief that human progress could be enhanced if the products of research could be translated to lay language and made available to all of the people of the nation for decision-making. The system has developed into a national network of more than 3,000 local offices serving the 3,150 counties in the U.S. with what has become known worldwide as the "County Extension Agent" and the "County Home Agent." Extension programs also include young people (4-H and older youth) and community and rural development.

* Director of Information

The Extension Service is often called "the educational arm of USDA" because it is the only system connected with USDA which has a State association connected directly with the Land Grant University and on beyond to local support at the county level.

How does the Extension retrieve information on research and materials?

1. State Extension Specialists working with the four main areas of:

(a) Agriculture and Natural Resources
(b) Home Economics
(c) 4-H Youth Programs
(d) Community and Rural Development

are located at the Land Grant University in each State and often officed in the department with their counterparts in research and teaching. Many Extension Specialists even have "joint appointments" which means they are carrying a joint responsibility of research along with performing Extension functions over the State. Some three-way appointments include teaching part time.

Hence, the State Extension Specialist retrieves information from his research counterparts at the State Land Grant University where he is stationed, from researchers located in other universities, from ARS-USDA researchers, and from private and other governmental sources.

2. Area Extension Specialists have developed in recent years, as agriculture became more complicated, with the Specialist covering a designated area in a State - usually several counties. For example, this person will have a Ph.D. in entomology to work on pest management programs, etc., and would be qualified to work at the state and national level in his area of expertise. He knows where to get information, but relies heavily on his State counterparts.

3. County Extension Specialists are the ones having daily direct contact with the local people who have problems needing a solution. These Specialists are supplied educational materials from the State Specialists as part of the on-going program. This will include fact sheets, publications, slide sets and other visuals, and radio and TV scripts and tapes, etc. Workshops with State and National Extension staff keep the county workers up to date on recent research developments. The County Extension Agent contacts the State Specialist for answers to questions which may not be adequately covered in materials at hand.

4. National Extension Specialists are limited in number, but they analyze subject matter and regulations, etc., available to them

from all States, government and other sources at the national level, and digest and route this back to their counterparts at the state level. National Specialists give leadership to establishing new national programs in the overall Extension effort.

5. Extension Editorial Staffs at the state and national levels are key people in the information exchange system. They edit and prepare the printed materials, radio and TV scripts, slide sets, take photos, maintain contact with the media and help plan and conduct Extension programs at the national, state and local level. They could be a valuable contact for you and would be the quickest way for you to find out what information Extension has on a specific material or subject at the state level. (A list of State Extension Editors is attached.)

6. Agriculture Research Editors at the Agriculture Experiment Stations located at each Land Grant University are another valuable source of information. They handle the publications on research and know where to find the latest data on all agriculture related research being carried on at that institution at that time. They also will know what is available from previous research. You will reach them by sending your request to the State Extension Editor, who will route your query to the editor handling the subject matter you need.

7. The information staff of the Agricultural Research Service consists of a national staff with Robert B. Rathbone, director, rm. 5133 S-Bldg., USDA, Washington, D.C. 20250 (202-447-3530).

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Materials Information in the Radiation Shielding Information Center

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The Radiation Shielding Information Center (RSIC) [1][1], established in 1962, serves the shielding community by collecting, organizing, processing, evaluating, packaging, and disseminating information mainly related to reactor and weapons radiation. *The scope includes the physics of interaction of radiation with matter, radiation production, transport and energy deposition, radiation detectors and measurements, engineering design techniques, shielding materials properties, computer codes useful in research and design, and shielding data compilations.* This information is analyzed, evaluated, synthesized, and repackaged in a form more authoritative, timely, and useful.

Promoting exchange and improvement of nuclear data, computer codes, and radiation transport information, RSIC provides strong support for the technology areas of its sponsors. The goal is to save time and prevent duplication of effort, to advance the state-of-the-art, to increase the value and content of information by correlating it with other information, and to implement government information-dissemination policy. Materials information is an integral part of all information in the subject areas covered by the Center.

Key words: Computer codes, materials properties, nuclear data, radiation transport, reactor, RSIC, shielding, weapons

1. INTRODUCTION

The development of nuclear technology has given rise to a multitude of engineering design tasks in the area of radiation shielding. The technology includes nuclear power, as well as low-energy and high-energy particle accelerators, medical radiation technology, the processing, storage and transport of radioactive materials, the handling of radioactive wastes, nuclear weapons technology, and so on. Thus, there is a variety of shielding problems which have to be faced by the design engineer. The Radiation Shielding Information

[1] Figures in brackets indicate the literature references at the end of this paper.

Center (RSIC) [1] must be concerned with the overall considerations in the design of a variety of shield systems, including shipping containers and storage facilities for radiation sources, medical radiation rooms, enclosed and open irradiation facilities, high-level radioactivity research facilities, electron and nucleon accelerators, nuclear fuel processing and radioactive waste storage facilities, nuclear weapons, and, last but not least, nuclear reactors for research, electric power generation and ship propulsion. The selection of materials is obviously an important part of nuclear shield technology.

The design of radiation shields for nuclear facilities is an interdependent multi-region, multi-phase process. Conceptual layout, choice of materials and engineering design involve complex engineering considerations to reach a balance between the aspects of safety and economy and the functional (operational and maintenance) requirements of nuclear facilities. RSIC fills an important role as an exchange medium between the generator and user of shielding information.

To fully understand the RSIC style, it is necessary to define the information analysis 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) 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."*

Since 1962, the RSIC staff has endeavored to make the envisioned concept come alive. Operating as a technical institute, RSIC serves those engaged in shielding, radiation analysis, and neutronics research and development.

The Center is sponsored by the U.S. Atomic Energy Commission (USAEC) Division of Reactor Research and Development (DRRD), the Division of Controlled Thermonuclear Research (DCTR), and by the Defense Nuclear Agency (DNA). This multiagency funding has proved to be an effective and efficient way to share technology which is of benefit to the contractors of each agency. By integrating developments in the various programs, the latest technology is made available to all scientists and engineers doing radiation transport calculations.

RSIC actively supports the Cross Section Evaluation Working Group (CSEWG) and cooperates with the National Neutron Cross Section Center (NNCSC), Argonne Code Center, with various working groups, and other centers and agencies to better serve the shielding community.

II. RSIC OPERATIONS

The RSIC program is directly related to and integrated in the nationwide efforts of the AEC and other agencies to provide data necessary to the analytical solution of any radiation transport problem, including reactor shielding design calculations. Such analysis requires the use of large computers and complex computer codes and associated data libraries. RSIC treats this kind of information as an inseparable part of shielding information. The effort made to understand it, to use it to analyze other shielding information, and to use it as a means of technology transfer has made RSIC an effective information analysis center. Computer code and nuclear data exchange has had a tremendous impact on radiation analysis technology.

By the nature of its functions and the manner in which it implements them, RSIC contributes substantially to the unification of the various areas of radiation transport and shielding. The dissemination of information to otherwise unrelated users is in itself a unifying activity. RSIC, however, promotes a closer relationship between Center and user. Communication channels between the Center and the worker in the field are kept open and extensively used. Many RSIC projects have benefitted by the active participation of the Center's users. Efforts to improve, update, and increase the code and data library collection are continually underway, with the shielding community cooperating to improve the technology by feedback, implemented through the *open code package concept.* Seminar-workshops, topical meetings, review articles, and data collection activities point to an industry-wide cooperative enterprise.

Specifically, the Center has developed a number of operations to support the functions already mentioned. These include computer code activities [3-5], literature indexing, information storage and retrieval [6], and nuclear data activities [7-8]. These all have direct benefit to work involving nuclear materials. RSIC collaborates with NNCSC to expedite the acquiring, processing, testing, and reviewing of "shielding" data to help assure that shielding requirements are more nearly met by the Evaluated Nuclear Data File (ENDF/B) [9]. In addition, we serve as the clearinghouse for the DNA data activities, being responsible for the maintenance and dissemination of the *DNA Working Cross Section Library* [8], and for the establishment and maintenance of processed data libraries for both DNA and AEC's Controlled Thermonuclear Division.

With the National Aeronautics and Space Administration (NASA) sponsorship over an eight-year period, RSIC supplied the shielding information needs for the space flights. We continue to hold a sizable store of space shielding information, including computer codes and compilations of data. They are available to all requesters.

In addition to data services, consultations, selective dissemination of information (SDI), newsletters, and working with government contractors in code development and data generation, we provide the research community with tested radiation shielding computer code and data library packages from the RSIC collection. More than 2600 separate letters of request were processed during CY 1973, resulting in more than 5000 separate activities to satisfy the requests (approximately 20.2/working day).

III. RSIC COVERAGE OF SHIELD MATERIALS

Let us take a close look at RSIC involvement with shielding materials. We examine and analyze shielding literature, including that on materials, categorizing and abstracting that selected for inclusion in the RSIC computerized Storage and Retrieval Information System (SARIS). The system is used to retrieve information to answer an inquiry, to compile bibliographies, to write state-of-the-art reviews and/or to routinely disseminate selected information to fill individual needs indicated by a customer profile. An archival microfiche file of the literature store is maintained and made available on request. We are interested in materials from several viewpoints, but mainly in their nuclear and atomic properties and their performance as shields. We watch particularly for state-of-the-art literature on the properties of materials for shielding, their radiation transport characteristics, cross sections, density, cost optimization, resistance to damage, and so on. We maintain a current awareness of data activities and code development as related to materials research.

Ionizing radiation transport in air is of such concern to weapons programs that RSIC has treated the theory, techniques, data and computer codes in a major seminar and published a state-of-the-art review, ORNL-RSIC-33, which has been widely distributed. In the context of this conference, we will confine the review mainly to materials associated with reactors. We borrow freely from the description of shield materials written by L. G. Mooney and N. M. Schaeffer, Radiation Research Associates, Inc., in the USAEC sponsored *REACTOR SHIELDING FOR NUCLEAR ENGINEERS*, N. M. Schaeffer, Editor, 1973, TID-25951, for which RSIC is credited with providing services and suggestions.

Personnel must be protected within reasonable limits of cost, weight, and space against the ionizing radiation emitted from reactors and their components. It is the purpose of RSIC to provide the shielding engineer with some tools and data to accomplish this.

We are much concerned with the basic processes by which reactor radiations are attenuated. Radiation attenuation analysis enters the process of the development of a shield design as just a design tool on two stages. The first stage is to obtain approximate estimates which will provide reasonable accuracy for a comparative assessment of design alternatives right on the drafting board. The second stage is to check whether the thicknesses of the various shield regions of the detailed design are adequate. The mathematical-physical models and calculational techniques for the latter task have received much emphasis in the complex task of shield design and engineering. Hence, our interest in computing technology and in compilations of numeric data is especially keen.

Materials selection and a related task, optimization, together offer the greatest potential for weight or cost savings. The materials task requires a variety of skills: nuclear interaction, heat transfer, chemical interaction, structural characteristics, other physical properties, and economics must all be applied in a thoroughgoing analysis. Calculational methods and computer codes are important information. There is an active nuclear data collection program and extensive properties handbooks are available [10].

The primary nuclear properties to be considered are obviously neutron and gamma-ray attenuation. As a rule, good gamma-ray attenuators also produce secondary gamma rays from neutron inelastic scattering and radiative capture; thus the production of secondaries is also a consideration. For shields requiring several orders of attenuation, volume and mass affect materials choice. Structural strength at operating temperatures is also involved. Some low-strength materials having excellent attenuation properties may be rejected because the structure necessary to support them offsets their primary advantage.

Inner layers of the shield usually require some thermal protection; thus cooling must be considered. Good gamma-ray attenuators are heavy metals and are usually the highest density material in the shield. To conserve weight and cost, these materials are in some cases placed nearest the core, which gives rise to a cooling requirement.

Different design objectives lead to the selection of different materials. For a fixed power-reactor system, cost is a primary consideration; thus, the local concrete aggregate becomes a baseline for comparison with other materials. Higher attenuation substitutes may be considered only if some cost saving results. For mobile systems, total weight becomes the primary consideration, and more exotic materials can be considered.

Concrete is the most commonly used radiation shielding material for fixed reactors and accelerators. Since concrete is a mixture of elements, the variation in composition is large. Therefore, when referring to concrete as a shielding material, we should state the specific composition in order for its characteristics to have meaning. RSIC covers 11 major categories of information about concrete.

Probably more than 90% of the stationary reactor systems designed for power production are shielded with concrete. As an illustration, of twenty-three test-reactor shields described in a 1968 survey published by the Radiation Shielding Information Center [11], six used both heavy and ordinary concrete, eleven used only ordinary concrete, and five used only heavy concrete. Only one shield is described without concrete. Fourteen contained water: eleven were swimming pool reactors, two were boiling-water reactors, and one was a homogeneous solution. Three others included heavy water. Other materials mentioned were iron, steel, wet sand, boral, graphite, borated graphite, polyethylene, earth, and boric acid. Most of the materials used in the experimental reactor shields, other than concrete, such as iron, lead, and graphite, individually have poor structural or radiation shielding properties; but, when combined in laminated configurations, result in extremely good shields. Other materials that have been used in large quantity for shielding are compacted soil, iron, lead, and water. RSIC includes all these materials in its coverage.

The following materials have received much attention.

(a) Water. Because of the success of the swimming pool reactor as a research tool and of its derivative, the pressurized water reactor, as a pioneer power source, water layers are found in reactor-shield analyses almost as often as concrete. Water is an excellent neutron attenuator because of its large hydrogen content. It is an inferior attenuator of gamma rays because of its low electron density.

Considerations when water is used as a shield material include containment, temperature control, corrosion, and purification (demineralization).

(b) Lead. Best of the conventional materials for gamma-ray attenuation, lead is exceeded only by uranium. Lead bricks are to be found in almost every radiation laboratory as portable shield bricks.

Lead shot makes good filler for cavities in plugs and doors in shields. If provision is made for extracting the filler in place, it becomes a great convenience should it become necessary to dismantle or remove the door.

(c) Graphite. A good neutron moderator and reflector material, graphite is used extensively in reactor design. Besides its use as a reflector-moderator, it is also found in thermal shields and occasionally as a primary shield material.

(d) Iron. Iron is almost always present in the reactor structure as steel and is used for thermal shields and pressure vessels.

(e) Boron. This element is used principally to absorb thermal neutrons. Pure boron has also been used as an additive to polyethylene and graphite to add neutron absorption properties to good neutron attenuators. It has also been added to some steels to reduce secondary gamma-ray productions and activation problems of iron.

(f) Concrete. Since concrete is a mixture of materials, the mixture can be tailored to provide optimum structural and shielding properties.

Weight, rather than cost, is generally the principal design criteria in the application to mobile reactor systems. The emphasis,therefore, shifts to the improved shielding provided by the so-called exotic materials used in layered combination.

The approach in designing minimum-weight shields for reactor systems usually is to select the most efficient of the neutron shielding materials compatible with the design and to combine this with the most efficient of the gamma-ray shielding materials rather than to select a single bulk attenuator medium. These two component materials are usually layered in some manner that yields minimum weight by providing the proper balance between primary and secondary radiations and geometric effects on material volume.

The efficiency of a neutron attenuator can be correlated to its hydrogen density, and the efficiency of a gamma-ray attenuator can be correlated to the total density of the material. Thus minimum-weight shield component materials are such combinations as lead plus polyethylene, tungsten (wolf-ram) alloys plus lithium hydride, or depleted uranium plus titanium hydride.

Although submarines were the first application for nuclear propulsion, the application to surface ships is also well known. Two such examples are the U. S. merchant ship N. S. *Savannah* and the Russian icebreaker *Lenin*. The reactor shield of the N. S. *Savannah* is composed of light water, lead, polyethylene, standard concrete, and heavy concrete. The reactor shields of the *Lenin* are composed of water, steel, and heavy concrete [11].

In addition to mobile reactor systems, other mobile or portable sources of radiation require shielding, e.g., neutron sources fabricated from plutonium-beryllium or polonium-beryllium and radioisotopes (usually gamma-ray emitters) resulting from high-intensity neutron exposures in reactors.

Shipping and storage casks must be provided for sources of this type, and they are usually constructed of lead for gamma-ray shielding and contain paraffin or other hydrogenous material for neutron shielding. These sources are usually small and present few design problems.

Weight-limited shields are also used for isotope power supplies, which use the heat generated by the decay of radioactive nuclides to produce electricity. Such sources have been used to power orbiting satellites and experimental equipment placed on the moon. Shields for these systems must obviously be efficient.

As mentioned, among the top contenders in materials for mobile reactor systems are lead, polyethylene, tungsten alloys, lithium hydride, depleted uranium (238), and titanium hydride. All of these are covered by RSIC.

The problem of finding the optimum materials arrangement for a shield that satisfies a given set of design criteria is the most intriguing in the area of reactor shielding [12]. It has challenged many investigators, and currently a general solution has not been found and may not be. Assuredly, a few workable schemes have been developed, and each study has contributed some insight to the subject. RSIC follows closely all work on the subject and seeks to add its support in a combined effort to advance the technology.

IV. RSIC INTERACTION WITH USERS

In attempting to meet the information needs of the radiation transport research community, RSIC aims to give a totalscope service. By treating nuclear data and computing technology as an integral part of the information we handle, we are able to offer information and tools needed to solve a radiation transport problem. We fill requests for bibliographies, computer-readable compilations of nuclear data, and computer code packages. We make ourselves available to troubleshoot, give advice, and consult on user problems. In turn, we expect the user community to work with us in pushing the technology by giving us their feedback on packaged information, reports of the results of their work, the nuclear data sets they generate, and exchangeable versions of their code development.

We are service-oriented and give quick response to a request. We are hospitable, giving freely of our time to tutor visitors and/or to make available the Center's resources for their use. They, in turn, take a personal interest in the work of the Center and help us to keep it viable.

We are accessible by letter or by telephone (see brochure appended). We transmit data and code packages on reels of magnetic tape, furnished by the requester. We welcome interested individuals to the RSIC Newsletter distribution. Through it, we keep the community informed about the information we handle. The reader, then, must take the initiative in securing RSIC materials and services.

RSIC is embedded in the Neutron Physics Division of the Oak Ridge National Laboratory, which has long been engaged in shielding and radiation transport research and development. 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 (LMFBR and GCFBR), to radiation from weapons, accelerators, and to radiation encountered in space. Our staff is augmented by the consultative services of working shielding specialists, who, themselves, generate much new information. The results of ORNL R&D, as well as that of other specialists across the country, in radiation transport, radiation protection, shield design and materials research is placed at our disposal for analysis, repackaging, and dissemination to the entire scientific community.

ESTABLISHED 1962

RADIATION SHIELDING INFORMATION CENTER

OAK RIDGE NATIONAL LABORATORY

P.O. BOX X - OAK RIDGE, TENNESSEE 37830

An Information Analysis Center
Serving Radiation Transport Scientists and Engineers

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- State-of-the-art and special shielding reports
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- Collection and distribution of operable codes with documentation
- Collection and distribution of processed data libraries with documentation
- Collection and distribution of evaluated cross section data
- Response to technical inquiries
- Monthly newsletter
- Abstracts and bibliography of radiation transport literature
- Computer-based information retrieval system
- Selective dissemination of information
- Archival microfiche file

OAK RIDGE NATIONAL LABORATORY

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Rare-Earth Information Center (RIC)

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THE CENTER

What are "Rare Earths"? Specifically they are the members of the III A Group of elements in the periodic table: Sc, Y, and the fifteen lanthanide elements, La through Lu. They are metals and not earths (oxides), nor are they rare. Cerium, the most abundant of the rare earths, ranks 28th in abundance of the naturally occurring elements, while thulium, the least abundant, is more plentiful than silver, gold, or mercury. If you didn't know that, or even if you did, the Rare-Earth Information Center (RIC) may be for you.

RIC serves the scientific community by collecting, storing, evaluating and disseminating rare earth information from various sources. It was established at the Ames Laboratory by the U.S. Atomic Energy Commission's Division of Technical Information in January 1966. In 1968 the support of RIC was taken over by Iowa State University's Institute for Atomic Research (just recently renamed the Energy and Mineral Resources Research Institute), through grants from the world-wide rare earth industry (see Appendix I). The main interest of the Center is the physical metallurgy and solid state physics of the metals and their alloys.

SERVICES

Since its establishment the Center has published the RIC News, a quarterly newsletter containing items of current interest concerning the science and technology of the rare earths. Subscription to the RIC News is free. The continued growth in the number of RIC News subscribers is shown in figure 1, and as of January 1, 1974 there were 2743 subscribers. The percentage of foreign subscribers is also shown in the figure.

RIC answers requests for information concerning the rare earths. All inquiries are kept confidential unless otherwise directed by the requester and most are answered within one or two work days. Beginning January 1974 a minimum charge of $25.00 was set to cover the expenses involved in answering most inquiries. The rules for assessing service charges are given in Appendix II. About 200 information inquiries are answered each year; approximately 25% are from non-U.S. countries. Internally, an additional 35 information requests are received from Ames Laboratory personnel. The kinds of institutions served are given in Appendix III.

At irregular intervals reviews, bibliographies and compilations are prepared and published by the Center.

In 1969 RIC expanded service to the scientific and technological community by providing extensive surveys or searches or state-of-the-art reviews, such as IS-RIC-4 (see below), and in-depth analyses or critical reviews, such as IS-RIC-5 and IS-RIC-6, on a cost recovery basis. In several instances these surveys or analyses have been published as reports at the request of the sponsoring company. Current publications available free from RIC are:

IS-RIC-4 "Rare Earth Metals in Steels", Nancy Kippenhan, Karl A. Gschneidner, Jr., March 1970

IS-RIC-5 "Thermochemistry of the Rare Earth Carbides, Nitrides and Sulfides for Steelmaking", Karl A. Gschneidner, Jr., Nancy Kippenhan, August 1971

IS-RIC-6 "Thermochemistry of the Rare Earths. Part 1. Rare Earth Oxides, Part 2. Rare Earth Oxysulfides, Part 3. Rare Earth Compounds with B, Sn, Pb, P, As, Sb, Bi, Cu, and Ag", Karl A. Gschneidner, Jr., Nancy Kippenhan, O. Dale McMasters, August 1973

In June 1973 the Center initiated a document depository service. Documents which, because of their nature or length, may not otherwise be suitable for publication in the scientific journals are eligible for deposit. Articles receive an identification number, are announced in the RIC News and are made available at a nominal charge. Presently twelve documents are on file.

INFORMATION RESOURCES

Rare earth information is collected from all available sources (books, journals, reports, conference notes, etc.). This information (~ 15, 000 references) is currently being stored on punched cards and on magnetic tape. In August 1973 we started indexing information for computer storage and retrieval, and on March 5, 1974 the first sets of references were retrieved. Presently about one-third of the journal articles are stored on tape; the remaining information is stored on punched cards. For the next year or two a dual retrieval system will be in use until the data on the punched cards are completely converted.

A file of journal articles (~ 10, 000), reports (~ 1, 500), books (~ 200), abstracts (~ 2, 000) and miscellaneous (~ 1, 000) concerned with the metallurgy, solid state physics of metals and alloys, analytical, inorganic and physical chemistry, ceramics, technology, geochemistry, and toxicity of the rare earth elements and compounds is maintained by RIC. Furthermore, the personnel of the Center have access to more than 12, 500 journals and periodicals and more than 300, 000 U. S. Government reports available at the Iowa State University Library and the Ames Laboratory's Document Library.

PERSONNEL

The Center's staff consists of one full-time and two part-time technically trained persons and one half-time secretary. The total scientific staffing level is 1. 67 full-time equivalent man-years.

WHO IS SERVED

The services of the Rare-Earth Information Center are available to individuals, government agencies, research and educational institutions, and industry. Requests for information may be made by telephone, in writing, or by visiting the Center. Visitors should call and make arrangements before coming to RIC. For telephone requests, dial: 515 - 294 - 2272; and for written requests address correspondence to: Dr. Karl A. Gschneidner, Jr., Director.

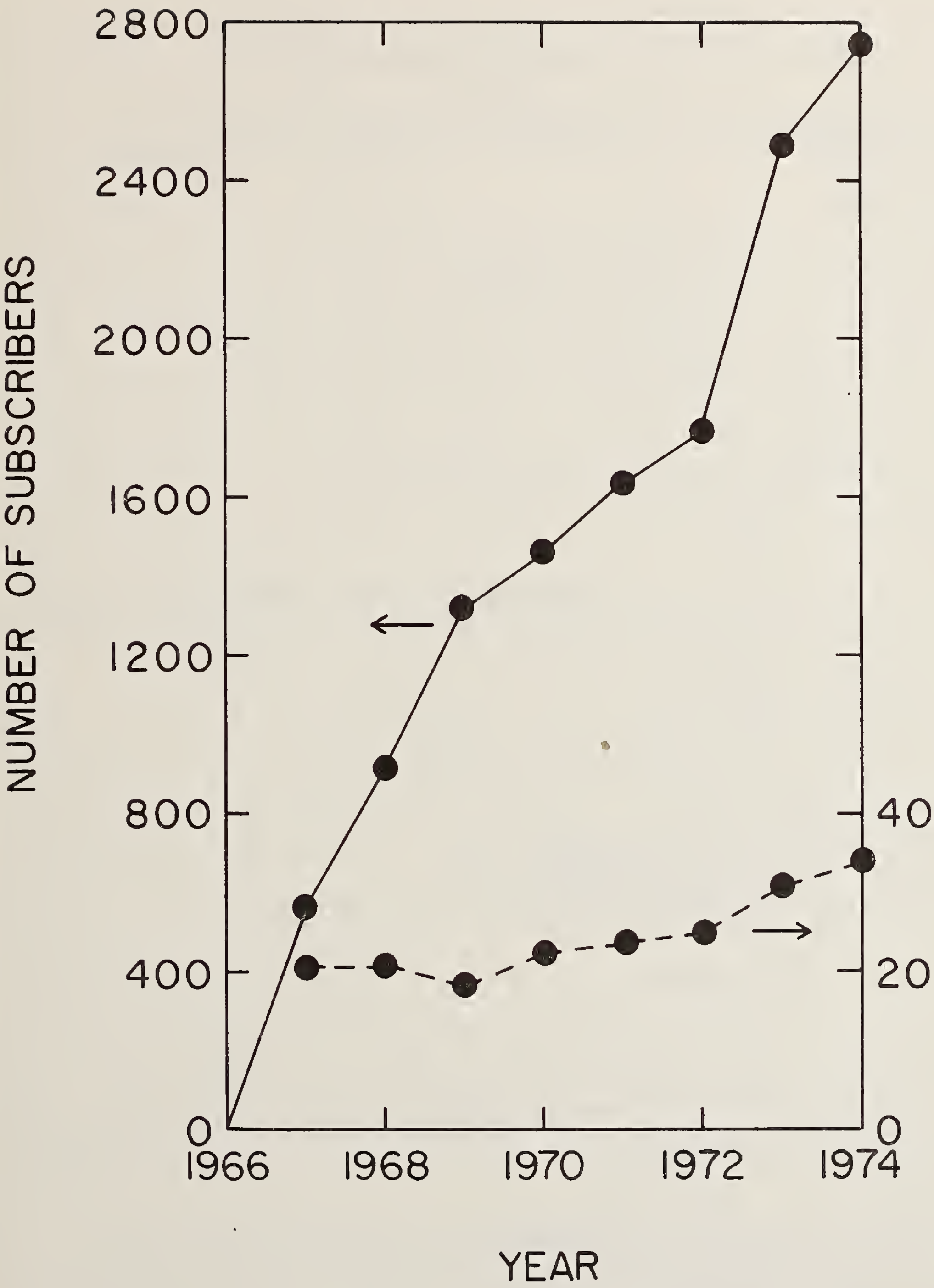

Figure 1. RIC News subscribers since the formation of the Center to January 1974 (solid line). The percentage of non-U.S.A. subscribers is indicated by the dashed line.

Appendix - I

Industrial Companies Who Have Supported RIC Since 1968*

Akzo Chemie NV (formerly Royal Sulphuric Acid Works, Ketjen, Inc.), The Netherlands (3)

Allied Chemical Corp., U.S.A. (2)

American Metallurgical Products Co., U.S.A. (5)

American Rare Earth & Foil, Inc., U.S.A. (1)

Atomergic Chemetals Co., U.S.A. (2)

Ban Eng Hong Tin Mining, Malaysia (1)

British Flint and Cerium, England (2)

Brown, Boveri & Company, Limited, Switzerland (2)

Bulldog Chemical Co., U.S.A. (1)

Cometals, Inc., U.S.A. (2)

Companhia Brasileira de Tecnologia Nuclear (formerly APROMON), Brazil (2)

Companhia Industrial Fluminense, Brazil (1)

Denison Mines Limited, Canada (2)

Elettrochimica Italiana, Italy (2)

Foote Mineral Company, U.S.A. (2)

General Electric Company, U.S.A.
- High Intensity Quartz Department (1)
- Lamp Materials Research Laboratory (4)
- Magnetic Materials Product Section (1)
- Research & Development Center (1)

TH. Goldschmidt AG, Germany (5)

W. R. Grace & Co., U.S.A. (6)

GTE Laboratories, Inc., U.S.A. (2)

GTE Sylvania (formerly Sylvania Electric Products, Inc.), U.S.A. (2)

Indian Rare Earths Ltd., India (5)

International Energy Co., U.S.A. (2)

Kerr-McGee Chemical Corp. Rare Earth Div., U.S.A. (4)

Kolon Trading Co., Inc., U.S.A. (1)

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*The number in parenthesis behind each contributor's name indicates the number of years that firm has supported RIC, including fiscal year 1974 (July 1, 1973 through June 30, 1974).

Appendix - I (continued)

Leico Industries, Inc., U.S.A. (5)

Lim Fong Seng Sdn. Bhd., Malaysia (3)

Lunex Company, U.S.A. (4)

A/S Megon & Co., Norway (5)

Michigan Chemical Corporation, U.S.A. (3)

Mitsubishi Chemical Industries Ltd., Japan (1)

Mobil Research and Development Corp., U.S.A. (2)

Molybdenum Corporation of America, U.S.A. (6)

Nippon Yttrium Co., Ltd., Japan (4)

Philipp Brothers, U.S.A. (1)

Rare Earth Corporation of Australia, Ltd., Australia (2)

Rare Earth Industries, Inc., U.S.A. (2)

Rare Earth Products, Ltd., England (2)

Reactor Experiments, Inc., U.S.A. (4)

Research Chemicals, U.S.A. (6)

Rhone-Progil (formerly Pechiney - St. Gobain), France (4)

Rikkihappo Oy (formerly Typpi Oy), Finland (3)

Ronson Metals Corporation, U.S.A. (6)

Santoku Metal Industry Co., Ltd., Japan (4)

Sawyer-Adecor International, Inc., U.S.A. (4)

Sel-Rex Corporation, U.S.A. (2)

Shinetsu Chemical Industry Co., Ltd., Japan (4)

Treibacher Chemische Werke, Austria (2)

United States Radium Corporation, U.S.A. (4)

Wako Bussan Co., Ltd., Japan (5)

Westinghouse Electric Corporation, U.S.A. (1)

In addition to the above contributors, the Ames Laboratory of the U.S. Atomic Energy Commission and Iowa State University's Energy and Mineral Resources Research Institute underwrite indirect costs and pay a small fraction of direct costs.

Appendix II

RIC's Service Charge Policy*

Effective January 1, 1974, the Rare-Earth Information Center will collect a service charge for answering most information inquiries. A minimum charge of $25 has been set to cover the expenses involved in answering most typical inquiries. If a particular inquiry requires more work the charges will be increased accordingly. If the charges are expected to be more than $50 the requester will be notified and we will proceed with the request only upon his approval.

There are some exceptions to imposing the service charge: (1) No charges will be assessed to those companies which contribute to the support of RIC—at least up to the amount of their contribution. (2) Charges will be waived for those who certify they do not have resources available to pay for the service, e.g., students. (3) No charges will be made for (a) routine requests, such as information about a rare earth conference, (b) requests for information about the availability of commercial rare earth products or (c) requests for additional information on articles or material presented in the *RIC News.*

The rationale behind this change is that the users of the Information Center benefit from the information obtained, and thus they or their institutions should be willing to pay for these services.

We believe that one of our important functions is to make information available to *anyone who needs it.* It is for this reason that we have attempted to keep the service charges as low as possible and to waive charges when imposing them would constitute a hardship.

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* Reprinted from the RIC News, VIII, [4], 2 (Dec. 1973).

Appendix III

RIC Users -- External Information Inquiries

User \ Year	1966	1967	1968	1969	1970	1971	1972	1973	Total	%
Government	68	25	23	35	33	23	40	24	271	15.7
Industry	188	92	68	89	87	117	92	79	812	47.1
University	81	53	29	47	37	57	54	51	409	23.7
Individual	29	34	20	12	11	20	17	16	159	9.2
Res. Inst. & Misc.	13	12	10	10	5	8	6	9	73	4.2
Total	379	216	150	193	173	225	209	179	1724	99.9

The Research Materials Information Center

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The function, subject coverage, and use of the Research Materials Information Center are described. They are to collect, analyze, index, and store in a coded microfilm system information on the preparation, availability, characterization, and physical properties of inorganic, ultrapure solid-state research materials; and to provide this information in response to inquiries and by publication of special bibliographies and compilations as indicated by the current needs of materials science centers in private, government, university, and industrial laboratories.

Key words: Availability, crystal growth, crystal structure, electronic properties, magnetic properties, optical properties, phase diagrams, research materials, thermal properties.

Introduction

The Center was established in 1963 as a part of the Research Materials Program in the Solid State Division to collect and provide information on purification, crystal growth, characterization, and availability of high-purity inorganic research quality specimens to both producers and users. Since that time ready access to an up-to-date listing of available materials has eliminated duplication of effort in attempting to produce materials already available; and the simultaneous listing of materials desired, but not available, has served to focus attention on important new areas of materials research.

It very soon became apparent that coverage would have to be expanded to include the basic physical properties and methods of characterization of inorganic research materials, since inquiries often specified only the desired properties and not a particular material. The RMIC therefore

*Oak Ridge National Laboratory is operated by Union Carbide Corporation for the U. S. Atomic Energy Commission.

also collects reviews, compilations, text books, published papers, reports, abstracts, preprints, references, and any other information dealing with the preparation, characterization, and basic physical properties of research materials.

Coverage does not include those properties that might be called "engineering" or "mechanical", such as those of structural materials. Information on radiation damage, electronic devices, and isotope production or technology was not included because of the coverage, existing or announced, of these subjects by other information centers.

Operation and Information Content of the Center

The basic information content of the Center comprises three separate collections, in an automated microfilm retrieval system. The first consists of over 1400 RMIC Data Sheets (see fig. 1), which are filled out by producers or users to request information on sources or to announce the availability of materials. Photocopies of these data sheets are mailed by the Center in response to inquiries to indicate which individuals, research groups, laboratories, or commercial suppliers have listed the requested materials. No exchanges, sales, loans, or gifts are handled directly by the Center; but each recipient of information is asked to notify the RMIC of the adequacy of the specimens received, so that its listings can be corrected if necessary. Few do.

Unanswerable requests indicate what materials are needed but not available, and lists of these materials have been published and distributed in the hope of stimulating efforts to prepare the needed materials or to improve the quality of a material to the level needed for a given research application.

The second collection includes questionnaires (fig. 2) distributed to the mailing list of the Center and also added to all mailed responses to inquiries from those not on the mailing list. Returned questionnaires indicate research interest, methods and equipment used, materials (if any) prepared, and the purpose of the work or intended use of the materials (usually single crystals) produced. These, with the literature collection to be described, indicate the major current lines of research -- and materials requirements for that research. In 1972 a screening of these questionnaires was used to produce a materials- and applications-indexed compilation (ORNL-RMIC-12) listing over 400 crystal growers and crystal-growth installations in 31 countries. (ORNL-RMIC-12 is now out of print, but a revision is planned for late in 1974.) The microfilmed questionnaires are also used, in connection with the data sheets, as clues to sources of materials and to establish lines of communication among scientists working on the same problems.

The third, and major, collection is that of the technical literature, about 90,000 items (papers, reports, compilations, abstracts, bibliographies, or references) dealing with materials, methods of preparation, characterization, and physical properties (electronic, optical, magnetic, crystallographic, thermal, etc.).

RESEARCH MATERIALS INFORMATION CENTER
SOLID STATE DIVISION
OAK RIDGE NATIONAL LABORATORY
P.O. BOX X, OAK RIDGE, TENNESSEE 37830
PHONE 615-483-8611, EXT. 3-1287

RESEARCH MATERIALS DATA SHEET

☐ THIS MATERIAL IS AVAILABLE
☐ THIS MATERIAL IS NEEDED

MATERIAL

FORM (SINGLE CRYSTAL, WHISKER, ROD, ETC.)

DIMENSIONS

ORIENTATION

ASSAY (%)

IMPURITY (DOPANT OR ISOTOPIC ENRICHMENT), ppm

STARTING MATERIAL (AND PURITY)

METHOD OF PRODUCTION (REFERENCE PERTINENT REPORT OR PAPER WHERE POSSIBLE)

METHOD OF FINAL ANALYSIS

SPECIFIC PROPERTIES TO BE STUDIED

SPECIFIC RESEARCH INTEREST OR APPLICATION

SPECIAL CHARACTERISTICS (INCLUDE HANDLING PRECAUTIONS)

AVAILABILITY FOR EXTERNAL DISTRIBUTION

NAME OF PRODUCER OR REQUESTER

SOURCE OF PROJECT SUPPORT

INSTALLATION

ADDRESS

UCN-3696
(3 12-71)

NOTE: This data sheet is more useful if it is completed in detail.

Fig. 1. Research Materials Data Sheet.

INFORMATION FOR
"COMPILATION OF CRYSTAL GROWERS AND CRYSTAL GROWTH PROJECTS"
(Rev. 1)

If you wish to be included in the new Compilation, please complete and return this questionnaire (even if it closely duplicates a recent submission).

Organization

Address

Project Title

Division or Department

Project or Department Head

Person to contact for information
Telephone number

1. What is your major interest in research materials [preparation of starting materials, crystal growth, characterization, physical properties research (if the last is included, what properties are examined?)]

2. What specific techniques and apparatus are used in your program (Czochralski, mass spectrometry, optical)?

3. What specific crystals or other materials are

   a) prepared or grown?

   b) examined?

(Continued on back of page)

Fig. 2. RMIC Questionnaire.

4. What is the purpose of the crystal growth or intended use of the crystals (e.g., ferroelectric or electro-optic materials, structure or magnetic studies, study of crystal growth methods)?

5. Are research quality specimens available for sale ( ), loan ( ), or gift ( ) to other research groups?

6. What specific crystals do you need that are not available?

7. General comments or suggestions.

Return completed questionnaire to:

RESEARCH MATERIALS INFORMATION CENTER
OAK RIDGE NATIONAL LABORATORY
P. O. BOX X
OAK RIDGE, TENNESSEE 37830

Fig. 2. RMIC Questionnaire-Continued

This collection, like the other two, is manipulated by a Recordak Miracode system that stores about 2000 pages in a cartridge of coded microfilm. Materials and properties are represented by 3-digit numbers, from a short thesaurus, which can be keyed into the system for searches in any combination of up to 10 descriptors using "and," or," or "not" logic. For internal use, all pertinent parts of books and data compilations (complete text, selected chapters, or in some cases only the title page and table of contents) are filmed, as are complete journal articles, preprints, and reports. In answering inquiries, however, only the title page, abstract, and page showing the requested data are sent out; it is up to the inquirer to obtain the complete text.

There were two reasons for the choice of this system over the usual computer listing (although a computer is used in the handling of special bibliographies drawn from the system, to create key-word indexes and the like). The first is the desirability of having the complete paper instantly available, to be sure that the specific question is indeed answered, to see the graph or curve. The second is the provision of the opportunity for browsing, and of narrowing or widening the range of the search, particularly by visitors using the equipment.

The RMIC is used by students and scientists from various materials science centers, universities, government agencies, industrial and national laboratories and institutes. Although the Center is supported entirely by the AEC, a large majority of the inquiries come from those under contract to other government agencies.

Use of the Center

Inquiries to the Center are usually by telephone or mail, and are answered by searches of one or more of the collections described. To aid in these searches several separate external materials and subject indexes to the microfilmed collection are maintained. These indicate, for example, the cartridges containing references to the crystal growth, synthesis, crystal structure, and phase diagrams of specific materials, providing rapid access (10 seconds per cartridge) without search of the entire technical literature collection of 305 cartridges at present. Another external index lists alphabetically by subject and by cartridge number all the reviews, bibliographies, and data compilations that have been filmed, including those produced by the Center itself.

Lists of related information centers are kept, with supplies of their descriptive brochures when available, for the referral of borderline or out-of-scope inquiries.

Several special bibliographies in the areas of greatest current interest in materials research have been commercially published as volumes of the ORNL Solid State Physics Literature Guides by Plenum Press and are listed at the end of this paper. Extensive materials-indexed bibliographies on different aspects of optical materials are in various states of preparation. However, although they are being used internally at the Center, publication is doubtful without additional support. These are on refractive indices, optical window and filter materials, reflectivities and optical dielectrics, and electro-optical materials. The first is being used to provide the papers for a critically evaluated compilation of the refractive indices of selected materials being done with the cooperation and partial support of the Office of Standard Reference Data of the National Bureau of Standards.

Over the years, as the coverage and capability has grown, the number of questions concerning preparation and properties has surpassed those dealing with available materials. It is difficult to indicate the variety of questions asked, but the following are typical: information on metal reflective coatings; dielectric materials with a specific refractive index and absorption coefficient; materials-indexed bibliography on low-temperature specific heats; identification of an unknown oxide, given the constituents and probable structure.

Potential and Plans

The potential of the RMIC is in the organized document collection and in the long-established international information exchange network, which indicates the current and opening areas of materials research. Present plans include coverage of the literature and the answering of inquiries, and continuation of the bibliography on optical materials. Any other projects, even the continuation of the ORNL Solid State Physics Literature Guides*, would require additional support in the terms of money and staff. The potential exists to undertake many other projects, such as a compilation of the phase diagrams of semiconducting compounds and some other "newer" materials of current interest, and documentation of the methods of preparation and the properties of inorganic materials for energy application.

*Volumes 1 and 6, on ferroelectric materials, although built largely on the RMIC collection, were published with the assistance of the Libraries and Information Systems Center of Bell Telephone Laboratories, which provided the computer services and much more. They would not have been possible without the enthusiasm and hard work of Donald T. Hawkins and the late Errett Turner of BTL.

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MATERIALS INFORMATION SERVICES
OF THE ENVIRONMENTAL INFORMATION SYSTEM OFFICE AND THE TOXIC MATERIALS INFORMATION CENTER[1]

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The Environmental Information System Office offers to users bibliographic references, factual information, numerical data, and evaluated reviews of data in and for all of the major environmental research areas active at Oak Ridge National Laboratory: energy, trace contaminants, human health, environmental impact, radiation research, land use and planning, ecosystems modeling, and analysis. The Toxic Materials Information Center is a materials-oriented center dealing with trace contaminants in the environment with particular emphasis on metals and organo-metallic compounds.

Funded by several federal agencies, EISO and TMIC services are available to all users, with priority accorded to the funding agency and other governmental agencies in that order. Limitations to outside use are determined by funding and staffing levels of the individual center.

Keywords: Air pollution, analysis, ecology, energy, environmental impact, land pollution, mutagenicity, toxic materials, toxicology, trace contaminants, water pollution

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[1]Work supported by the National Science Foundation RANN Program under NSF Interagency Agreement No. Ag 389 with the U. S. Atomic Energy Commission at Oak Ridge National Laboratory operated by Union Carbide Corporation for the USAEC under Contract No. W-7405-eng-26.

[2]Coordinator, Toxic Materials Information Center, and Director, Environmental Information System Office, respectively.

INTRODUCTION

To complement and augment its research efforts in environmental areas, Oak Ridge National Laboratory (ORNL) maintains a large-scale environmental information network known as the Environmental Information System Office (EISO). Under the direction of Dr. Gerald U. Ulrikson, EISO offers to ORNL and other users entry to the information retrieved in and for all of the major environmental research areas active at ORNL: energy, human health, environmental impact, radiation research, trace contaminants, land use and planning, ecosystems modeling and analysis. The organization is outlined in figure 1. The Toxic Materials Information Center (TMIC) is one of several affiliated information centers within this information network, and it stresses the environmental aspects of trace contaminants; the human health aspects are covered by other information centers such as the Toxicology Information Response Center (TIRC) and Environmental Mutagen Information Center (EMIC).

EISO has component information centers or data collections related to the areas of biomedical sciences, ecological and environmental sciences, physical and chemical sciences, and maintains a central services unit.

The Biomedical Sciences Section includes the Biomedical Studies Group (BMS), the Toxicology Information Response Center (TIRC), and the Environmental Mutagen Information Center (EMIC). Services rendered by the Biomedical Sciences Section include toxicology literature collection and evaluation, data extraction and data base building, state-of-the-art reviews, and consultation. These services can be used to discern real and potential biologic effects and hazards due to human interactions with chemicals. Topical subject areas and disciplines are selected for extensive literature review and reference collection. State-of-the-art reviews are prepared either internally by BMS or contracted externally to topical experts in selected fields of competence. The reviews are submitted for publication in recognized scientific journals. Longer reviews or those containing an extensive bibliographic section (keyworded and annotated references) are printed as BMS-ORNL publications. The toxicology data extraction and resultant data base building involve selection and utilization of basic source references, types and definition of data elements, and correlation with scientific research evidence. The BMS is funded by the Toxicology Information Program, National Library of Medicine; the U. S. Forestry Service, U. S. Department of Agriculture; the U. S. Atomic Energy Commission; and the Environmental Protection Agency.

The Toxicology Information Response Center, sponsored by the National Library of Medicine's Toxicology Information Program, was formed in the fall of 1971 to establish a national and international center of toxicology information. It provides information on a wide variety of chemical classes; pharmaceuticals, industrial chemicals, food additives, pesticides, and environmental pollutants. Requested information may range from a specific toxicologic datum to metabolic, pharmacologic, and other biologic phenomena. The center utilizes various information sources such as MEDLINE, TOXLINE, and ORNL computerized data bases and secondary sources including <u>Biological Abstracts</u>, <u>Chemical Abstracts</u>, <u>Excerpta Medica</u>, <u>Index Medicus</u>, and others. TIRC's resources and services are available to all individuals. There is a charge for services, based on the scope, time coverage, and type of product required - bibliography, annotated bibliography, and others.

The Environmental Mutagen Information Center was organized by the Environmental Mutagen Society (EMS) in 1969. EMIC's mission is to create, maintain, and disseminate a data base of chemical mutagenesis information. Information contained in the EMIC data file is either pertinent to the testing of chemicals in one of the many available mutagenic assay systems or contains data useful for understanding the known or suspected mutagenic activity of environmental chemical agents. The information collected for this data base is processed and disseminated to the scientific community. The Center's citation file currently contains 12,000 entries for articles published primarily since 1961 in about 1,200 publication sources. This information file contains bibliographic details and keywording of chemicals, organisms, and systems studied. To make this information easily available, bibliographies with permuted title and author indices are printed and distributed to individuals active in mutagenesis research. When specific questions arise in the scientific community or among health officials, special literature compilations are selected and printed. To make these data more convenient, EMIC has initiated a tabular abstraction of selected data in its holdings. These data are entered into computer files linked to the citation file. The staff of the Center also prepares literature reviews at periodic intervals on urgent problems involving the widespread occurrence of specific mutagens in the human population. Yearly reviews of the literature reporting mutagenic action of chemicals are also produced by EMIC. EMIC is funded jointly by the National Cancer Institute and the National Institute of Environmental Health Sciences.

Ecological and environmental sciences information groups include the Toxic Materials Information Center (TMIC) and the Environmental Response and Referral Group (ERRG). TMIC collects, stores, and disseminates pertinent information on materials in the environment, with particular emphasis on metals and organometallic compounds. TMIC was established as a project support center for NSF-RANN funded Ecology and Analysis of Trace Contaminants (EATC) program at ORNL. The Center's activities have become quite diversified since its inception and its multiple objectives include the following: to serve as the focal point for all information acquisition, storage, retrieval, and dissemination for the 14 EATC task groups; to serve as an information line between EATC task groups and with external groups with similar interests; to prepare and issue bimonthly the NSF-RANN Trace Contaminants Abstracts and newsletter covering the activities of the nationwide Trace Contaminants Program of NSF; to prepare and publish periodically an indexed directory to all NSF-RANN Trace Contaminants Program participants; to respond to inquiries for information on toxic materials in the environment from researchers, administrators, and laymen; to create data bases from which inquiries can be answered and special bibliographies can be drawn and published once the need for such has been demonstrated; to maintain distribution lists and special directories for the EATC Program; to extract environment data in a tabular format for certain environmental pollutants; to participate in the preparation of state-of-the-art reviews; and to provide information services to the EPA/AEC Testing Protocols for Environmental Transport Study under way at ORNL.

The Environmental Response and Referral Group responds to requests for environmental information from sources all over the world; provides information services to ORNL research teams engaged in preparing environmental impact statements for nuclear power plants; cooperatively exchanges information with USDA Forest Service in establishing a forest thesaurus, in establishing various environmentally oriented Forest Service data bases, and in preparing input to technical documents for publication; maintains a computerized record of all documents ordered for ORNL's environmental scientists (Document Acquisition and Control, or DAC); maintains a small but selective environmentally oriented resource center with, for example, a complete set of environmental impact statements for all nuclear power plants, the Great Lakes Bibliography, and a complete set of the Nuclear Science Abstracts; maintains a directory of technical environmental specialists and centers by location, telephone numbers, discipline training, and interest; and prepares state-of-the-art or generic documents as required.

EISO information activities in the area of physical and chemical sciences center on the Energy Information Center and the Energy Research and Development Inventory. The current Energy Information Center began as a project support center for the NSF-RANN funded energy work at ORNL and serves as a nucleus for the emerging energy information complex at ORNL. This energy data base now includes 2,800 bibliographic entries, covering energy in general: electric power (generation, transmission, distribution, supply and demand studies, economic studies, forecasts of supply and demand, use); energy sources (coal, petroleum, natural gas, shale oil and tar sands, hydrogen, nuclear, solar, geothermal, and other unconventional sources such as wastes, wood, tidal, and wind); energy (conservation, supply and demand studies, economic studies, forecasts of supply and demand, conservation, policy); environmental effects of energy (waste heat, air and water pollution); and energy uses (residential, commercial, industrial, agricultural, transportation).

The Energy Research and Development Inventory data base and publication were first prepared during late 1971 and early 1972 under sponsorship of the National Science Foundation. It is being updated and expanded under the additional sponsorship of the U. S. Atomic Energy Commission. Government agencies, academic institutions, private industry, and other sponsored research are being covered in the survey. The scope of research projects of interest is broad, including: (1) all types of energy sources - fossil fuels, nuclear, hydroelectric, solar, geothermal, tidal, wind, wood, plant, animal materials, and waste products; (2) electric power - generation, transmission, distribution, and storage; and (3) energy uses - residential, commercial, industrial, transportation, agricultural, and specialized applications. In addition to exploration, mining processing, resources and reserves studies in relation to energy sources, information on any basic or applied research, engineering development, economics, environmental effects, regulations, and legislation studies relevant to the above subjects are also of interest. Current efforts include improving format organization, revising subject categories, and broadening questionnaire and report dissemination. Based upon the results of this survey, the Energy Research and Development data base has been updated and released through the U. S. Government Printing Office.

The information storage and retrieval processes are performed by a centralized data processing and computer production group working in conjunction with ORNL's Computer Sciences Division. The Data Processing Center is responsible for the input of bibliographic, abstract, index, numeric, questionnaire, and other forms of data. Input is done through remote terminals or Magnetic Tape/Selectric Typewriter with upper and lower case capability to direct access computer files. The computer production group has the responsibility for submission, follow-up, and other activities involved in the computer job aspects of data management, publication and indices production, searches, and other information areas required by EISO and several other ORNL groups.

This brief description of the overall Environmental Information System serves only to acquaint one with the framework of our consolidated information activities. Though each of these centers deals with "materials" in some context, our Toxic Materials Information Center is oriented toward the effects of specific materials being released to the environment. The activities and data holdings of TMIC will be covered in more detail, bearing in mind that the other centers in EISO are engaged to a large extent in similar activities relating to their respective specialities.

For an information system to operate in a relevant and timely manner, it must be conceived and designed for the user and remain service-oriented throughout its existence. Information needs of the users must be simply stated for the information system to meet its objectives. Table 1 lists five major general types of information needs as defined by our users and requested from our information systems.

Table 1. Environmental Information Needs

Bibliographic References
Directory of People, Places, and Projects
Inventory of Current and Proposed Research
Factual Information
Numerical Data
Assessment of Information

BIBLIOGRAPHIC INFORMATION

In recent years the emphasis of environmental research has changed from the small, individual disciplinary research projects, where researchers were aware of the state-of-the-art of a given project. Today many research projects are multi- and interdisciplinary applied research programs. Researchers of many disciplines (engineering, mathematics, chemistry, etc.) are now concerned with biological and ecological information in relation to the applied environmental programs currently being developed.

Many of the bibliographic services available are oriented toward disciplinary objectives, i.e., Chemical Abstracts, [1][3] Biological Abstracts, [2] Engineering Abstracts, [3] Physics Abstracts, [4] Metals Abstracts. [5] In

[3]Figures in brackets indicate the literature references at the end of this paper.

gathering the needed bibliographic information for a given request or building an interdisciplinary applied information base, an information system can use the large computer readable data bases produced by bibliographic services (Table 2). The repackaging of this information rather than building of new data bases is extremely cost effective and expedient. TMIC uses this method of data base creation as well as the time-honored method of manually selecting and abstracting pertinent papers for inclusion in certain data files. The Toxic Materials general data base contains approximately 9,600 abstracted citations in trace contaminants ecology, analysis and mathematical modeling. In addition, several specialized data bases are maintained; they are listed in Table 3.

Table 2. Examples of Computer Searchable Bulk Data Bases Available

Data Base	Frequency of Issue	Approx. No. of Records/Issue
BA (Biological Abstracts)	24/year	5,835
BRI (Bio-Research Index Biological Abstracts	12/year	8,333
CBAC (Chemical-Biological Activities, CAS)*	26/year	1,150
CAE (Chemical Condensates - Even Issues, CAS)*	13/year	7,900
CAIN (Catalog and Indexing System, National Agricultural Library)	12/year	11,000
CAO (Chemical Condensates - Odd Issues, CAS)*	13/year	4,900
NSA (Nuclear Science Abstracts)	24/year	2,700
USG (Government Research Abstracts)	12/year	2,200

*CAS = Chemical Abstracts Service.

The Toxic Materials Information Center compiles these data bases principally to meet its obligations as the focal point for information acquisition, storage, retrieval, and dissemination for the NSF-RANN Environmental Aspects of Trace Contaminants Program in general and as the project support center for the ORNL

Ecology and Analysis of Trace Contaminants Program funded by NSF-RANN. Once these data bases have been created and computerized, they are available to others through response to specific inquiries; also, special bibliographies can be extracted, indexed, and published directly from the computerized data bases without remachining the data. Examples of TMIC special bibliographies include Cadmium in the Environment, [6] Trace Elements in Sewage/Sludge, [7] and Environmental Transport of Chemicals. [8]

Table 3. TMIC Special Data Bases

Subject areas	Citations	Comments
Environmental modeling	8000	B
Trace elements in coals and other fuels	800	B
Trace contaminants in soils and sediments	1500	B
Cadmium	2500	B
Arsenic	900	B
Mercury	1450	B
Chlorine	880	B
Environmental quality indicators	600	A, C
Liquid wastes	250	A, D
Environmental transport	1005	E

A – file with abstracts
B – file partially with abstracts
C – created by W. A. Thomas, G. Goldstein, W. Wilcox, ORNL
D – created by W. J. Boegly and W. D. Griffith, ORNL, HUD funded
E – support data base for EPA/AEC study on environmental transport of chemicals

DIRECTORIES AND INVENTORIES OF CURRENT RESEARCHERS AND RESEARCH PROJECTS

A second important need of researchers is a directory of people, places, and current research projects. We keep this type of information in two degrees of completeness. The EISO computerized directory lists approximately 20,000 persons by name, address, telephone number, and various types of identifying labels and/or keywords. This directory is used to maintain distribution lists and to locate researchers and administrators. More sophisticated subsets can be prepared and used to maintain and publish directories for specific programs such as the NSF-RANN Trace Contaminants Directory. [9] Once these data bases are constructed, they can be used for searching "geographic locations" by "zip code" or area telephone number and/or experts by professional or research interest.

Comprehensive data files listing current research projects in detail are prepared wherever funding is available. This type of information base is important only if it is kept current. Two of our files (computerized and subsequently published) are: Inventory of Current Energy Research and Development, [10] and the NSF-RANN Trace Contaminants Abstracts. [11] The Trace Contaminants Abstracts is a bimonthly abstract journal recording where results are being reported by the grantees in the NSF-RANN Trace Contaminants Program. The abstracts are accompanied by a more informal newsletter containing brief program notes and meeting notices and reviews. This abstract journal facilitates the exchange of information between the grantees as well as between the grantees and others interested in this area of environmental concern. If a program or agency will keep this information current, the contents can be used to produce annual progress reports by programs or agencies. This operation ultimately can save bench workers time in responding to their administrator needs.

FACTUAL INFORMATION FILES

It is becoming increasingly more important for information centers to answer questions rather than build comprehensive bibliographic files. Factual information about a chemical substance in the environment is necessary to assess the effects of that chemical. Many factual information files exist today; however, many of these have been produced with a single objective. There are desk top reference books such as the Chemical Rubber Publishing Company's Handbook of Chemistry and Physics [12] for chemical and physical data and Biology Data Book [13] for biological data.

The need has become pressing to reduce to a more assimilable form the scientific data contained in the growing volume of literature being generated. Both scientists and information processors are giving thought to developing a method of extracting and summarizing pertinent data from technical papers and reports without destroying the integrity of the data reported.

The necessity for establishing such data files, particularly in the area of toxic chemicals, has been recognized by such groups as the United Nations Advisory Committee on the Application of Science and Technology to Development, the Scientific Committee on Problems of the Environment of the International Council of Scientific Unions, and the United Nations Conference on the Human Environment. To date, Dr. Alexander Hollaender (Consultant) and Dr. F. Schmidt-Bleek of the University of Tennessee have been engaged in a feasibility evaluation of an International Registry of Potentially Toxic Chemicals as requested by the United Nations Advisory Committee on the Application of Science and Technology to Development. [14]

This proposed registry is viewed as a computerized compendium of data by various national and international agencies, designed to coordinate and stimulate activities at the international level to effectively reduce or eliminate the worldwide hazards from potentially toxic chemicals. The Toxicology Information Program, National Library of Medicine, under the direction of Dr. Henry Kissman, is also engaged in feasibility studies of a large-scale toxicology data file of this same general nature.

The Environmental Information System Office of ORNL is interested in proving the viability of the concept of such a large-scale system and is using the efforts of its individual information center units to construct various interlocking data files that show promise of conversion to a large integrated file. For example, the Environmental Mutagen Information Center (EMIC) has extracted and published data concerning the mutagenicity and teratogenicity of a selected number of food additives. [15] In addition to published data, the EMIC funding agency now requires data from all its contractors to be added to this file. In this manner, EMIC will assimilate and distribute this information to all its users.

The Biomedical Sciences Section of EISO is defining the data field descriptors and beginning to extract toxicologically related information for the Toxicology Information Program of National Library of Medicine (figure 2). They are also engaged in extracting data for an insecticides file for the U. S. Forest Service.

The Toxic Materials Information Center is determining the feasibility of reducing scientific and technical data pertaining to the sources, transport, and fate of trace contaminants in the environment (figure 3). These data, to be machine-stored in their reduced form, could be subsequently ordered on any two subject categories and printed out in tabular form.

When these files are added together, making a comprehensive data file, information will be available to study the impact of chemicals or substances in the environment, and more complete information will be stored in one place for setting standards and criteria to protect environmental quality.

NUMERICAL DATA FILES

The last type of data, needed mainly by researchers but also decision makers, is numerical data bases concerning environmental measurements. With the growing concern for rational land use and planning, environmental impact of industrial and federal construction, and economic growth and development of man-made changes in our environment, there is a need for detailed unanalyzed numerical data that can be merged with other information for final assessment.

Though TMIC is not yet storing numerical data, information system specialists can play a major role in knowing where files are located, the content of the data files, the means of accessing the data, and the shortcomings and strong points of the data in relation to the applicability of data to the needs of the requestor.

ASSESSMENT OF INFORMATION

The information gathered in the files just described is often passed on to the requestor for evaluation. However, information systems can play a significant role in the evaluation of data and the subsequent preparation of reviews and state-of-the-art documents. Senior information specialists with academic specialities in the area under review can serve to unify the efforts of the more generally oriented information center staff with those of the highly specialized research participants or university professors to produce an extremely useful and accurate state-of-the-art document. TMIC participated in the preparation of the review document Cadmium, The Dissipated Element [16], and has just completed a review on heavy metals in the aquatic environment in conjunction with Dr. Harry Leland of the University of Illinois to be part of the Journal of Water Control Federation yearly review issue.

CONCLUSIONS

Thus, TMIC and all of EISO strives to be flexible enough to handle all types of data needed by their user communities. Whether providing bibliographic references, factual information, numerical data, as evaluated reviews, the user's needs must be the keystone to the development and operation of all information systems.

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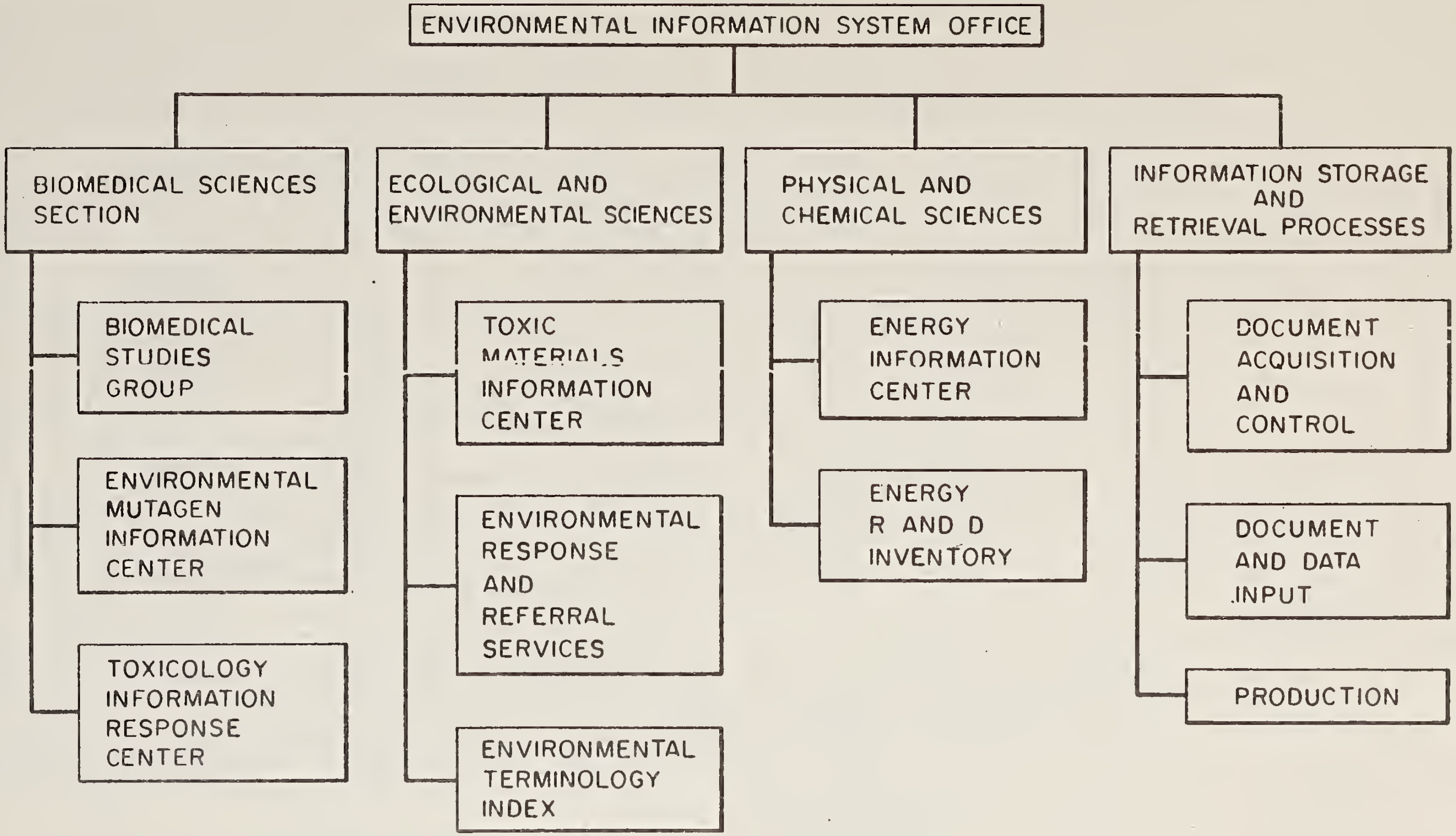

Fig. 1. Environmental Information System Office organization

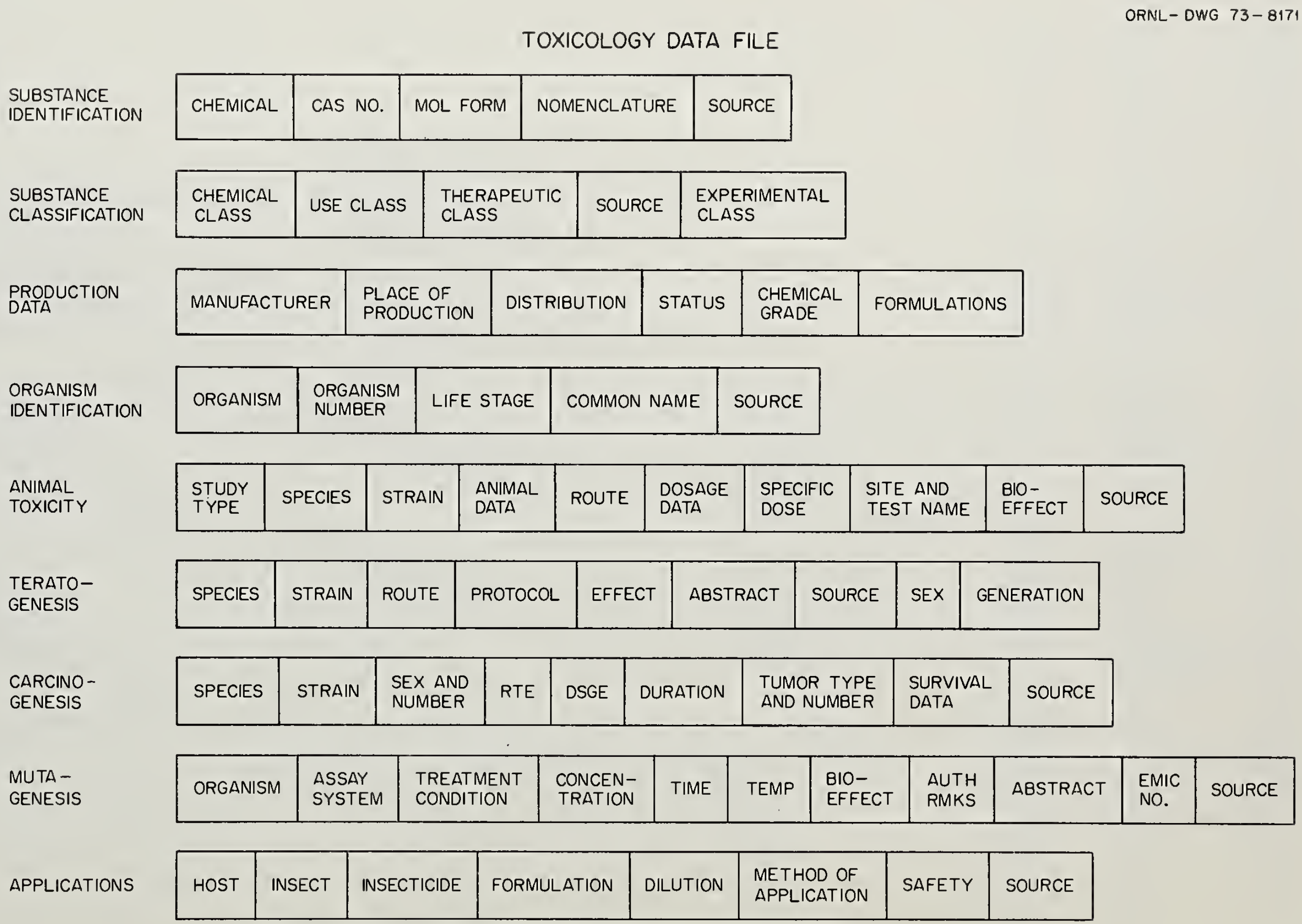

Fig. 2. Toxicology data descriptors.

Substance identification	1 Substance	2 CAS number	3 Molecular formula	4 Synonyms	5	6 Reference source						
Physical properties	7 Substance	8 Atomic/molecular weight	9 Melting point	10 Boiling point	11 Vapor pressure	12 Specific gravity	13 Solubility	14 Reference source				
Environmental standards	15 Substance	16 Air ambient	17 Air emission	18 Water general	19 Water effluent	20 Water drinking	21 Comment	22 Reference source				
Production/uses	23 Substance	24 Manufacturer	25 Location	26 Production (quantity)	27 Uses	28 Comment	29 Reference					
Disposal abatement	30 Substance	31 Environmental source	32 Disposal	33 Losses	34 Abatement	35 Comment	36 Reference source					
Environmental monitoring	37 Substance	38 Environmental source	39 Range/geography	40 Discharge form/quantity	41 Medium	42 Organism	43 Collection method/time	44 Method of analysis	45 Concentration	46 Other substances measured	47 Comment	48 Reference source
Transport/ persistency	49 Substance	50 Environmental source	51 Medium	52 Half-life	53 Physical changes	54 Chemical changes	55 Biochemical change	56 Organism	57 Comment	58 Reference source		
Biologic uptake/elimination	59 Substance	60 Route of entry	61 Organism	62 Tissue	63 Methods	64 Concentration/concentration factor	65 Half-life	66 Elimination rate	67 Comment	68 Reference source		

Fig. 3. Environmental data descriptors.

Government - Industry Data Exchange Program

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This paper briefly describes the orgin and evolution of the Government-Industry Data Exchange Program, its content, method of operation and utilization. It also identifies major sponsoring and participating government agencies and provides the methodology to become a program participant.

ALERT, Calibration procedures, Engineering technical data, metrology, Failure mode, Failure rate, quality, reliability, safety, Technology transfer, Urgent Data Request

The problems facing both government and industry in the acquisition of hardware are many and complex in today's economic environment. Cost-plus-fixed-fee contracts have been replaced by fixed-price-incentive-fee, design-to-cost, and (some) cost-plus-incentive-fee contracts. These contracts include stringent schedules, reliability demonstration requirements, and proven sub-unit capability requirements. The growing complexity of hardware being developed is also a major problem; yesterday's equipment was composed of a few hundred single-function parts, whereas today's equipment contains several thousand multi-function parts. State-of-the-art design requirements create additional problems, particularly in consideration of the rapidly expanding field of integrated circuitry. There is neither time nor money available for each project to perform its own independent research and development; therefore, maximum utilization of existing technology must be accomplished.

Technology transfer, or the use of existing knowledge, can be a key factor in meeting the present cost-conscious contracting environment with its many various requirements. GIDEP (Government-Industry Data Exchange Program) is a data program which enables participating activities to achieve their objectives through the utilization of existing engineering data generated by others. GIDEP provides a system for the routine collection and dissemination of engineering data on parts, components and materials, and related technical information. This information is maintained on microfilm and computerized indexes within the participant's facility and is immediately available for use by the engineers in-house. Further, GIDEP provides a communication network whereby a participant may query any or all of hundreds of other government and industrial participants for assistance on a specific technical problem.

GIDEP contains information which can (and does) assist in the identification and solution of problems, making more intelligent decisions, improving profitability and reducing costs in such areas as proposal preparation, research and development, system/equipment design, reliability and maintainability, production quality, and logistics support. In the following pages, an overview of GIDEP is provided, including its evolution, types of data banks, areas of application, and possible future types of data.

GIDEP was originated in the late 1950s to provide an automatic interchange of engineering evaluation and qualification test data on parts, components and materials among the contractors and military agencies involved in the ballistic missile weapon systems programs. These activities realized they were each testing similar parts from the same vendors to similar environments for similar applications. Therefore, they reasoned that an automatic interchange of this test data would enable each activity to benefit from the testing previously conducted by others, thereby resulting in considerable savings in terms of time, money and facilities. In 1959, the IDEP (Interservice Data Exchange Program) was chartered by the Army, Navy and Air Force, with the task of distributing the data inputs automatically to all participants in the program. The basic concept was to have this collection of data available within the participant's activity for the immediate use of the engineer when he needed it. The scope of the program was limited to parts, components and materials test data generated by parts users (not parts manufacturers) with the specific exclusion of proprietary and classified data. The program was funded by the tri-Services, with no payment for submission of data and no charge for the receipt of data.

In 1966, NASA (National Aeronautics and Space Administration) and CAMESA (Canadian Military Electronics Standards Agency) joined the program and it was renamed the Interagency Data Exchange Program. This resulted in an increase in both the sources and the users of data.

The ALERT System, established by NASA and incorporated into GIDEP in 1967, provided for the identification and notification of actual or potential problems on parts, components, materials, manufacturing processes, test equipment and safety conditions among the participants.

In 1968, the NCSL (National Conference of Standards Laboratories) transferred their library of test equipment calibration procedures to GIDEP for a similar voluntary interchange of these procedures among the participating contractor and government activities. The same concept applied, wherein an activity could benefit in time and money through utilizing the calibration procedures already generated by others for the same test equipments.

The Joint AMC/NMC/AFSC/AFLC Logistics Commanders reviewed the existing IDEP Program in 1970 with a view toward strengthening its management, expanding it to cover additional participants, products and types of information, and consolidating reliability data exchange efforts among the military departments. The Joint Commanders agreed to designate the Chief of Naval Material as the single-Service Program Manager for this DoD and NASA data exchange program (renamed GIDEP).

In early 1973, other government agencies were offered the opportunity to participate in this program. The Atomic Energy Commission (AEC), Defense Supply Agency (DSA), Federal Aviation Administration (FAA), National Security Agency (NSA) and Small Business Administration(SBA) have designated representatives to the GIDEP Government Advisory Group. This group consists of representatives from each of the participating government agencies, and provides advice and recommendations to the Program Manager on management and operation of the program.

The EXACT(International Exchange of Authenticated Electronic Component Performance Test Data) Program is a 13-nation foreign data exchange program patterned after the GIDEP program. A limited exchange agreement has been established between GIDEP and EXACT, wherein the entire EXACT data bank has been made available to all GIDEP participants and selected GIDEP reports (only those parts which have successfully passed all tests) are transmitted to EXACT. All failure data on U. S. parts are excluded from transmission to EXACT. This agreement was established to provide the United States with visibility of parts testing overseas and to advertise the high quality of U. S. parts to potential overseas customers.

The FARADA (Failure Rate Data) Program, formerly a separate tri-Service/NASA reliability data exchange program, was intergrated into GIDEP as a third major data bank in July 1973. The purpose of this integration was to consolidate and strengthen its management and to streamline the failure rate/mode data into a more usable form for the participating activities.

Project SETE (Secretariat for Electronic Test Equipment) was a separate tri-Service/NASA/FAA program for the accumulation, coordination, analysis and exchange of scientific, technical and management information in the specialized field of electronic test, checkout and support equipment. In order to strengthen the management of this program and to provide increased visibility and utilization, responsibility for management and operation of Project SETE was assigned to the GIDEP Program Manager in early 1973, as a coordinated function with GIDEP.

Under single-Service program management, GIDEP has proven highly successful both as a cost avoidance vehicle and as a tool for achieving greater reliability in military hardware. As a result of this success, the military services have made participation in GIDEP mandatory for their design, development and production activities. A Military Standard is presently being prepared for use in contractually requiring GIDEP participation (both data submittals and utilization) in selected development and production contracts.

The Air Force recently completed a study on the technical and economical feasibility of a Defective Parts and Components Control Program (DPCCP). Major efforts are now in process to develop the detailed operational methodology of DPCCP, with an implementation target date of 1 July 1974. The primary objectives of this program are to: provide specific identification of suspect parts (ALERT); initiate such action as required to remove defective parts from existing equipments and stock inventories; and preclude the redesign of these defective parts into new systems under development. GIDEP will provide the central Failure Experience Data Bank for the collection, processing and dissemination of the suspect parts data. Assuming the Air Force DPCCP is successfully implemented, the Army, Navy and NASA have indicated their intent to establish similar dedicated (and coordinated) programs for the control of defective parts in current and future systems.

The GIDEP data banks are contained within the Navy's UNIVAC 1108 computer at Corona, California. This information is presently accessible by remote terminals. A detailed operator's instruction manual has been developed and a pilot program is established among a selected number of GIDEP participants enabling them to search and query the data banks directly by their own remote terminals. If this pilot program proves successful, other GIDEP participants will be offered this service.

The meat of GIDEP is in the data banks and services it provides. These are:

The Engineering Data Bank (EDB) contains engineering evaluation and qualification test reports, nonstandard parts justification data, failure analysis data, manufacturing processes, and other related engineering data on parts, components and materials. These data are normally generated during the systems development phase of the acquisition cycle. Test reports received from EXACT are included in this data bank. The reports are placed on 16-mm microfilm cartridges and distributed to all full participants along with a computer indexed listing of the reports. Partial participants receive the report index and may obtain any report upon request to the GIDEP Operations Center. Cumulative lists are published between updates in order to provide information on reports which have been received at the Operations Center but which have not yet been entered in the report index.

Engineering reports submitted to the Operations Center are assigned a nine-digit generic code for report indexing. The code identifies specific parts and certain standard components covered by the reports. Extra numbers or letters are added to the nine-digit code to provide information on the activity submitting the report. The first three digits of the generic code identify the major part classification. The next two digits define the function of a part or its application. The alphabetical listing of parts and the accompanying part classification five-digit numbers are provided in a sub-title index in the front of the report index. The remaining four digits of the nine-digit generic code provide additional descriptive information with regard to construction of the part. Words which describe the part follow the generic code in the index. The last four digits added to the generic code reveal the originator of the report and the number of the report in the sequence of reports originated on the part in question.

The Metrology Data Bank (MDB) contains test equipment calibration procedures and related engineering data on test systems, calibration systems, and measurement technology. Major outputs from Project SETE will be included in this data bank. Output format of the MDB is the same as the EDB, namely 16-mm microfilm cartridges of the documents and computerized indexes. In the index, calibration procedures are tabulated by the manufacturer test equipment model number. Tabular data then indicates the reel on which the procedure is located and the reel access number.

The Failure Rate Data Bank (FRDB) contains failure rate/mode data on parts, components and materials based upon engineering analyses, field performance data and information on operational systems and equipments. The former FARADA outputs were hard-copy handbooks of computerized failure rate data listings, including statistically analyzed and environmentally segregated listings. More stringent requirements for data inputs will increase the validity of the data file. Outputs of the FRDB will be computerized listings of the data structured in such formats as to be of most convenient use to the reliability engineers needing the data. Also, the source documents supporting the failure rate data entries are available to the participants on 16-mm microfilm cartridges, thereby providing the engineers with complete detailed information for indepth analysis. Failure summaries identify parts and components by the first five letters of the generic code major part classification. The failure information provided included the overall failure experience and the summaries of failures reported by each activity.

The Failure Experience Data Bank (FEDB) contains GIDEP ALERTs generated as significant problems are identified on parts, components and materials. The bank is a computerized file of approximately 35 fields of specific data entries for each ALERT, including complete part identification (e.g., Vendor Part No., Industry Standard No., Part Type Designator, Mil-Spec No., National Stock No., Part Name), vendor's cognizant CAS Code, problem summary, problem cause indicator (e.g., defective part, inadequate specification, improper application), corrective actions taken by both vendor and user, corrective action effectivity date (e.g., S/N, lot/date code), source document reference, etc. The bank is accessible by remote terminal and may be searched and/or sorted by any of the 35 fields. The source documents (i.e., ALERTs) are referenced and are presently contained in the EDB microfilm cartridges. A separate microfilm file of these source documents may be established at a later date, dependent upon volume and need. The FEDB was created to support the GIDEP ALERT System and to serve as the centralized data bank for the Air Force Defective Parts and Components Control Program. There are presently three standard output listings of the FEDB with other listings planned, dependent upon the requirements of the Air Force DPCCP. The ALERT Summary is sorted by part number and generic code and issued quarterly to all GIDEP participants. "ALERTs Sorted by Cognizant CAS Code" listings are issued quarterly to all DCASRs (Defense Contract Administration Services Regions) to provide DCAS with visibility of the ALERTs being generated aginst vendors under their cognizance. "ALERTs Sorted by Vendors" is an alphabetical listing of ALERTs by vendors issued quarterly to the procurement and supply activities of the Defense Supply Agency. These latter two listings are available to GIDEP participants upon request to the GIDEP Administration Office.

While the GIDEP communication network is not an actual "data bank" per se, it is an extremely effective and valuable system of obtaining needed technological information. The UDR (Urgent Data Request) System enables a participant to query all other participants in GIDEP on his specific problem. When a participant has exhausted all internal sources of information on a particular topic, a UDR defining the topic is initiated which the GIDEP Operations Center distributes to all participants. Those participants having additional information on the topic transmit their data directly to the originator of the UDR. A roster of the participants, including name and phone number of all GIDEP Representatives, is also provided enabling each participant to communicate directly with any of the hundreds of government and industrial participants throughout the nation.

A series of Area Indoctrination Clinics are being conducted in key geographic points across the nation. Both government and industrial activities in each area are invited to these Clinics for indepth briefings on the content and use of GIDEP. These Clinics are intended to accelerate the implementation of GIDEP within the many activities currently becoming participants as a result of the mandatory regulations and the forthcoming contractual Military Standard.

Those government activities who have need for the type data handled in GIDEP and those industry activities who need and generate such data are invited to become participants. Requests for participant status should be addressed to:

GIDEP Operations Center
c/o OIC, FMSAEG Annex Code 862
Corona, California 91720

IV. Department of Defense Session

Chairman: Joseph L. Blue
Defense Supply Agency

Introductory Remarks

"The DoD Program for Technical Information about Materials"

Joseph L. Blue
Defense Supply Agency

I wish to express my appreciation for having been invited to address this group and to serve as Conference Leader for the DoD portion of the program. During the next three hours you will be provided specific information regarding each of the DoD Materials Information Analysis Centers by representatives of those Centers. In view of that fact, I will not attempt at this time to review the operations or services of the Centers but will confine my remarks to some of the considerations which are involved in the development and maintenance of a viable Information Analysis Center Program.

First of all, and in recognition of the interagency aspect of this meeting, I would like to place the Information Analysis Centers in their proper context within the DoD Scientific and Technical Information Logistical Support System.

At the hub of this system is the Defense Documentation Center, or DDC as it is commonly known. DDC's predecessor was ASTIA - the Armed Services Technical Information Agency and, at that time, it was essentially a large bookstore operation - receiving, storing and filling requests for technical reports. In the last twelve years, DDC's role has changed to what is now essentially a computer center designed to answer three important questions of the DoD R&D community: What research has been completed? What is currently on-going? and, What research is planned? Scientists and engineers need this information to ensure that new research builds on the documented base of what has already been accomplished and to preclude unwarranted duplication of effort. To provide this information, DDC maintains several data banks including the traditional technical report collection, a work unit data bank containing information pertaining to on-going in-house and contractor research efforts and a planned file consisting of summaries which document planned projects and related tasks.

While the DDC exists primarily to serve the needs of DoD, certain DDC services are available to other Federal Agencies, consistent with security and other applicable considerations. Any Agency representatives desiring additional information are encouraged to contact DDC at Cameron Station, Alexandria, Va.

I will defer discussion of the Information Analysis Centers for now since I will discuss this aspect of the system in more detail later. On the outer ring we have depicted the Scientific and Technical Library functions and the Research and Development Laboratories which are integral to the system, both in terms of receipt and input of information.

The libraries provide unique support for the R&D missions of their parent activities by circulating books and periodicals, performing bibliographic searches and generally rendering personal library services to a wide variety of specialists in their organizations. DDC and IAC services are usually procured thru these libraries which thus serve as retail stores in the total S&TI support system.

The role of the generators - users in the R&D laboratories cannot be over-emphasized since they are producing as well as using information. As in any Agency, the scientist or engineer is the key to the effectiveness of the DoD S&TI support system. It is the technical report of his findings, given through primary distribution to selected colleagues in his field, to DDC for subsequent secondary distribution, and to the IACs for evaluation and retention, that makes the system work. Thus the contribution of the individual is vital both for the information he provides and for the feedback he gives to the system as to ways to improve it.

Increasing the productivity of these scientists and engineers is the primary reason for the existence of the other part of the system - the Information Analysis Centers.

The Centers attempt to accomplish this productivity increase through the timely dissemination of authoritative information in certain well defined areas of technology. The Centers collect, store, review, analyze, and synthesize the results of research and development effort in these areas. As a result of this activity the Centers are able to provide evaluated, up-to-date information in the format most useful to the ultimate users. As depicted on the slide, this processing is essentially a smelting operation in which the "ore" from the world's raw research literature is mined, and then refined in the IAC to produce the "gold", evaluated, synthesized information needed by the technical community. The refining process is accomplished in the IACs by scientists and engineers whose basic jobs are research and development and who are recognized experts in their fields.

With the rapid growth of science and technology we have experienced increased emphasis on Information Analysis Centers. I believe this emphasis is extremely well placed. A busy research scientist or practicing engineer has neither the time nor the physical means to sift through all the isolated references to his specific interests. To search through the thousands of journals and reports which might contain such information is time consuming if not impossible for any individual or small group of individuals, even if all other work is brought to a halt.

Research workers and design engineers must, as a matter of course, accept the consequences - working with incomplete information, repeating tests which have already been done and results published, eliminating a potentially useful material for lack of time to test it adequately or failing to consider a new material which might be useful in the specific application.

Technical librarians and information specialists also must endure long interruptions in their professional work to pore through indices and catalogs searching every entry on a little known topic. Even if the search is successful the data are usually in a form that is not directly usable and substantive advice on the value and reliability of the information is still not available. These are the conditions that the Information Analysis Centers are intended to correct, and, by serving as central sources of evaluated information, minimize the requirement for unwarranted duplicative search efforts.

Having established this background, we can now move to consideration of the factors which will, I believe, determine the success or failure of an Information Analysis Center Program. First, what type of Centers should we have? I believe that we need full service Centers. By that I mean Centers located in research and development atmospheres with immediate access, on an as needed basis, to scientific and engineering expertise in the full range of subject matter within the Center's mission. Without outside assistance, the Centers should have the capability to produce the full range of products and services required by IAC users. Anything less runs the risk of not meeting the user's needs.

Of course having the capability to produce a full range of products is not sufficient to meet user needs unless the products produced have the quality of technical excellence. All of us involved with Information Analysis Centers should keep in mind that the Center puts its reputation and its credibility on the line each time it releases a product, be it a handbook, an inquiry response, or whatever. The Center is responsible for insuring the technical adequacy, indeed the technical excellence of its products. That requirement for technical excellence is an essential ingredient which sets IACs apart from documentation Centers and technical libraries.

Our second consideration is also related to user needs, but in this case I have reference to identification of those needs. For the DSA administered Centers we identify the user communities which the Centers will serve in priority order. First priority, of course, is given to DoD components, contractors and grantees. Secondly, where appropriate, the Centers are to serve other U. S. Government Agencies and their contractors. Finally, to the extent practical without impairment of service to those users, the Centers serve the private sector, consistent with security and other limitations. But while we have defined user groups in these and other ways, including user groups within technologies, we have not sufficiently addressed the question of what these users really need. All of the Agencies are investing large sums of money each year in generating information, in information evaluation, and in producing information products and services. Yet, no concerted effort has been made to assess the need and the usefulness of the products thus developed. The final determination to produce products should be made on the basis of firm evidence of the contribution these works could make in terms of increasing productivity. In recognition of this condition we at DSA are planning to conduct an in-depth study of the need for materials engineering reference works for defense scientists and engineers at the bench level. We would encourage other Agencies to undertake the same kind of effort.

During the discussion of the products and services available from the IACs which you will hear this afternoon I am sure that there will be references to the service charge program. The requirement to recoup costs through service charges is not new but is still not understood in some quarters. During the last meeting of managers and users of DoD IACs, Mr. Makepeace of ODDR&E made some comments in this regard which are worth quoting. He said, "The service charge program is now an essential and integral part of the DoD policy with regard to the Information Analysis Centers. From our point of view this policy is necessary and desirable for some very specific reasons. The service charge policy assures that the products of the Centers are in fact oriented to the needs of their user communities. Users simply will not buy services they do not want or need. A properly administered service charge program is fair - the user pays for the work done and the benefits he receives. Service charges, furthermore, provide a dependable means of assessing the viability of the Information Analysis Centers. We have recently learned that the DuPont Company has instituted an internal service charge policy for its information services, an indication of coming industry acceptance of this concept. Service charges are and will continue to be a basic policy for the IAC program."

Mr. Makepeace has very clearly and concisely stated the basic considerations involved in the service charge policy. Additionally, this policy has enabled us to extend the Centers' services to other Government Agencies such as the ones represented here today, as well as to the public sector. In each case the result is increased authoritative information transfer.

In the transfer of Scientific and Technical Information, as with other programs, standing still is tantamount to falling back. This is no less true of the IACs. We must, therefore, stay abreast of new developments in technology which may have potential for application in improving IAC operations, products and services. For example, new developments increasing the availability of remotely accessable data bases may be exploited to reduce the costs of acquiring, cataloging, storing and retrieving documents. Any savings realized in this end of the operation can be used to improve and increase output products. Also, in recognition of the increasing inter-disciplinary nature of the needs of our user communities we should look toward more products developed as a cooperative venture between two or more IACs as opposed to development of inadequate products due to disciplinary or technological restraints in our scopes of operations. These are but two examples of the opportunities open to us. There are, of course, many more, not the least of which is the reason for our meeting, i.e., greater use of each other's information.

In summation I would like to return to my earlier comments on the primary reason for the existance of IACs, that is to increase productivity. Productivity is the measure not of how hard we work but of how well we use our intelligence, our imagination and the capital resources available to us. Productivity will improve to the degree that we are able to use our management skills to organize work more efficiently and use our ingenuity to develop improved information transfer techniques. This meeting is obviously intended to optimize the use by all the Agencies of the information available within each separate agency. That is a worthwhile goal, for the challenge facing each of us is to use all the intelligence, ingenuity, and skill at our command to increase the productivity of those we serve.

Metals and Ceramics Information Center

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This paper presents a description of the Metals and Ceramics Information Center (MCIC). MCIC is a Department of Defense Information Analysis Center which collects, evaluates, and disseminates technical information on the characteristics, processing, and application of the advanced metallic and ceramic materials. Discussed are the origin, mission, materials scope, organization, information operations, publications, and services of the Center.

Ceramic technology, current awareness services, databooks, information analysis center, inquiry services, metals technology, structural materials, technical reports

Origin

One of the oldest — and largest — of the DoD Information Analysis Centers, the Metals and Ceramics Information Center (MCIC) is now in its twentieth year of continuous service to the materials community. The program was initiated in 1955, when the Office of the Director of Defense Research and Engineering, concerned with technical delays in the development of titanium for military systems instituted the Titanium Metallurgical Laboratory (TML) at Battelle's Columbus Laboratories. TML was instrumental in the intensive efforts of the 1950s which brought titanium from the status of a relatively unknown engineering material to its current wide use in aerospace and commercial applications.

In 1958, the scope of the Center was expanded to include most of the advanced metals, and the program retitled "Defense Metals Information Center (DMIC)". Its services to government and industry included preparation of a large variety of engineering reports, handbooks, technical bulletins, and advisory services. DMIC served as the prototype for a number of other information analysis centers including the Ceramics and Graphite Technical Evaluation Center, established at the Air Force Materials Laboratory in the mid

*Associate Manager and Manager, respectively.

1960s. Later chartered as a DoD IAC, this program was assigned to Battelle in 1967 as the Defense Ceramic Information Center (DCIC).

The present Metals and Ceramics Information Center resulted from the merger of these two concurrent programs in August 1971. The scope was further broadened to include metal and ceramic based composite materials, and the current policy of fees for publications and services was implemented. At the same time, contract responsibility was transferred from the Air Force to the Defense Supply Agency, and technical monitorship from the Air Force Materials Laboratory (which had monitored the program since 1955) to the Army Materials and Mechanics Research Center.

Mission and Scope

MCIC's primary function is to provide timely, authoritative technical information on the characteristics and utilization of the advanced metals and ceramics. Although its first obligation is to serve Department of Defense components, contractors, and grantees, MCIC's resources also are available to the private sector and industry at large. Materials in the Center's scope include:

Metals: titanium and titanium-base alloys, beryllium and beryllium-base alloys, high-strength steels, high-strength aluminum alloys, superalloys, refractory metals, coatings for these metals, magnesium, rhenium, and other metals and alloys used in critical structural applications

Ceramics: single crystal and polycrystalline metal oxides, sulfides, carbides, borides, nitrides, silicides, intermetallics, metalloid elements, glasses, carbons, graphites and coatings for these materials.

Composites: combinations and composites having metallic and/or ceramic elements.

To accomplish these purposes, the MCIC program consists of the following four basic functions:

1. Maintenance of a comprehensive, up-to-date, authoritative technical information base
2. Response to requests for technical advice and assistance from government agencies, contractors, suppliers and the public sector
3. Issuance of a series of timely Reviews of Recent Technical Developments on a variety of subjects within the MCIC scope
4. Publication of technical reports, handbooks, and related documents apprising the state of the art of metals, ceramics, and processes within the MCIC scope.

In addition, MCIC provides capabilities for special assignments, such as preparation, publication and maintenance of engineering handbooks, conduct of critical surveys, materials technology assessments, etc.

Organization of MCIC

The Center employs a full-time staff of approximately twenty engineers, information specialists and secretarial assistants. These provide the basic day-to-day functional operations, including maintenance of the information files and administration of the Center services. But the technical substance of the program depends on the utilization of more than 100 engineers and scientists on the Battelle staff who contribute on a part-time basis as required. It is this select coterie of qualified authorities in the metals and ceramic technologies which constitutes the principal strength of MCIC; their experience and daily participation in advanced materials research provide the Center's users with expert advice and authoritative state-of-the-art publications.

MCIC maintains an office on the West Coast, located in Battelle's Long Beach, California, facility. This office provides personal and quick-response services to that major segment of the Center's user community in the western states.

Information Operations

The principal purpose of the MCIC technical information base is to provide its staff and the user audience with a comprehensive, readily accessible source of current information on the materials within the Center's scope. With a coverage of nearly two decades, the current MCIC files include more than 100,000 accessions, technically reviewed, evaluated, and indexed. This represents the largest collection of its kind in this country. Additions to the files are made at the rate of about 3500 accessions per year.

Primary attention in the selection of input is given to government contractual R&D reports, which constitute about two-thirds of the MCIC collection. Another 25% consists of journal articles, 7% is unpublished technical papers and the remainder comes from internally generated reports, contributions from industry sources, manufacturer's literature, etc.

All MCIC accessions are reviewed by specialists with background in the subject content. Each reference source is evaluated for applicability to the scope, for quality of information, for completeness and for usefulness to the mission of the Center. Indexing uses a controlled but open-ended thesaurus which at present employs about 35,000 terms, with generic up-posting to permit maximum flexibility in search strategy. The Center's current files are automated (conversion to a computer storage/retrieval system was made three years ago), using an interactive, time-shared program developed by Battelle. The system employs CDC 6400 and Cyber '73 equipment, with remote access via high-speed CRT terminal.

MCIC's own information files are supplemented by the extensive collections of the several technical libraries in Battelle's facilities. These provide broad coverage of the open literoture, both US and foreign. Recently, a further important enhancement of MCIC's information and data resources has resulted from installation of a direct, on-line connection to the automated information of the Defense Documentation Center — the only such capobility in ony nongovernment facility.

Although MCIC's files are designed primarily to serve as a tool for its own stoff ond advisory engineers, recent experiments have demonstrated the feasibility of direct on-line access from user locations as distant as Southern California. It is anticipated thot future developments may lead to a network of industrial and government agencies, clients, utilizing this information base on a personal, real-time basis, via telephone/CRT connection.

Services and Publications

MCIC serves its user community both through personal technical advisory service and with a variety of authoritative publications in metals and ceramics technology. Excepting only sensitive information, the Center's services and publications are available without restriction to industry and individuals, as well as to all government agencies. As with most similar information programs, MCIC has found it necessary to charge agencies for its services.

Technical Inquiries

The philosophy of MCIC management is that the most important service which may be provided is assistance in the solution of urgent, immediate technical problems. Thus, quick response to technical inquiries has always been given high priority. The approach is to put the inquiring engineer or scientist directly in touch with a contemporary, professionally qualified engineer in the particular technology of concern. Most often, assistance can be given by telephone or informal letter report. Inquiries handled by MCIC range from those requiring only a few minutes for response to studies calling for several months of professional time. For example, the question may be simply, "What are the preferred titanium alloys for die forging?" or, on the other hand, the inquiry may call for the analysis of the source of material failures and the writing of a series of process specifications.

Charges for MCIC's technical inquiry services are made on the basis of costs incurred. Payment may be made through either MCIC or National Technical Information Service (NTIS) Also, technical service agreements may be established with MCIC.

Special Studies

The resources of MCIC have been employed by DoD, other government agencies, and industry for a variety of special analyses, updating compilations and standards, and state-of-the-art reports. Such special tasks generally are supported through supplemental funding. The following titles indicate some of the special tasks which have been conducted recently by MCIC.

- Comparison of Soviet versus US Materials Technologies
- Report on High-Temperature Materials for TTCP
- Analysis of US Research on Advanced Materials for TTCP
- US versus USSR Technology Assessments on

  Submarine Hull Materials
  Low-Drag Polymers
  Reentry Vehicle Materials
  Superconductor Materials
  Silicon Nitride for Gas-Turbine Applications
- Current Awareness Service on Applications for Composites
- Program Analyses on NDTI Standardization
- Revision of MIL-STD Handbook on Titanium
- Survey of In-Situ Composites for AGARD Handbook
- Preparation of Chapter on NDT for AGARD Handbook
- Planning Surveys of Materials Technologies for USAF
- Status of the Titanium Industry — 1974
- Classified Planning Papers for ODDR&AT(ET)

  Structures Technology
  Materials Technology

Publications

These comprise state-of-the-art reports, reference handbooks, and bulletins on recent developments in metals and ceramic technologies. MCIC's publications are intended to provide timely, reliable technical information to the engineering community.

The Center regularly issues comprehensive reports on topics of current concern; titles of recent state-of-the-art publications include

- Oxidation of Iron-, Nickel-, and Cobalt-Base Alloys
- Impurity Effects in Beryllium
- Electrodeposited Metals as Materials for Selected Applications

- Fracture Analysis with the Scanning Electron Microscope
- Crack Behavior in D6ac Steel
- Processing of Superalloys
- Advances in Welding Technology
- Bioceramics
- Metallic Prosthetic Materials

Reference handbooks published and maintained by MCIC are

- The Titanium Alloys Handbook
- Damage Tolerant Design Handbook
- Forging Practices Manual
- Engineering Properties of Ceramics

These manuals, providing the engineer with design data, properties, and processing information, are supplemented regularly as new data become available. Several additional major handbooks are in preparation.

MCIC's Reviews of Metals and Ceramic Technology are two series of technical newsletters, issues on metals being distributed weekly and those on ceramics published monthly. Written informally, addressed to the active materials, process, and design engineer, the bulletins summarize recent reports and research studies which have resulted in significant advanced technology.

Publications of the Center are distributed through MCIC and the National Technical Information Service (NTIS, Springfield, Virginia 22151). Prices of the technical reports range from $7.50 to $22. Handbooks are priced in the $35 to $40 range. The Reviews of Metals and Ceramic Technology are offered by subscriptions; $95 and $25 per year, respectively. Discounts are available on quantity orders.

MCIC recently ventured into other forms of technical communication, with the preparation of two state-of-the-art files on "Fracture Analysis by Scanning Electron Microscopy" and "Biomedical Applications of Metals and Ceramics". Both are intended as introductions to the subject, to be supplemented by the related MCIC engineering reports. Additional films are planned and consideration is being given to the preparation of reports on materials technology via video-tape presentations. These new forms of documentation are available on a loan basis or purchase.

MCIC Newsletter and Film

The Center issues a monthly newsletter to its users and members of the materials community. It includes reports of significant developments in materials technology, announcements of new MCIC products and services, reviews of pending government R&D contract programs, and notices of technical meetings. The Newsletter is available without charge to any interested individual or company engaged in materials research, development, and/or utilization.

An eight-minute film introduction to MCIC operations, products, and services also is available for loan at no charge.

For additional information on how you may benefit from use of MCIC's technical resources, write or call the Center at either of the addresses given below:

Metals and Ceramics Information Center

Battelle-Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone: (614) 299-3151, Extension 2758

Battelle-Columbus Laboratories
Long Beach Ocean Engineering Facility
965 Harbor Scenic Way
Long Beach, California 90802
Telephone: (213) 435-6242 or 436-1241

Plastics Technical Evaluation Center (PLASTEC)

Harry E. Pebly*

Keywords: Adhesives; composites; computerized information system; foams; plastics information; Plastics Technical Evaluation Center; specifications; technical reports; testing methods; tooling.

The Plastics Technical Evaluation Center (PLASTEC) is one of approximately twenty technical information analysis centers sponsored by the Department of Defense (DoD) to provide the defense community with a variety of authoritative information services. Located at Picatinny Arsenal, PLASTEC has been serving this community since 1960 via state-of-the-art reports, handbooks, newsletters, current awareness studies, engineering assistances, bibliographies, literature searches, technical inquiries, and special investigations on plastics, composites, and adhesives.

Its library houses over 25,000 selected holdings from government and private industry which have been evaluated, indexed, and abstracted. These holdings include technical reports and conference papers, trade literature, specifications, selected bibliographies and periodicals as well as government and commercial indexes to the general literature. The library welcomes visitors but is not staffed to provide loan service. Printouts of computer searches of our holdings of non-proprietary information containing citations, abstracts, and index terms are available. PLASTEC has developed a relationship with DDC which permits PLASTEC access to the Defense RDT & E on-line network, and input, storage, and retrieval from its own collection using the same on-line terminal.

PLASTEC's staff of specialists offers professional services in a wide range of interests such as packaging, electronics, deterioration (e.g., weathering, microbiological, compatibility), new materials, composites, foams, adhesives, specifications, test methods, tooling and processing, etc. At the direction of DoD these technical services are available to the entire U.S. scientific and technical community on a fee basis. The charge, determined by the nature of the inquiry, runs about $30 per specialist manhour. Such charges enable this center to recover a part of its operating expense and make funds available for improved and expanded services. Minor inquiries which can be handled in a routine manner are presently accomplished without charge. Service charges for inquiries can be paid directly to PLASTEC.

* Director, Plastics Technical Evalution Center, Picatinny Arsenal, Dover, New Jersey 07801

From time to time PLASTEC specialists publish technical reports and notes on information felt to be of interest to the technical community. These reports are sold by the National Technical Information Service of the Department of Commerce (NTIS) located at 5285 Port Royal Road, Springfield, Virginia 22151 at a price commensurate with their handling and printing cost. A complete list of PLASTEC reports and notes is available upon request.

The PLASTEC staff of ten calls upon the Arsenal's Materials Engineering Division for consultation when appropriate and is also assisted by an on-site contractor for literature processing services.

Telephone numbers at the Center are 201-328-4222, -3189 or -5859.

Thermophysical and Electronic Properties Information Analysis Center [TEPIAC]
A DoD Information Analysis Center

Operated By

Center for Information and Numerical Data Analysis and Synthesis [CINDAS]

Y. S. Touloukian

Keywords: Computerized information system; data bank; electrical properties; electronic properties; magnetic properties; optical properties; Retrieval Guide; technical reports; Thermophysical and Electronic Properties Information Analysis Center; thermophysical properties.

General Information

The Thermophysical and Electronic Properties Information Analysis Center (TEPIAC) was established in 1973 as a result of a merger of the DoD Thermophysical Properties Information Center, established in 1960 and the Electronic Properties Information Center, reactivated in 1973. CINDAS operates TEPIAC for the Department of Defense under a DSA contract and serves all DoD contractors and others on their need for thermophysical, electronic, electrical, magnetic, and optical property data for a broad range of materials.

Briefly stated, TEPIAC's activities consist of the following: locates, obtains, catalogs, codes, and evaluates research documents; makes literature searches; stores, retrieves, and makes available technical papers (on microfiche); performs data analyses, syntheses, estimations, and recommendations; generates reference data tables; performs theoretical and experimental research; and provides technical advisory and consulting services.

Current Scope of Coverage

Approximately 130,000 unclassified technical papers from worldwide sources have been identified, secured and coded in depth. This bibliographic information is computerized for detailed literature searching and periodic publication of Retrieval Guides. About 12,000 new technical papers are added to the properties file each year.

Information and data on more than 70,000 different substances and materials are currently coded for the following properties:

THERMOPHYSICAL PROPERTIES

1. Thermal conductivity
2. Accommodation coefficient
3. Thermal contact resistance
4. Thermal diffusivity
5. Specific heat at constant pressure
6. Viscosity
7. Emittance
8. Reflectance
9. Absorptance
10. Transmittance
11. Solar absorptance to emittance ratio
12. Prandtl number
13. Thermal linear expansion coefficient
14. Thermal volumetric expansion coefficient

ELECTRONIC, ELECTRICAL, MAGNETIC, AND OPTICAL PROPERTIES

PROPERTY

(1) Absorption coefficient
(2) Dielectric constant
(3) Dielectric strength
(4) Effective mass
(5) Electric hysteresis
(6) Electrical resistivity
(7) Energy bands
(8) Energy gap
(9) Energy levels
(10) Hall coefficient
(11) Magnetic hysteresis
(12) Magnetic susceptibility
(13) Mobility
(14) Refractive index
(15) Work function

PROPERTY GROUPS

(16) Electron emission properties
- i. Field emission
- ii. Photoemission
- iii. Secondary emission
- iv. Thermionic emission

(17) Luminescence properties
- i. Cathodoluminescence
- ii. Electroluminescence
- iii. Mechanical luminescence
- iv. Photoluminescence
- v. Thermoluminescence

(18) Magnetoelectric properties
- i. Ettingshausen effect
- ii. Magnetoresistance
- iii. Nernst effect
- iv. Shubnikov-de Haas effect

(19) Magnetomechanical properties
- i. Anisotropy energy
- ii. Magnetostriction

(20) Photoelectronic properties
- i. Dember effect
- ii. Photoconductivity
- iii. Photomagnetic effect
- iv. Photopiezoelectric effect
- v. Photovoltaic effect

(21) Piezoelectric properties
- i. Piezoelectric effects
- ii. Pyroelectric effect

(22) Thermoelectric properties
- i. Peltier effect
- ii. Seebeck effect
- iii. Thomson effect

For further information on technical services or publication, write or call:

Mr. Wade H. Shafer, Assistant Director
Center for Information and Numerical Data Analysis and Synthesis
Purdue Industrial Research Park
2595 Yeager Road
West Lafayette, Indiana 47906

Telephone: 317/463-1581

Machinability Data Center - Data Publications and Services

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This paper identifies the annual high costs of machining in the USA ($60 Billion) and the Government's cost recovery contractual goals as principal environmental factors which presently influence the Machinability Data Center's operations. MDC's machining data publications are identified. Cost savings as a result of the dissemination and use of MDC publications and specific technical inquiry services are estimated to total more than $158 Million. A national numerical machining data bank is considered as an important file for implementation and support of modern manufacturing systems and a methodology for developing such a data bank is suggested.

Data banks, information analysis centers, machining costs, machining data banks, Machinability Data Center, Machining Data Handbook, machining data publications, machining costs

Principal Environmental Factors

Operational functions and the products and services of Information Analysis Centers are determined largely by the environment in which a particular center is functioning. In the case of the Machining Data Center (MDC), a favorable economic environment looms as one of the most important characteristics. Table 1 shows that over $60 Billion are estimated to be spent annually in the United States to cover labor and overhead costs in the metalworking industry. Table 1 also lists substantial annual expenditures for machine tools and cutting tools:

Table 1

Machining Costs in the USA

The statistics below are for the purpose of providing perspective concerning the economic importance of metal cutting (machining and grinding) in the USA.

Approximate Annual Labor and Overhead Costs for Operating Metal Cutting Machine Tools in Industries in the United States:

Total number of metal cutting machine tools	=	2, 692, 000*
Estimated labor cost + overhead	=	$10-12 per hour
Average working day	=	8 hours
Number of working days per year	=	250
Average number of direct labor personnel per machine	=	1
Total cost of labor + overhead:		
2, 692, 000 x $10 x 8 x 250 x 1	=	$53, 840, 000, 000
2, 692, 000 x $12 x 8 x 250 x 1	=	$64, 608, 000, 000

It appears reasonable to conclude that the cost of labor + overhead for machining required for manufacturing in the USA is of the order of

$60, 000, 000, 000 annually

*Based on American Machinist Eleventh Inventory (1973)

Total Shipments Including Exports of Metal Cutting Type Metalworking Machinery:

$1, 169, 000, 000 (1972) $1, 500, 000, 000 (1973 Estimate)

Source: U.S. Department of Commerce

Machine Tool Accessories Industry:

Small cutting tools for machine tools and metalworking machinery in the amount of:

$670, 000, 000 (1970) $830, 000, 000 (1973 Estimate)

Source: U.S. Department of Commerce

A random sampling of the current state of the art in machine tool plants, both large and small, in the United States indicates that considerable cost savings can be achieved with an increased and judicious use of improved machining data. It is interesting to reflect that a mere one percent across-the-board savings can develop an annual savings of $600 Million. It should be pointed out, however, that such savings are not directly recoverable by agencies responsible for funding. These savings are diffuse and would ordinarily be diverted for improving product quality, increasing research and development to meet foreign competition, providing better manufacturing facilities, accommodating other costs, and for yielding a more realistic profit margin.

Attitudes and policies of funding agencies also play a large role in determining the functional priorities of an Information Analysis Center. In the case of MDC, yearly funding at the present time is at a level of $150,000 per year. MDC's contract includes a very important item, namely, a cost recovery goal designed to develop income in the amount of 90 percent, i.e., $135,000, through sale of products and services. It is significant to note that funds of this order of magnitude can be developed only through sale of "best sellers" and not from sale of specialized technical data publications which usually sell approximately 500 to 1500 copies per edition. In other words, cost recovery goals have had considerable influence in establishing work priorities--in this case, an emphasis on data publications which have high income potential.

Data Publications of MDC

The principal publication of the Machinability Data Center is its Machining Data Handbook, now in its second edition. This 1000-page handbook provides approximately 41,000 starting machining recommendations for 1100 alloys and for more than 55 material removal operations such as turning, milling, drilling, reaming, tapping, grinding, electrical discharge machining and electrochemical machining. A typical data page is shown in Table 2.

In the period May 1, 1972, through April 11, 1974, 11,290 copies of this handbook have been sold. This and previous editions of the handbook have generated cost savings estimated at $92,370,000. Table 3 provides details of the method used for approximating savings from publications as well as from specific inquiries.

Major savings, as indicated in Table 3, resulted from the distribution of the Machining Data Handbook. It should be pointed out that while savings from specific inquiries were significant, most of the specific inquiries were processed before the cost recovery program was put into effect, that is, before charges were made for inquiries. Of the 7144 inquiries made to date, 6842 occurred in the period from 1965 to 1972. Since January 1, 1972, only 128 inquiries were paid for, and these developed an income of about $10,000.

Typical additional data publications of the Center, including a computer program, are listed in Table 4.

Table 2

Turning, Single Point and Box Tools

MATERIAL	HARD-NESS BHN	CONDITION	DEPTH OF CUT inches	HIGH SPEED STEEL TOOL			CAST ALLOY TOOL		CARBIDE TOOL			
				SPEED fpm	FEED ipr	TOOL MATERIAL	SPEED fpm	FEED ipr	SPEED - fpm BRAZED	SPEED - fpm THROW-AWAY	FEED ipr	TOOL MATERIAL
16. STAINLESS STEELS, CAST (cont.) Martensitic ASTM A296: Grades CA-15, CA-40 ASTM A426: Grades CP7, CP9	275 to 325	Quenched and Tempered	.150	60	.015	T15, M33, M41 Thru M47	75	.015	265	305	.015	C-6
			.025	70	.007	T15, M33, M41 Thru M47	85	.007	300	340	.007	C-7
	375 to 425	Quenched and Tempered	.150	40	.010	T15, M33, M41 Thru M47	55	.010	140	165	.010	C-6
			.025	50	.005	T15, M33, M41 Thru M47	65	.005	165	190	.005	C-7
17. PRECIPITATION HARDENING STAINLESS STEELS, CAST ACI Grade CB-7Cu ACI Grade CD-4MCu	325 to 375	Solution Treated	.150	45	.015	T15, M33, M41 Thru M47	55	.015	225	260	.015	C-6
			.025	50	.007	T15, M33, M41 Thru M47	60	.007	275	300	.007	C-7
	400 to 450	Solution Treated and Aged	.150	35	.010	T15, M33, M41 Thru M47	45	.010	140	175	.010	C-6
			.025	40	.005	T15, M33, M41 Thru M47	50	.005	175	210	.005	C-7
19. GRAY CAST IRONS Ferritic ASTM A48: Class 20 SAE G1800	120 to 150	Annealed	.150	145	.015	M2, M3	155	.015	500	550	.020	C-2
			.025	185	.007	M2, M3	200	.007	650	725	.010	C-3
Pearlitic-Ferritic ASTM A48: Class 25 SAE G2500	160 to 200	As Cast	.150	90	.015	M2, M3	100	.015	365	400	.020	C-2
			.025	140	.007	M2, M3	150	.007	460	540	.010	C-3
Pearlitic ASTM A48: Classes 30, 35 and 40 SAE G3000	190 to 220	As Cast	.150	80	.015	T15, M33, M41 Thru M47	90	.015	300	340	.015	C-2
			.025	120	.007	T15, M33, M41 Thru M47	130	.007	360	410	.007	C-3
Pearlitic + Free Carbides ASTM A48: Classes 45 and 50 SAE G3500, G4000	220 to 260	As Cast	.150	55	.015	T15, M33, M41 Thru M47	65	.015	225	265	.015	C-2
			.025	85	.007	T15, M33, M41 Thru M47	85	.007	275	325	.007	C-3
Pearlitic or Acicular + Free Carbides ASTM A48: Classes 55, 60 and 60+	250 to 320	As Cast or Quenched and Tempered	.150	35	.010	T15, M33, M41 Thru M47	40	.012	125	150	.012	C-2
			.025	50	.005	T15, M33, M41 Thru M47	55	.005	175	190	.005	C-3
Austenitic (NI-RESIST) ASTM A436: Types 1, 1b, 5	100 to 215	As Cast	.150	75	.015	M2, M3	100	.015	250	285	.015	C-2
			.025	100	.007	M2, M3	150	.007	350	395	.007	C-3
Austenitic (NI-RESIST) ASTM A436: Types 2, 3, 6	120 to 175	As Cast	.150	65	.015	M2, M3	80	.015	200	225	.015	C-2
			.025	85	.007	M2, M3	130	.007	300	340	.007	C-3

See Sections 2.1 and 2.2 for Tool Geometry.
See Section 3 for Cutting Fluid.

Table 3

Estimated Cost Savings from MDC's Operations
(January 1, 1965 - April 11, 1974)

Specific Inquiries

Total Number of Specific Inquiries 7,144

Estimated Total Number of Machining Situations Included in the 7,144 Inquiries x 5 - 35,720

Estimated Savings per Machining Situation Response - $800

Estimated Total Savings Resulting from Specific Inquiries - 35,720 Machining Situations x $800 = $ 28,576,000

Publications

Total Number of Data Publications Copies Distributed (excluding Machining Data Handbook) - 22,599

Estimated Number of Machining Situations Utilized per Data Publication Copy - 5

Estimated Total Number of Machining Situations - 22,599 Data Publication Copies x 5 - 112,995

Estimated Savings per Machining Situation - $300

Estimated Total Savings Resulting from Data Publications (excluding the Machining Data Handbook) - 112,995 Machining Situations x $300 = $ 33,898,500

Total Number of Machining Data Handbook, 2nd Edition, Sold through April 11, 1974 - 11,290

Total Number of Machining Data Handbook, 1st Edition, Distributed* 9,000 hardbound + 6,000 softbound - 15,000

Total Number of ORDP 40-1 softbound (forerunner of Machining Data Handbook) Distributed* - 4,500

Total Number of Machining Data Handbooks Distributed - 30,790

Estimated Number of Machining Situations Utilized per Machining Data Handbook - 10

Estimated Total Number of Machining Situations - 30,790 Handbook copies x 10 - 307,900

Estimated Savings per Machining Situation - $300

Estimated Total Savings Resulting from Machining Data Handbook - 307,900 Machining Situations x $300 = $ 92,370,000

Grand Total = $154,844,500

*These data products were sponsored by the U.S. Army under separate contracts which were issued to Metcut prior to MDC becoming operational. The 4,500 copies of ORDP 40-1 and the 6,000 softbound 1st Edition of the Handbook were sold by the U.S. Government.

Table 4

Typical Additional MDC Data Publications

MACHINING OF HIGH STRENGTH STEELS WITH EMPHASIS ON SURFACE INTEGRITY, AFMDC 70-1, 268 Pages, 8½ x 11 in., Hardbound.

DETERMINATION AND ANALYSIS OF MACHINING COSTS AND PRODUCTION RATES USING COMPUTER TECHNIQUES, AFMDC 68-1, 124 Pages, 8½ x 11 in., Paperbound.

1968 SUPPLEMENT TO MACHINING DATA FOR NUMERICAL CONTROL, AFMDC 68-2, 104 Pages, 8½ x 11 in., Paperbound.

MACHINING DATA FOR NUMERICAL CONTROL, AFMDC 66-1, 270 Pages, 8½ x 11 in., Paperbound.

GRINDING RATIOS FOR AEROSPACE ALLOYS, AFMDC 66-2, 20 Pages, 8½ x 11 in., Paperbound.

MACHINING DATA FOR BERYLLIUM METAL, AFMDC 66-3, 26 Pages, 8½ x 11 in., Paperbound.

MACHINING DATA FOR TITANIUM ALLOYS, AFMDC 65-1, 56 Pages, 5½ x 8½ in., Paperbound.

NCECO – N/C MACHINING COSTS
A computer program which calculates and prints out the individual cost elements, total cost and operation times for analyzing various alternative machining conditions. The program is written in FORTRAN IV for the IBM 1130 computer system and includes software and documentation.

The publications listed in Table 4 are of a more specialized nature, with average sales per title approximating 1000 copies except for NCECO where sales of this new product total 5. The importance of these "low sale" publications to the technical community should not be overlooked. For example, the text on Machining of High Strength Steels with Emphasis on Surface Integrity has had an important influence on improving the machining practices used on high strength steels. This kind of information helps avoid surface damage which can lead to structural failure of aircraft. Machining Data for Numerical Control and NCECO - N/C Machining Costs are examples of publications which supply specialized data and systems for those manufacturers who are better prepared to accept more refined data than the starting data recommendations provided in the Machining Data Handbook.

Specific Inquiries

MDC furnishes data and other related information to help clients in the solution of specific material removal problems. Experienced machining data analysts are supported by IBM 1130 computer files consisting of about 25,000 documents, 8100 specific inquiries and approximately 2500 documents in a surface integrity satellite file. Inquiry services under the Government's cost recovery program are subject to charges with the average inquiry costing $50-$100. Telephone and brief letter inquiries are answered at no charge.

User File

MDC maintains a User File consisting of about 5500 key people in U.S. industry and government. There is no User File charge; also, all Users receive a bimonthly newsletter, "Machining Briefs," free of charge.

Services for the Future

Undoubtedly, there will be a continuing need for updated editions of the Machining Data Handbook, including a metric version at some time in the future.

Other very important machining data needs are also indicated. In modern manufacturing, we are now at the threshold of new and important developments which require the creation of a national numerical machining data bank in support of many of the new technologies, such as computer aided manufacturing, adaptive control, etc. Considering the large number of alloys, machining operations, and metal cutting conditions which may be demanded from a data bank, it is obvious that there is neither sufficient time nor is there any possible chance that funds will be available to experimentally generate all of the data required for a complete data bank. As almost a sole alternative, a computer based system must be developed which with limited hard data can provide reliable interpolations and possibly even extrapolations for all the essential parameters in a data bank. Additionally, provision must be made for a system which will effectively handle feedback of shop experience for upgrading of data quality.

On an experimental basis, MDC is using mathematical modeling techniques to provide numerical data based upon existing hard data for a particular material group and specific machining operation. One of the most exciting information problems presented is to develop a modeling system which will take fragmentary data--that is, isolated data in the literature and from manufacturing plants--and make it meaningful for serving a much broader range of parameters. However, developing a modeling system for closing numerical gaps is a difficult information processing problem. Several other major problems which require solutions for making data relevant to the requirements of machining centers are (1) modeling to satisfy parameter requirements for tools performing multiple operations and (2) modeling to develop systems for utilization of tools exposed to a variety of conditions in completing a job function--for example, a spectrum of depths of holes in the case of drills instead of holes of the same depth.

If funds can be made available, it appears that it will be feasible to develop a viable national numerical machining data bank. It is anticipated that this data bank and other supporting files will be utilized by companies mainly interested in using it to set up their own stand-alone systems. Use will be made of MDC's system design along with data supplied for selected materials and machining operations. If industry requirements for on-line machining data increase, then the system can also be operated to fulfill such demands. Finally, a national numerical machining data bank will be invaluable for rapid updating of the Machining Data Handbook. The system as now conceived could accommodate to changing format and parameter requirements, and, in fact, additional handbooks could be generated to service the specialized needs of various industries. As an example, the feed rates and the depths of cut used in the automotive industry differ widely from those used in steel rolling mill machine shops.

A new service of MDC which will be initiated shortly is a seminar program. In spite of extensive competition in the field of seminars, it appears that MDC has access to personnel and information to help in planning unique curricula. The first seminar which will be held is titled "Practical Machining Principles for Shop Application." Others to follow are "Manufacturing Update for Management Planning," and Computer Analysis of Machining Costs."

Summary

The largest source of cost recovery funds for MDC has been through the sale of publications, primarily from the Machining Data Handbook. This handbook and other MDC specialized data publications are considered to be extremely important for helping upgrade machining technology in the United States and are thought to be of great value for developing substantial cost savings. The development of a national numerical machining data bank is considered necessary for implementation and support of modern manufacturing systems. Significant income to MDC is anticipated as a result of the operation of a national numerical machining data bank; however, for some years to come, MDC will look to updated versions of the Machining Data Handbook for supplemental funds to help support its present level of operation.

Nondestructive Testing Information Analysis Center

George Darcy
Army Materials and Mechanics Research Center

Keywords: Army Materials and Mechanics Research Center; electromagnetics; materials testing; nondestructive testing; Nondestructive Testing Newsletter; radiography; technical reports; ultrasonics

In 1964, the Department of Defense, through Headquarters, U. S. Army Material Command, recognized as operational the Nondestructive Testing Information Analysis Center (NTIAC) of the Army Materials and Mechanics Research Center (AMMRC). As a consequence, and in compliance with DoD Instructions, this operating center was then officially established within the framework of the DoD Scientific and Technical Information Program as the DoD Center for the Analysis of Nondestructive Testing Information.

The mission of NTIAC is to collect, maintain, and disseminate information in the field of nondestructive testing (radiography, ultrasonics, electromagnetics, and other nondestructive testing methods). Information is collected from technical reports, the open literature, and other sources, and is stored in a rapid retrieval system. Such information is disseminated upon request, to government installations and others. A Nondestructive Testing Newsletter and Report Guides to Literature in various subfields of nondestructive testing are also published.

In addition to the NTIAC staff of nondestructive testing experts who are directly responsible for operation of the center, the full resources of a distinguished staff of scientists, engineers, and technicians are available at AMMRC to provide assistance in those areas requiring augmented technical support.

The NTIAC acquires and stores, under bibliographic control, not only the world's literature on nondestructive testing, but also unpublished reports, memoranda, and miscellaneous documents related to technical aspects of nondestructive testing. Periodic contact is developed and maintained, through personal visits and correspondence, with senior investigators and practitioners engaged in technical work related to nondestructive testing. An important aspect of NTIAC current awareness is the participation in and/or the planning of technical conferences or symposia in the field of nondestructive testing attractive to senior investigators or practitioners.

All documents and other source material (items) on nondestructive testing are indexed, abstracted, coded, and filed for reference and use. use. A register of sequential accession numbers is kept for assigning index identification to items. Abstracts are generally limited to one hundred words or less, and are coded to reflect title, author(s), source information, and content. The cards are then filed and the coded information is put on the master descriptor cards of a special visual coordinate indexing system. The files of NTIAC contain, therefore, descriptor cards, abstracts, and items. Search and retrieval are accomplished by searching the descriptor cards by code, identifying and locating the abstract, and, if the abstract warrants, locating the original item.

In addition to identifying, collecting, abstracting, indexing, and filing the items, NTIAC also prepares critical reviews, monographs, and other publications on the state-of-the-art in selected areas of nondestructive testing.

Periodically, Report Guides to Literature on the various fields of interest in nondestructive testing are published. These guides reflect the new and significant publications in a particular field of interest, and consist of copies of abstracts, together with the pertinent descriptors and accession numbers, from the files of NTIAC. The guides are essentially literature searches and provide users with a miniature retrieval system on specific subjects. A Nondestructive Testing Newsletter is published as the volume of news warrants. Other services include: providing brief and detailed answers to technical inquiries; consulting and advisory services; preparation of analyses and evaluations; providing short lists of literature citations in response to specific requests; furnishing locations of hard-to-find bibliographical materials; extensive literature-searching services; and on-site use of NTIAC holdings.

Services and on-site use are available free of charge to all qualified requesters. Documents are not loaned; requesters receive abstract-card copies on which document source information is provided.

All requests for information or services should be addressed to:

Director, Army Materials and Mechanics Research Center
ATTN: Nondestructive Testing Information Analysis Center
Watertown, Massachusetts 02172

Telephone requests can be made by calling:

(617) 926-1900, Extension 343 or 552

The AUTOVON number is:

684-8343 or 684-8552

CONCRETE TECHNOLOGY INFORMATION ANALYSIS CENTER (CTIAC)

Bryant Mather*

Key Words

Analytical procedure; bibliographies; computerized information system; concrete; concrete technology; construction material; construction methods; portland cement; state-of-the-art summaries; technical reports; test methods

Introduction

1. The U.S. Army Corps of Engineers has been deeply involved in concrete technology - the intelligent use of concrete as a construction material - for over a century. Such involvement in concrete technology inevitably includes analysis of information on concrete technology. Since concrete technology is an important element of the technological base of the civilian economy as well as of military technology, there has necessarily been an interchange of information between the military and civilian sectors and the public and private sectors. The research and development center for concrete technology of the Corps of Engineers, the U.S. Army Engineer Waterways Experiment Station (WES), has been and is the principal point of contact for information exchange within the Federal establishment, the defense establishment, and between these and the civilian and private sectors of the economy. It was, therefore, highly appropriate that when a Department of Defense (DOD) Concrete Technology Information Analysis Center (CTIAC) was established on 18 April 1968, it was established at the WES and that its Director be the Chief, Concrete Laboratory, WES.

Background

2. Under date of 17 March 1965, the Office, Chief of Engineers (OCE), requested the Director WES, to review AR 70-22 "Centers for Analysis of Scientific and Technical Information" and comment on the extent to which WES was already engaged in work of this sort, areas for which establishment of centers at WES should be considered, and related topics. In reply, it was stated that WES was rather deeply engaged in this sort of activity and recommended consideration of the establishment of several centers, one of which was in the area of <u>concrete technology</u> which would deal specifically with (a) mass concrete materials and construction methods, (b) analytical procedures and test methods, and (c) portland cement grout mixtures; with initial service responsibility to the DOD. It was noted that the WES

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Concrete Laboratory had gathered, analyzed, evaluated, condensed, and published reports on the state-of-knowledge or state-of-the-art in a number of areas, and that the capability of its staff is superior to that found elsewhere in the world for treating some of these areas. Estimates of needed funds and spaces were made.

3. In August 1965, in accordance with AR 70-22, proposals for establishment of six centers were sent from WES to OCE. It was proposed that the CTIAC draw upon the work of other groups such as the Centre Internationale du Batiment (CIB), CEMBUREAU, Portland Cement Association (PCA), American Concrete Institute (ACI), Highway Research Board (HRB), American Society for Testing and Materials (ASTM), RILEM, National Bureau of Standards (NBS), etc.

4. In April 1966, OCE submitted proposals to the Office, Chief of Research and Development (OCRD), for approval of the establishment of eight centers to serve the DOD.

The CTIAC was established by memorandum dated 18 April 1968 from the Director, Defense Research and Engineering (DDRE), to the Assistant Secretary of the Army, R&D.

5. On 29 April 1970, TISA Project 02/07, "Cost Analysis of Information Centers," was activated to develop information relative to the level of effort being expended by the Waterways Experiment Station Technical Library and the staff of the Concrete Division in the operation of the Concrete Technology Information Analysis Center. Information collected was to include the activity that was conducted and its nature, the clientele served, and the cost. This information was to serve as a basis for cost distribution comparison with other Information Analysis Centers (IAC) in which document acquisition, storage, etc., is chargeable wholly to IAC accounts rather than to other supporting studies. A member of the technical staff of the CD was assigned as project leader. The CD staff and the WES Library were to maintain records of all requests for services from CTIAC, action taken, response made, difficulties encountered, time expended, and elapsed time required to complete the necessary action. Reports were submitted to the Project Leader for analysis and assembly. Problem areas were studied with a view to improving the services. The need for supporting funds and personnel spaces on a regular basis was evaluated. The report on this project was published in December 1972, entitled "Concrete Technology Information Analysis Center, Evaluation of Pilot Study," WES Miscellaneous Paper C-72-24, TISA Project Report No. 41 (Project 02-07), and CTIAC Report No. 11.

Objective and Approach

6. The technical objective of the CTIAC is stated as follows:

> "To collect, analyze, evaluate, and disseminate information in the broad field of concrete technology and perform all functions of a DOD Information Analysis Center as prescribed in AR 70-22."

7. The approach is stated to be:

"Information is collected; the 'International Exchange of Information Scheme' in concrete technology is participated in; queries are responded to; reports covering the state-of-the-art and annotated bibliographies are prepared and distributed; reference searches and loans are provided."

Data Base

8. The CTIAC is supported by the Library Branch, Technical Information Center, WES, which contains approximately 200,000 items including books, periodicals, reports, pamphlets, standards, microforms, unpublished matter, and other data. The Library is a bibliographic center, containing a dozen catalogs of other libraries in related fields of interest, capable of supporting research on the doctoral level. Library resources are supplemented by services of the Defense Documentation Center; the installation of a Defense RDT&E On-Line computer terminal in the Library has greatly facilitated the flow of information between DDC and WES.

FY74 Program

9. Despite a deliberate decision not to publicize widely the existence of the CTIAC, the volume of inquiries and requests for service continues to increase. A major element in CTIAC plans for FY74 must therefore be to prepare to provide answers to inquiries and services to users as requested. In providing services it is often necessary to provide to the inquirer, directly from the CTIAC, copies of one or more relevant bibliographies or summaries of the state-of-the-art. To date, with very few exceptions, these documents have been produced and published using other funds. It is planned, as a method of increasing the efficiency of response of the CTIAC, to produce, publish, and reprint such of these reports as may be necessary to meet user requirements, as resources permit. Many users will still need to be referred to DDC or NTIS because of unavailability here of copies of relevant documents in print, a condition that often precludes providing the required information in a timely manner. In some cases this situation is mitigated by the use of library loan copies of relevant documents. Revision of the CTIAC portion of the WES microthesaurus to put it in COSATI format and to add relevant new terms to keep up with the state-of-the-art will be initiated. The data base will be reviewed and steps taken to enhance its capabilities by recommending additional purchases, subscriptions, and exchanges. Reference searches will continue to be provided in cooperation with the Library Branch, Technical Information Center. Plans for automated search and retrieval will be developed jointly with other WES TIAC's in cooperation with the WES Technical Information Center. It is estimated that about 500 technical queries will be responded to and that five state-of-the-art reports will be published.

International Exchange of Information

10. During the period 2-6 March 1970, the Director, CTIAC, was a member of a delegation of six individuals from the United States, and the only representative of the U.S. Government, at the Conference on International Exchange of Information on Cement and Concrete Research, held at the Institution of Civil Engineers, London, England. There were 30 registrants from 18 organizations in 10 countries. The host was the Cement and Concrete Association (C&CA) in conjunction with the Concrete Society. U.S. participation was coordinated by the ACI. A full report was distributed by the ACI in April 1971.* As a result of informal agreement at this conference, the CTIAC has received a very substantially increased amount of useful information from the other organizations that participated.

Relation of CTIAC to the Civil Works Mission of the Corps of Engineers

11. The justification for the operation of a CTIAC of limited scope solely to serve the Civil Works mission of the Corps of Engineers was stated in 1971, in part as follows:

a. Statement of the Problem: The CW mission in managing the nation's water and related resources involves the design and construction of a variety of concrete structures, the use of portland-cement-based grouts in foundation work, and other technological and engineering activity based on concrete and cement technology. Related to this mission is the need to accomplish the necessary R&D so these activities will be conducted efficiently, reliably, and economically - in accordance with the current standards of good practice, and to know and set forth these standards in specifications and manuals. There needs to be a Corps facility charged with responsibility to keep aware of the state of knowledge in the several aspects of concrete technology to which designers, planners, specifiers, researchers, constructors, and contract administrators can turn to learn what the state-of-the-art is in this area. This facility will also provide output of assistance in planning R&D and in preparing specifications and manuals.

b. Present Procedure and Possible Improvements: At present the sort of need mentioned above is not met because no such facility is functioning effectively. When a question arises as to the state-of-the-art or the state-of-knowledge it may be and often is addressed to a variety of agencies in the hope that among those addressed an answer may be found. Depending on the nature of the problem one seeks assistance of technical societies,

*American Concrete Institute, Conference on International Exchange of Information on Cement and Concrete Research, London, England, March 2-6, 1970, Detroit, Michigan.

other federal or state agencies, universities, corporations, research organizations in other countries, individual experts, etc. Often the information is not located. The most complete collection of data in concrete technology in the Department of Defense is at the WES.

c. Urgency: It is believed especially urgent that this project be initiated promptly. One previous source of much valuable assistance of this nature, the Portland Cement Association, has drastically reduced its activity in this area, to about 10 percent of that which was formerly provided. The volume of requests for such service is increasing as the concrete technology community both within and outside the DOD becomes increasingly aware of the existence of the CTIAC.

d. Sequential Phasing of Tasks: The project will be undertaken in steps. The first phase will involve establishment of priorities for the creation of the several functioning elements. This will be followed by the creation of these elements. Finally, there will be the expansion as required by demand for services and available funding. The functions to be served include:

(1) Bibliography compilation.
(2) Consultant.
(3) Data compilation.
(4) Identification service.
(5) Indexing.
(6) Literature surveys.
(7) Loans.
(8) Referral.
(9) State-of-the-art studies.
(10) Technical analysis and evaluation.
(11) Technical answers.

e. Estimated Magnitude of Payoff: Analyses of information in the field of concrete technology that have been made previously, using funding available for such analyses as a preliminary phase of an investigation, have in several cases revealed that the proposed investigation was not needed, that the sought-for results were available. When such is the case, there is a tendency to do the work anyhow if funds have been made available. This can be avoided by obtaining the information on the state-of-knowledge before authorizing the investigation. Today it often occurs that CE specifications and engineer manuals, as they are revised, are updated to a state-of-the-art that represents only the personal expertise of the revisers and are obsolete before being promulgated with regard to matters not brought to the attention of the revisers. These are examples of the payoff to be expected from this project. It is estimated that the savings to the Corps of Engineers from avoiding unneeded investigations and from having its specifications and manuals reflect the current state-of-the-art would be of the order of $1,000,000 p.a., in the field of concrete technology.

f. Coordination within the Concrete Technology Community: The CTIAC will not generate new knowledge based on experiments or construction experience. It will assemble, analyze, and provide such knowledge to others as needed. It will therefore maintain contacts with and coordinate with the entire concrete technology community in the United States and in other countries.

g. Duplication: This project does not overlay or duplicate work accomplished or under way by others within or outside the Corps. Others are accumulating and analyzing concrete technological data but no one is doing this for the scope of the needs of the CE and the DOD.

h. Remarks: The operation of the CTIAC as here proposed will enable the reservoir of concrete technological information available and increasingly collected at WES to be put to use efficiently in assisting the CE to effectively and economically accomplish its mission. It is not intended that the professional man-years of effort per annum contemplated be individuals who work full-time conducting the professional part of this project, but rather that all the available professionals at WES, who jointly constitute the largest and most expert available pool of talent in the field of concrete technology available to the CE, in-house, would contribute as required to the accomplishment of this work assisted by the library and information specialists also available at WES.

12. For a number of years, two senior members of the Concrete Laboratory staff served as members of separate panels of The Technical Cooperation Program (TTCP) involving representatives of the defense establishments of the United States, the United Kingdom, Canada, and Australia. The panels involved were P-2 on Non-Metallic, Inorganic Materials on which Mr. Leonard Pepper served, and P-4 on Methods of Test and Evaluation on which Mrs. Katharine Mather served. The major work of these staff members in carrying out the mission of the panels, as assigned to them by the Chairmen, has been in information analysis and evaluation. These activities have been terminated and the information analysis function previously served thereby is now a part of the CTIAC function.

Conclusions

13. The following conclusions appear warranted:

a. The WES has operated a kind of CTIAC for many years and will continue to do so for the foreseeable future.

b. The WES operates a CTIAC because it needs to do so in certain areas as a necessary part of its mission in concrete technology R&D.

c. The WES, as the DOD concrete technology R&D center, distributes the product of its R&D activity to interested users as widely as permissible under security requirements and seeks to receive the product of similar activity by others throughout the world. Analyzed information on the state-of-knowledge or the state-of-the-art is a necessary prerequisite to justifiable and economical initiation of additional R&D effort.

d. Since the concrete technology community of the world is generally aware of the WES contributions to the advancement of that technology, that community approaches WES when it needs information and information analysis.

e. It is believed proper for the information gathering, storing, retrieval, analysis, and dissemination activities of WES that are conducted as integral features of its funded concrete technology R&D projects to be funded by the sponsors of these projects, as they have in the past.

f. It is further believed proper for those similar activities, unrelated to any currently funded R&D projects, but which relate directly and specifically to areas of concrete technology covered by specifications and manuals issued by the Office, Chief of Engineers, to be funded by OCE.

g. The remaining functions that WES is called upon to perform that do not represent reimbursable work for a sponsor of R&D nor direct support of the mission of the Corps of Engineers should be supported by other funding. These activities can, as they have generally in the past, be conducted in a generally perfunctory, inadequate, cost-minimizing way that provides very limited response but holds down charges to overhead. Such a course of action ignores the responsibility to make knowledge usefully available, that goes with having developed knowledge.

For out of olde feldes, as men seith,
Cometh all this newe corn fro yere to yere;
And out of olde bookes, in good faith
Cometh all this newe science that men lere.

-- Chaucer,
The Parlement of Foules.

THE MECHANICAL PROPERTIES DATA CENTER PRODUCTS, SERVICES AND INFORMATIONAL CONTENT

R. C. Braden
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Traverse City, Michigan

This paper presents a brief description of the data content, products and services of the Mechanical Properties Data Center. Comments regarding user awareness of information services and "better technical information" are included. Suggestions are made regarding the role that the Interagency Council for Materials might play in improving the efficiency and effectiveness of government sponsored or operated information activities.

Data storage/retrieval, handbooks, mechanical properties, Mechanical Properties Data Center, structural metals and alloys, technical information, user awareness.

(The Mechanical Properties Data Center is a DoD Information Analysis Center under contractual sponsorship of the Defense Supply Agency with technical monitorship by the Army Materials and Mechanics Research Center, Planning Directorate, Watertown, MA. The Center is currently operating under Contract DSA900-74-C-1770).

The Mechanical Properties Data Center was established under Air Force sponsorship in 1960 to acquire, store, retrieve and disseminate well defined mechanical properties data on materials of importance to aerospace, defense and other government needs. In response to this mission the Center has developed a computerized data storage/retrieval system, currently utilizing an IBM 370 Model 135, to store and manipulate the measured results from twenty-six (26) standardized mechanical properties test types. A general inventory of the data file contents will be included in the published version of this discussion and, for those of you who may have an immediate interest, we have provided some handout materials which includes an Inventory Report.

The system now includes approximately one and one-quarter million tests, each including measured values such as ultimate tensile strength, yield strength, reduction of area, percent elongation, modulus, Poisson's ratio, etc. Additionally, information

MECHANICAL PROPERTIES DATA CENTER

13919 West Bay Shore Drive
TRAVERSE CITY, MICHIGAN 49684

INVENTORY REPORT *752* DATE: *September 1973*

- - - - - QUANTITY OF RETRIEVABLE TEST RESULTS BY TEST TYPE - - - - -

MATERIAL TYPE OR BASE	TENSION	COM-PRESSION	SHEAR	BEARING	VESSEL BURST	CREEP	STRESS CORROSION	FATIGUE	IMPACT	FRACTURE TOUGHNESS	CRACK PROPAGATION
Low Alloy Steel	40,676	1,507	1,248	1,079	145	4,014	1,194	20,364	51,651	3,646	147
Stainless Steel	41,079	2,509	4,970	1,295	--	4,753	3,504	**	2,973	1,842	103
Tool Steel	15,699	303	406	256	17	966	338	*	1,476	754	--
Super Alloys & Maraging Steels	31,294	1,077	1,382	886	13	3,928	1,426	27,045	10,974	3,107	--
Cast Iron	365	--	--	--	--	189	--	*	--	--	--
Nickel or Chromium Base	43,316	2,083	4,720	1,227	--	17,439	699	**	1,011	747	25
Aluminum	50,357	4,536	5,204	3,790	--	2,453	20,617	23,954	1,881	3,028	748
Titanium	91,071	6,498	9,853	9,345	--	7,574	1,374	23,950	15,140	2,026	109
Magnesium	9,000	3,024	845	586	--	542	--	1,735	282	2	27
Cobalt	6,949	558	497	472	--	3,303	71	--	92	10	--
Copper	2,582	49	68	--	--	366	138	1,008	420	--	--
Silver	93	--	--	--	--	--	--	--	29	--	--
Zinc	40	--	--	--	--	--	--	--	130	--	--
Tungsten	4,239	74	12	7	--	1,187	--	--	--	--	--
Plutonium or Uranium Base	267	106	--	--	--	--	--	--	174	--	--
Lead and Tin Base	449	--	152	--	--	--	--	--	574	--	--
Tantalum	4,681	77	211	--	--	1,211	--	--	--	--	--
Columbium	9,090	58	529	21	--	2,308	--	--	20	40	--
Molybdenum	10,663	170	228	48	--	2,192	--	--	630	48	--
Beryllium	8,448	528	246	120	--	447	--	564	482	--	--
Zirconium	425	6	--	--	21	125	--	--	11	--	--
Hafnium	7	--	--	--	--	--	--	--	--	--	--
Paladium	25	--	--	--	--	--	--	--	--	--	--
Carbon	184	--	--	--	--	12	--	--	--	--	--
Vanadium	510	8	8	--	--	5	--	--	--	--	--
Dissimilar Metal Joints	1,747	--	364	--	--	60	--	--	--	--	--

SUPPLEMENTARY DESCRIPTIVE INFORMATION AND RESULTS

Alloy Composition	107,891
Supplementary Test Results	63,242
Heat Treat Details	80,944

* Fatigue data for this Material Type are combined with those of Low Alloy Steels.
** " " " " " " " " " " " Super Alloys & Maraging Steels.

on testing variables, composition, material form, heat treatment or condition and data source are stored, when reported, to completely define the test situation. This depth of detail permits retrieval on the basis of the users' specific needs and in terms that would normally be used to convey test program instructions to a test lab, including, of course, definition of those of variables of primary interest to the investigator. Test results on over four thousand (4,000) structural metals and alloys are available from the computerized file. Obviously, not all materials are represented by a full range of test results. This data base is made up of approximately 85% government sponsored materials investigations, 10% from industry and 5% from other sources, including foreign. Data are added to the file at a rate of 3-4 thousand test results per month.

Searches may be conducted to retrieve requested mechanical property test results for a specified alloy product or to identify an alloy which exhibits specified mechanical properties when tested under given conditions.

Information retrieval is accomplished by searching the storage file for the applicable material descriptors or properties and testing variables that have been stored with the test results. The most efficient computer searches are conducted when all of the material and testing variables are defined. For this reason we urge our clients who seek mechanical property test data to specify as many of the material and testing variables as practicable when submitting their search request. Phrasing a search request should be no different than transmitting requirements to a test lab; the basic considerations are the same.

Inquiries for data may be directed to the Center by letter, telephone or TWX. Additional information on costs and how to use the data is presented in the handout material that we have provided.

The MPDC information system recognizes that numerical data does not satisfy all the requirements of those involved in the evaluation and application of metals and alloys. To serve these diversified needs, the Mechanical Properties Data Center also offers literature search services, based on the same type of detail as utilized in data retrieval, to identify documents pertinent to very general or very specific mechanical properties related topics. Approximately 100,000 documents are indexed to facilitate computer retrieval and bibliographic printout. New documents are being acquired on a continuous basis at a rate of 150 to 200 per month. Of these about 75% are indexed for the technical library and 10% are encoded and added to the data file.

We at the Center have generally considered the data or bibliographic searches to be our most vital service since such response to inquiries can reflect the most recently generated pertinent information and can be provided on a timely basis. However, the introduction of service charges and the dependency of most contractor operated Centers on income from products and services has necessitated a redirection of emphasis. Sponsors and contractors have generally agreed that handbooks, state-of-the-art reports, special study reports and similar published products are a more efficient and saleable method of information dissemination. In keeping with this philosophy, the Mechanical Properties Data Center now regularly publishes two Handbooks and generates annual Supplements for each.

The Aerospace Structural Metals Handbook is our best known and most widely distributed publication. This document was originated at Syracuse University in 1958 under Air Force Materials Laboratory sponsorship and guidance. In 1968 the responsibility for continued publication was transferred by the Air Force Materials Laboratory to the Mechanical Properties Data Center. Each year since that time we have published and distributed an annual supplement consisting of from 14 to 20 new or revised alloy chapters each. Chapters for this Handbook are generated by materials specialists in government, industry and education with data support, graphics, publishing, promotion and distribution provided by the Center.

Aerospace Structural Metals Handbook Consultants

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This 4-volume set now includes comprehensive properties coverage on 210 ferrous and non-ferrous materials in 3,000 pages. Over 5,000 graphic displays and 1,600 data tables are utilized to completely characterize structural materials of importance in aerospace and defense applications.

Aerospace Structural Metals Handbook - Contents

Chapter	Material Designation	Chapter	Material Designation
	Austenitic Stainless Steels (con't.)		
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1306	Type 314	1314	21-6-9
1307	Types 316 and 317		
	Martensitic Stainless Steels		
1401	Types 403, 410, 416	1406	USS-12MoV
1402	Type 420	1407	Greek Ascaloy
1403	Type 422	1409	AM-363
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1405	Type 400 A, B and C		
	Age Hardening Steels		
1501	17-4PH	1508	AF-71
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3104	355, C355	3108	KO-1 Cast
	Aluminum Alloys; Wrought, Heat Treatable		
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3202	X 2020 and Clad X 2020	3213	2618
3203	2024	3214	X7005
3204	Clad 2024	3216	2021
3205	X 2219 and Clad X 2219	3217	7049 Al
3206	6061	3218	7001 Al
3207	7075	3219	7175 Al
3208	Clad 7075	3220	X7475 Al
	Aluminum Alloys; Wrought, Not Heat Treatable		
3301	5052	3303	5456
3302	5056	3304	X5090 Al

Chapter	Material Designation	Chapter	Material Designation
	Magnesium Alloys; Cast		
3401	AZ63A	3406	QE22A
3402	AZ91	3407	ZH62A
3403	AZ92A	3408	HZ32A
3404	EZ33A	3409	ZK61A
3405	ZK51A		
	Magnesium Alloys; Wrought, Heat Treatable		
3501	AZ80A	3506	ZK60
3502	EK31XA	3507	LA141A
3503	HK31A	3508	LA91A
3504	HM21A	3509	AM100A
3505	HM31A		
	Magnesium Alloys; Wrought, Not Heat Treatable		
3601	AZ31B	3603	AZ61A
3602	ZE10A		
	Titanium Alloys		
3701	Ti, Commercially Pure	3713	B120 VCA Ti-Alloy
3703	Ti-4Al-3Mo-1V	3714	Ti-6Al-2Sn-4Zr-6Mo
3706	Ti-5Al-2.5Sn	3715	Ti-6Al-6V-2Sn
3707	Ti-6Al-4V	3718	Ti-6Al-2Sn-4Zr-2Mo
3708	Ti-7Al-4Mo	3719	Ti-1Al-8V-5Fe
3709	Ti-8Al-1Mo-1V	3720	Ti-6Al-2Cb-1Ta-0.8Mo
3711	Ti-11Sn-5Zr-2.5Al-1Mo	3721	Ti-8Mo-8V-2Fe-3Al
3712	Ti-8Mn	3722	BETA III
	Titanium Alloys; Cast		
3801	Ti-6Al-4V, Cast		
	Nickel Base Alloys		
4101	Inconel Alloy 600	4111	Hastelloy Alloy R235
4102	Inconel Alloy 702	4112	Hastelloy X
4103	Inconel Alloy 718	4113	Nimonic 80 A
4104	Inconel Alloy 722	4114	GMR 235
4105	Inconel Alloy X-750	4115	TD Nickel
4106	Inconel Alloy 751	4116	Monel Alloy K-500
4107	Inconel Alloy 901	4117	Inconel Alloy 625
4108	713LC	4118	RA-333
4109	D979	4119	Inco 713C
4110	Hastelloy C	4120	TD NiCr

Chapter	Material Designation	Chapter	Material Designation
	Nickel Base Alloys		
4201	Inconel Alloy 700	4208	Waspaloy
4202	M-252	4209	Nimonic 115
4203	Nicrotung	4210	Nimonic 90
4204	Nimonic 105	4211	Mar-M-200
4205	Rene' 41	4212	IN 100
4206	Udimet 500	4213	B-1900
4207	Udimet 700		
	Cobalt Base Alloys		
4301	Haynes Alloy No. 151	4307	V-36
4302	L-605	4308	WI-52
4303	S-816	4309	Mar-M-302
4304	Stellite 6	4310	Haynes Alloy No. 188
4305	Stellite 31	4311	Mar-M-509
4306	Stellite 21		
	Beryllium Alloys		
5101	Beryllium, Commercially Pure	5102	Lockalloy
	Columbium (Niobium) Alloys		
5201	Columbium, Commercially Pure	5207	FS-80
5202	D-31	5208	B-66
5203	F-48	5209	Cb-752
5204	D-43	5210	Cb 132/132M
5205	D-36	5211	Cb-129Y
5206	FS-85		
	Molybdenum Alloys		
5301	Molybdenum, Commercially Pure	5303	TZM
5302	Molybdenum Base Alloy		
	Tantalum Alloys		
5401	Tantalum,Commercially Pure	5403	T-111
5402	Ta-10W	5404	T-222
	Tungsten Alloys		
5501	Tungsten, Commercially Pure		
	Vanadium Alloys		
5601	Vanadium, Commercially Pure		
	Zirconium Alloys		
5701	Zircaloy 2		

Appendices

The continued publication of this important Handbook has been assisted by partial funding from NASA. Approximately 50% of the production costs are recouped from sales.

The second regular publication of the Center is the Structural Alloys Handbook. This reference is aimed at sectors of the engineering and manufacturing community whose products generally do not utilize the more exotic and costly materials of construction. Typically, they are designers and/or producers of buildings, bridges, consumer items, heavy equipment/machinery and transportation equipment. Our decision to serve this audience was prompted by many considerations, not the least of these was the need to broaden our audience for saleable products. It was also apparent that the need for reliable properties data for most manufacturing activities was becoming increasingly important as the demands for material conservation and product reliability become significant factors in the general manufacturing process. Rule-of-thumb properties values and overdesign do not satisfy these conflicting requirements. The Structural Alloys Handbook is presently serving this need in over five hundred organizations including more than twenty government agencies, most of which have regularly acquired the annual supplements.

The Structural Alloys Handbook is generated totally in-house by the Mechanical Properties Data Center staff with the support of the data file and technical library. The 1974 edition, which incidently represents the second publishing year of this reference, includes data on several hundred metals and alloys in over 700 pages. Very detailed chapters on over 50 commonly used metals and alloys ranging from cast irons through wrought aluminums are included.

Structural Alloys Handbook - Contents

High Strength Low Alloy Steel

- Selector Chart
- A-242
- A-440
- A-441
- A-514, A-517
- A515, A-516
- A-537
- A-572, A-588

Wrought Stainless Steel

- Selector Chart
- 201, 202 Stainless Steel
- 410 Stainless Steel
- 430 Stainless Steel

Wrought Steel

- Selector Chart
- Low Carbon Steels
- 1020 Steel
- Medium Carbon Steels
- High Carbon Steels
- 4140 Steel
- 4340 Steel

Wrought Aluminum

- Selector Chart
- 3003, 3004 Aluminum

Appendices

Symbols and Abbreviations	A
Test Types	B
The Well Defined Test	C
Si Conversion Factors & Tables	D

This Handbook contains two rather unique features to assist users in the evaluation process. One of these is the section following each chapter, called Report Summaries and Conclusions, which summarizes verbally the findings and conclusions of the most significant references used in the development of the chapter. These summaries enrich the data by presenting qualitative interpretation of test program results that may not be obvious from the data alone. The summaries are also employed to present conclusions from programs that did not produce quantitative information.

Selector Charts are another feature of the Structural Alloys Handbook. These charts provide mechanical, physical and fabrication characteristics in an easy to use matrix format for quick comparison of materials in a "survey" manner. Each material section, such as Cast Iron, Wrought Aluminums, Stainless Steels, etc. is preceded by a Selector Chart. A Selector Chart and a Handbook Chapter are included in the handout materials.

The program brochure distributed prior to this meeting, prepared by the Interagency Council for Materials, cites as one of its primary objectives "The provision of better technical information on materials properties and performance". A second area of concern of the Working Group on Materials Information and Data is the apparent lack of awareness on the part of information specialists of the range of on-going materials information programs. The need for better information can benefit, at least in the area of mechanical properties, if existing guidelines and concensus standards were more rigidly observed. The quality of poorly defined or carelessly generated information cannot be upgraded by running it through a computer with sophisticated software. In regard to the apparent lack of awareness I think it fair to say that most DSA sponsored Centers would appreciate the opportunity to increase their promotional efforts, however, to do this on an individual basis would necessarily result in a decline in available products and services. The Mechanical Properties Data Center presently generates and distributes in excess of 10,000 promotional mailings annually. In addition to this we participate, as an exhibitor, in at least one major materials oriented trade show each year. Even this minimal effort puts a strain on our budget which is complicated by the uncertainty of income from sales.

Awareness and the quality of technical information are concerns that have received considerable attention, at least from the DSA sponsored Centers. Both concerns can be served to some extent by contractual statements that obligate contractors and in-house government materials investigators to conform to minimum levels of reporting detail and to utilize Centers as first step to determine how much pertinent information may exist relative to a proposed program. An additional requirement that contractors provide direct distribution of program results to Centers whose missions overlap the area of investigation would affect some economies in the acquisition process of the Centers. At the same time the availability of timely information would be improved. In all fairness it must be noted that some agencies have already incorporated one or more of these requirements in their contracts. Review and recommendations regarding these contractual statements and their effect might be a logical task for the Working Group on Materials Information and Data. It also seems appropriate that the Working Group be concerned with the indescriminate use of "distribution limitation statements" in government reports and what appear to be rather excessive charges for some reports of government sponsored work. These conditions often impose hardships on the Information Centers. Hopefully, the Interagency Council for Materials through the Working Group on Materials Information and Data can favorably influence these practices and thus assist in the efficient conservation and utilization of a very valuable resource - - materials information.

V. Department of Interior Session

Chairman: Andrew S. Prokopovitsh
Bureau of Mines

Water Resources Scientific Information Center (WRSIC)

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Washington, D. C. 20240

The WRSIC of the Office of Water Resources Research is the Federal center for disseminating information dealing with water-related research. It provides funds or reciprocal services and utilizes existing information-handling facilities to collect and organize the material into a machine-readable data base. These include literature centers of competence, state water resources research institutes, abstracting services, Federal agencies, and foreign information centers. The data base is installed at the Oak Ridge National Laboratory as part of the RECON system. In addition to the water information, seven other data bases may be accessed to provide service to requesters. The information is available in various forms including special searches, topical bibliographies, abstract announcement journal, listing of research reports and a catalog of on-going water resources research. The center disseminates information with the assistance of a regional information network and state water resources research institutes which receive funding from the Office of Water Resources Research. Plans for the future involve broader coverage of water-related research and expansion of the network to service users.

Information exchange, information management, information network, information retrieval, information services, information systems, specialized information center, water resources information.

[1] Assistant Manager, WRSIC

As the name clearly indicates, the Water Resources Scientific Information Center is primarily a "water-oriented" agency not a "materials-oriented" agency. However, because water is a fundamental resource vital to society and has direct bearing on research in all areas, it is entirely fitting that this organization be included among the materials information agencies meeting here. The problems encountered in all of the areas represented here today must overlap, and any resources which can be saved by better intercommunication, can be utilized for the better purposes of attacking problems directly.

After recommendation by the Weinberg report in 1963 the Water Resources Scientific Information Center was established under the authorization for water resources research, training and information dissemination provided by the Water Resources Research Act of 1964. In 1965 the Office of Science and Technology recommended it be placed in Department of the Interior and in January 1966, the Secretary of the Interior placed it in Office of Water Resources Research (OWRR). It was then designated as the Federal-wide Water Resources Information Center by the President's Science Adviser. Operations started in the fall of 1967 with its prime objective to insure prompt flow of scientific and technical information to the water resources community throughout the United States. As the focal point for the water resources scientific information activities it is now actively engaged in coordinating and supplementing existing services and providing such services as best can be accomplished on a nationwide level in cooperation with participating agencies.

The operating policy of WRSIC is based on the following principles: (1) use of existing capabilities of other agencies and organizations, (2) use of specialized research competencies in universities and elsewhere as sources of processed information, (3) use of existing information and documentation services, and (4) maintenance of an information base in machine-readable form to enable application of advances in information-handling technology, integration and development of national systems, decentralization of processing of input to data base and computer searching and composition. These "other" agencies include Federal agencies who participate in water-related research, state water resources research institutes and literature centers, and their grantees and contractors as well as publicly owned enterprises whose interest is water. Recently WRSIC also has begun to tap foreign government agencies for possible input.

Under the guidance of the center, documentation dealing with all aspects of water-related research is collected, abstracted and indexed and processed into a computer data base. To assure that all of this information generated by all these sources can be retrieved for effective interchange and management, WRSIC has set down certain standards which are followed in creating input to the data base. A recently updated abstracting and indexing guide, and the second edition of the Water Resources Thesaurus, published in 1971, are provided to the contributing agencies.

Agronomy, bacteriology, chemistry, economics, engineering, geology, hydrology, law, limnology, mineralogy, physics, soil science and zoology become associated with water quality, metropolitan water systems, sediment control, conservation of estuarine water resources, and systems planning and management processes to cover the water resources fields of research. The subject classification scheme which is used to record this information systematically, includes the following fields:

01	Nature of water
02	Water cycle
03	Water supply augmentation and conservation
04	Water quantity management and control
05	Water quality management and control
06	Water resources planning
07	Resources data
08	Engineering works
09	Manpower, grants, facilities
10	Scientific and technical information

The input data worksheets which are used to process the input are similar to those recommended by the COSATI guidelines and used by other data processing agencies; however, minor modifications are included to assure that data peculiar to water resources research are recorded properly.

In accordance with its objectives WRSIC obtains the input from various sources by special agreements with them to exchange the input for output services. The contributors to WRSIC data base comprise the following:

<u>Centers of Competence</u> - These are literature facilities and information centers who are already reviewing literature in support of certain aspects of water resources research. Because of the competence of their personnel and the volume of scientific documents they handle and process they are able to provide high-quality analyses and review and index and abstract the material to comprise about 90% of the citations which are announced in the abstract journal. Ten of these competent groups are being supported by WRSIC and two more in cooperation with the Environmental Protection Agency (EPA).

<u>Water Resources Research Institutes</u> - Another source of high-quality input is the state water resources research institutes and centers supported by the Office of Water Resources Research (OWRR). Currently there are 51 of these, one in each state and Puerto Rico. These institutes abstract and index the documents they produce, and provide the input to the WRSIC data base.

Federal Agencies - Those engaged in water-related research also contribute an appreciable portion of the information. Included are agencies in the Department of the Interior such as Geological Survey as well as others like EPA, Department of Transportation, and USDA Forest Service.

Abstracting Service - In order to exploit the foreign language and broad-coverage capabilities of a large discipline-oriented abstract journal, Biological Abstracts, the WRSIC has an arrangement with the BioSciences Information Service and Biological Abstracts (BIOSIS) whereby abstracts related to the biological aspects of water resources are being selected for inclusion in the WRSIC data base. This is a comparatively new source of input but already the broader coverage has been found to be very useful in servicing the users.

Foreign Organizations - As mentioned before, in the past year some foreign contacts were made and agreements signed with Environment Canada in Canada, Commonwealth of Scientific and Industrial Research Organization in Australia and Department of Water Affairs in South Africa. Only the initial input has been received from South Africa and Canada but indications are that these also will be important additions to the data base.

The WRSIC data bank now has about 70,000 records to which 1,000 are added monthly. It has been found that the input from all sources provides a coverage of literature in forms of journal articles 88%, reports 10%, and other forms like books, proceedings of symposia, etc. 2%.

The output that results from the retrieval of this information is varied. There are the conventional publications of an information center as well as a new on-line search capability for prompt response to inquiries for answers to specific problems.

At the first of this year by agreement with the Atomic Energy Commission the WRSIC data base was installed at the Oak Ridge National Laboratory as a part of the RECON System. In exchange WRSIC and its network centers will have the capability to search this data bank as well as seven others related to nuclear science and the environment. Since water-related research interfaces with so many other research fields, this is considered a major step forward in the effort of intercommunication among information-handling organizations. Projected endeavors of WRSIC to augment its role as a national water resources information center is to use this RECON system to develop a network of regional access terminals. They are to be placed strategically at sites which are best-located to give better and quicker service to users of water-related information services. Up to this time preliminary arrangements have been made with three centers ---- Cornell University, North Carolina State University and University of Wisconsin. These three terminals will be used to perform searches of the data base in answer to requests in their areas. The terminal at WRSIC will be used to develop and test new programs and procedures which will maximize the utility of the system. It will also be used for local searches. As soon as it is economically feasible plans will be made to expand the network and get more terminals which will then be able to serve smaller and closer areas more quickly.

In the meantime the center believes that the conventional media of communication and dissemination of information are still just as important and effective as they ever were.

The abstract journal "Selected Water Resources Abstracts" (SWRA) which announces documents processed into the data bank is published twice a month. It carries bibliographic data, availability, and abstracts and subject terms so that a user can determine if the document announced is relevant to his research. Periodically, on the basis of recommendations by the scientists of the Office of Water Resources Research, or users, or awareness that many requests are coming in for a certain subject, topical bibliographies are compiled and printed. If a subject is of exceptionally high interest, sometimes arrangements are made for literature surveys which in addition to the WRSIC information base, then include other references selected from a broader review of the subject.

For a more limited distribution, the center publishes an annual compilation of project summaries of research in progress done in cooperation with the Smithsonian Science Information Exchange and called the Water Resources Research Catalog. Last years issue appeared in two volumes and reported 7,300 research projects being carried on in 50 states, the Canal Zone, District of Columbia, and the Virgin Islands as well as about 60 foreign countries. This is a valuable tool for administrators who make decisions concerning the support of research.

Also for those directly associated with OWRR programs, WRSIC publishes a list of the reports which are generated by the research which is supported by the Office of Water Resources Research. The publication is cumulated every quarter with the annual issue appearing after the 30th of June. The reports are listed and their availability is given.

Generally, the public not associated with OWRR programs can get the publications from the National Technical Information Service (NTIS) in Springfield, Virginia. This includes the abstract journal and most of the bibliographies. The Catalog can be obtained from the Government Printing Office (GPO). Prices are subject to change. Special data or information searches are provided by the network centers to requesters from areas which they are authorized to service. Government agencies and their grantees or contractors may come directly to WRSIC for publications and service. Sometimes extra copies of the bibliographies in the WRSIC series can be provided by the center as long as the supplies last. The reports announced in the journal are obtained from the contractors or from NTIS or GPO if so noted. Those that are reprints from journals are usually available from the authors. WRSIC does not have copies of any reports for distribution.

Most of the users who require reference information can best be serviced by their state institutes or by the centers of competence. Searches for specific items can always be made on the terminals at the regional network centers.

Plans for the future are concerned with a broader coverage of material to include in the data base, access to other data bases which interface water resources research, and quicker and better service to requesters who have urgent problems. It is the hope of the water resources community that the fulfillment of these goals will alleviate or even prevent the problems of probably our most vital natural resource, water.

MATERIALS ACTIVITY IN THE

OFFICE OF SALINE WATER

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Abstract

The two projects still active in the OSW Materials Program are described. The OSW Materials Test Center is discussed, and the accomplishments of the investigations at the Center are listed.

Key Words

Corrosion, desalination, distillation, hot sea water and materials.

In 1952, the Office of Saline Water undertook a program of research on methods for producing potable water from saline waters at low cost. In 1964, in the belief that materials were vital to the performance and economy of desalting plants, the OSW initiated a program to generate information on the behavior of materials in hot saline waters. This program was implemented through research projects sponsored at universities, government laboratories, not-for-profit institutes, and industrial laboratories. Considerable progress was made, and the program's potential was beginning to be realized when it was severely curtailed at the beginning of calendar year 1973.

Midway through FY 1973, the Office of Management and Budget ordered the OSW to reduce and redirect its efforts. The study of subjects related to the evaporative processes was stopped completely, and the list of subjects for continued study did not include materials. Accordingly, except for one project, the materials investigations in progress were not renewed; and only one new project has been initiated. This paper is presented to describe these remaining parts of the OSW Materials Program.

Materials Manual

The only new materials project funded by the OSW since the OMB issued its order is a small one in terms of dollars and effort. However, it represents the culmination of a large effort and has great potential value to a number of industries in addition to the desalting industry. This project, to be carried out by personnel of the Dow Chemical Company, is to produce a manual or handbook for materials selection for desalting plants. This manual will present, in useful form, the results of all the OSW projects to study materials behavior in real sea water. The project will be completed late in 1974.

Materials Test Center

The other on-going project mentioned earlier involves the operation of the OSW Materials Test Center at Freeport, Texas. This facility is operated for the OSW by The Dow Chemical Company, and it is undoubtedly unique. A description of the facility may be useful, since other organizations may be interested in making use of its capabilities.

The physical plant at the Materials Test Center consists of an administration building which contains offices, a meeting room, two laboratories, and a control room for the experimental equipment. Adjoining the control room is a large concrete pad for the sea water treating equipment and for the various test units. This equipment is described as follows.

I. Sea Water Treating Plant

The function of this plant is to remove dissolved carbon dioxide and oxygen gases from the incoming sea water. Raw sea water, after skimmming and screening, is acidified by addition of sulfuric acid to a pH of 4.0; this destroys bicarbonates. It then passes through a vacuum deaerator counter-current to stripping steam. The degassed sea water is collected in a storage tank to be forwarded to the various test units. Final water chemistry adjustments are made at the individual test units.

All wetted portions of this treating plant are made of fiber-reinforced plastic, noble alloys, or plastic-lined pipe. It has a capacity of 200 gallons per minute and produces treated water containing less than 3 PPM dissolved carbon dioxide and less than 5 PPB dissolved oxygen.

II. Sea Water Softening Unit

The function of this unit is to provide softened sea water to permit evaluation of materials at temperatures that would otherwise result in deposition of calcium sulfate scale. It consists of an ion exchange contactor and an independent treating plant. The contactor is a commercially available unit in which ion exchange resin is hydraulically pulsed around the inside of a closed loop. In this loop, undesirable ions are absorbed from the sea water and the resin is regenerated and rinsed. The independent treating plant is used to remove dissolved gases from the softened sea water.

This unit also utilizes fiber-reinforced plastics, plastic-lined pipe, and noble alloys throughout. It has a capacity of 100 gallons per minute, and it removes 85-90% of the calcium ion and 45% of the magnesium ion in sea water. Resin regeneration is by a sodium chloride brine.

III. OSW Research Units

These units are used to study, on metallic coupons, the effect of water chemistry on the behavior of alloys in desalting environments. They are useful in screening alloys for desalting service, in exploring new techniques for predicting alloy behavior, and in the appraisal of commercial instruments for servcice in monitoring corrosion.

The installation consists of two "loops" for the exposure of metallic coupons. One unit contains a flash evaporator to concentrate sea water, and either loop can be operated in a once-through or circulating mode. Both units have separate controls permitting variation of temperature, pH, flow rate, and dissolved oxygen over a wide range of conditions; these variables are controlled automatically. The equipment is constructed of non-corroding materials including plastic-lined pipe, titanium, Hastelloy-C and Alloy-20 stainless steel.

IV. Metallic Materials Test Units

These units (5) provide the opportunity to simulate, on a pilot plant scale, the conditions encountered in desalination plants of the distillation type. These units have independent and versatile controls for temperature, pH, dissolved gases, and liquid flow.

Unit 1 is constructed of mild steel and consists of a brine heater, a flash chamber, a vertical-tube evaporator, a heat-recovery exchanger, and a number of test sections for tubes, panels, and probes. It is useful at temperatures up to 250°F.

Unit 2 consists of a titanium brine heater and a flash chamber with teflon-lined piping. It is used to test materials at temperatures exceeding 300°F.

Unit 3 consists of 3 once-through flow units that can be utilized in a variety of ways. One of the three units has been modified to permit studies on high velocity erosion and cavitation of metals in hot sea water. An apparatus for impingement testing of metals is also operating in this area. Unit 3 is constructed of Teflon-lined and other plastic-lined pipe.

V. Non-Metallic Materials Test Unit

The function of this unit is to permit evaluation of the performance of such non-metallic construction materials as fiber-reinforced plastics, thermoplastic systems, paints, coatings, cements and linings in flowing sea water.

The unit includes six test cells, each 20-feet long by 12-in. OD, with a capacity of 120 samples 8"x14" in size, and four pipe loops each capable of testing 15 10-ft. spools of 2 in. OD. In constructing these units, maximum use was made of non-metallic materials.

This unit can be used to expose materials to a variety of feed conditions at temperatures of 110°F, 160°F, 210°F, and 250°F.

VI. Stainless Steel Pilot Plant

This pilot plant was installed by the Committee of Stainless Steel Producers of the American Iron and Steel Institute and was used for three years to demonstrate the applicability of stainless steels to desalination plant service.

This pilot plant is an actual distillation unit with a capacity of 3,000 gallons per day. It matches portions of typical conventional plants and can be operated at a variety of feed and effluent conditions.

VII. Aluminum Pilot Plant

This plant was installed and operated by the Aluminum Association to determine the potential of aluminum alloys for desalting plant service. This plant also incorporates the designs found in large commercial desalting plants. It has a product water capacity of 3,000 gallons per day and can operate at a variety of feed and effluent conditions.

VIII. Copper Pilot Plant

This small distillation plant was installed and operated by the Copper Development Association to allow studies of copper alloys under conditions found in large multiple-effect distillation plants.

This plant incorporates all features of larger plants and provides for a wide range of feed and effluent conditions. It has a capacity of 6,000 gallons of product water per day.

The foregoing descriptions are, of necessity, brief. Space and time do not permit complete discussion of the units and their capabilities, but potential users are invited to inquire for further details.

ACCOMPLISHMENTS

During the period of operation of the Materials Test Center, much significant information has been obtained. A number of key items are listed as follows:

1. Assessment of factors affecting the behavior of aluminum, stainless steel, mild steel, and copper alloys.

2. Demonstration of the importance of fully controlled sea water chemistry.

3. Demonstration that contaminative gases (H_2S, NH_3, CO_2) have major influence on metal performance in submerged and vapor zones.

4. Demonstration that a low-cost sea water inhibitor may permit use of conventional steel throughout the plant.

5. Demonstration that specific aluminum, copper, stainless steel, and low-alloy steels are candidates for desalination construction materials.

6. Demonstration of automatic techniques for monitoring materials behavior in an operating plant.

7. Demonstration of the detrimental effect that chlorination has on the performance of copper alloys.

8. Demonstration of factors influencing film repair of alloys undergoing impingement attack.

9. Demonstration of the independent and interactive effect of sea water concentration upon materials behavior.

10. Demonstration of a method to predict the pitting susceptibility of alloy families.

11. Demonstration of analytical techniques to accurately and quickly measure a wide variety of heavy metal ions, gases, and organic constituents in sea water.

12. Demonstration of the undesirable role that cystine (in sea water) plays in the performance of copper alloys.

13. Demonstration of the relative impingement, cavitation, and erosion resistance of alloy families to hot sea water.

14. Recognition of role that sea water alkalinity plays in the performance of alloy families.

15. Determination that both dissolved oxygen and sulfides can coexist in elevated-temperature seawater.

16. Determination of the manner in which deaeration affects ammonia ion, residual chlorine, and hydrogen sulfide entering a plant with the incoming sea water.

17. Preliminary testing of new alloy compositions.

18. Acquisition of guideline information on the performance of alloys at sea water temperatives above 250°F.

19. Compilation of information on a "Galvanic Series" for alloys in hot sea water.

20. Compilation of information on galvanic-coupling of alloys in hot sea water.

21. Demonstration of the behavior of alloy families in stagnant or quiescent sea water (with particular emphasis on the stainless steels).

22. Data acquisition on the behavior of titanium (alloys) in the desalination environment.

23. Determination of the factors affecting the behavior of non-metallic materials of construction in the desalination environment.

24. Development, fabrication and testing of a low PPB copper analyzer.

25. Development, fabrication, and testing of a low PPB dissolved oxygen analyzer.

26. Acquisiion of performance data on a 100 gpm sea water ion-exchange softening unit.

27. Acquisition of data relating aggressive sea water chemistry conditions to the overall heat transfer coefficients of representative alloys.

FUTURE PLANS

Although much has been accomplished, it is obvious that many things remain to be done before complete information is available on the behavior of materials in hot sea water. For the Office of Saline Water, however, it appears that time may have run out. At this time there is no assurance that any materials studies will survive beyond June 30, 1974. In the meantime, the OSW is most anxious to find any organization that might be interested in acquiring its Materials Test Center or in offering even partial support for its continued operation.

BUREAU OF MINES INFORMATION-PUBLICATION PROGRAM

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ABSTRACT

The Office of Mineral Information, whose Chief reports directly to the Director, is responsible for all public information activities of the Bureau of Mines, including its scientific and engineering publication program. The central office in Washington initiates new Bureau-industry-sponsored informational films, prepares press notices and popular-type pamphlets and brochures, and approves, edits, and arranges for the printing and distribution of reports in the Bureau's several official series. The Pittsburgh branches print and distribute publications, prepare drafting and photographic work, and handle the booking and shipment of Bureau motion picture films.

The paper covers the authority to publish in the Organic Act of 1910 of the Bureau of Mines, as amended in 1913, tells where reports in energy, mining, metallurgy, health and safety, and economics and statistics originate, and describes the various publications, journal articles, and motion pictures. The paper also discusses contract reports, distribution outlets for sales and free reports, and mailing lists.

Keywords: Bureau of Mines; energy; health and safety; metallurgy; mining; Office of Mineral Information

[1]Chief, Division of Technical Reports, Office of Mineral Information.

OFFICE OF MINERAL INFORMATION

1. Responsibility. The Office of Mineral Information is responsible for all information activities of the Bureau of Mines. Its Chief reports directly to the Director and advises and assists the Director on all information matters.

2. Informational film program. The Bureau has been cooperating with industry and private organizations in the production of motion picture films since after World War I. These films are produced at no expense to the Government and prints are made available to the Bureau of Mines by the cooperator for distribution on short-term loan from the Bureau's film library in Pittsburgh, Pa. The Bureau also places selected films in depositories at leading universities, school systems, and libraries. Two basic types of films produced concern mineral commodities and the natural resources of various States. A film catalog telling about the program is available from the U.S. Bureau of Mines, Motion Pictures, 4800 Forbes Avenue, Pittsburgh, Pa. 15213.

3. Press releases and pamphlets. A Division of Public Information is responsible for preparing press notices on important research developments and other activities of the Bureau, and for the preparation of popular-type pamphlets and brochures. This Division also is responsible for contacts with the press and all other information media.

4. Publications. A Division of Technical Reports is responsible for approving for presentation and for publication manuscripts originating at the Bureau's 19 research centers, four field operation centers, and in Washington. An editorial staff edits the manuscripts for clarity, grammar, style, completeness of references, reproducible illustrations, and other details. The Division arranges for printing and distribution of reports. It also maintains central control of the publication mailing lists.

5. Pittsburgh operation. A Division of Production and Distribution operates a GPO field printing plant, photographic and drafting shops, a motion picture film library, and a publication-distribution office.

BUREAU OF MINES PUBLICATIONS

1. Authority to publish. By its Organic Act of 1910 (30 U.S.C.1, §1), as amended in 1913, the Bureau of Mines is authorized to publish and distribute the results of its research and investigations. Hence, it is the Bureau's policy to allot funds for this purpose. The publication is the final product, making known the results of the Bureau's research to the scientific community and the general public. It must represent the highest standards of scientific truth, accuracy, objectivity, and clarity.

2. Where reports originate. Reports are prepared by the Bureau's scientists and engineers at 19 research centers and laboratories throughout the United States and by the Bureau's mineral commodity specialists and economists at four field operation centers and in Washington. The reports concern research in energy, mining, metallurgy, and health and safety, as well as economic and statistical information on all mineral commodities. After thorough technical review, reports are approved for editing and publication by the Bureau's Office of Mineral Information.

3. Types of Bureau publications. There are two principal types of Bureau publications: Nonperiodic series consisting essentially of publications issued after a specific study or research project has been completed, and periodic series published weekly, monthly, quarterly, annually, biannually, triannually, or quinquennially.

A. Nonperiodic Publications.

(1) Bulletins report the results of broad and significant projects or programs of scientific, historical, or economic research, or other investigations, including comprehensive and important mineral resource studies and compilations. Bulletins are usually prepared after all laboratory and field work has been completed, but they sometimes report a major phase of a larger or continuing investigation or research study. They rarely represent the first public report on the subject. As a rule, they encompass published work together with essential unpublished data and detail.

(2) Handbooks are instruction or information manuals designed to improve efficiency in the mineral industries or to promote the wise use of mineral resources. Based on research and the practical experience of Bureau personnel, they cover a wide range of subjects, such as questions and answers on boiler-feedwater conditioning.

(3) Reports of Investigations present the results of research and investigations conducted by the Bureau at its research centers or laboratories, or in mines, quarries, smelters, refineries, oilfields, plants, and other non-Bureau properties. They differ from Bulletins in that they describe the principal features and results of individual experiments

(single or multiple); minor research projects; or a significant coordinated phase of a major project or program. Reports of Investigations may include a summary of several projects or activities in a given subject area that are not necessarily related directly to each other, new technical or economic theory, mineral resource studies that emphasize original evaluation of deposits, results of laboratory analyses of an unusual nature, and comparative and nonroutine testing of cores, explosives, and other commodities.

(4) Information Circulars differ from Reports of Investigations in that they are not concerned primarily with original Bureau research or investigative work. They cover surveys of mineral resources and related mining and operating activities; guides to marketing of mineral commodities; compilations of historical or statistical and economic data on minerals; summaries of scientific and technical meetings and symposiums; bibliographies; descriptions of instrumentation and techniques; and descriptions of new industrial mining methods and metallurgical processes (as distinguished from those developed by the Bureau).

(5) Technical Progress Reports present highly significant and newsworthy developments in Bureau of Mines programs and are intended for use in conveying information that, to be of maximum value, must be published in a matter of days. No longer than 25 double-spaced pages, including tables and illustrations, they are expanded fact sheets giving the technical background and details necessary to supplement a press release that reports important progress in an area of Bureau activity meriting widespread public interest. They follow the style and format of Reports of Investigations, and a more comprehensive treatment of the subject may be reported later in that series.

(6) Cooperative Publications result from investigations conducted cooperatively by the Bureau of Mines and another Government or outside organization. Although usually written either wholly or in part by Bureau personnel, they are published by the other organization. They must be transmitted through channels for approval for publication by the Office of Mineral Information. They are also edited by the Division of Technical Reports unless a cooperating Federal agency requests that it edit the report. Cooperative publications include Monographs and Joint Reports.

(a) Monographs report research and investigations conducted under a formal cooperative agreement with Federal, State, or local government agencies, or with colleges, scientific and technical societies, trade associations, or private industries. They are printed by an outside publisher with the consent of the Bureau. Publication costs are borne by the cooperator, who also handles the sale and any free distribution of printed copies. Monographs follow Bureau style and format similar to Bulletins or Reports of Investigations.

(b) Joint Reports may be issued in lieu of Monographs when another Government agency is the cooperating organization. Usually they are jointly prepared, financed, and published.

(7) Special Publications include popular-type pamphlets prepared for the general public and distributed in response to requests for information on specific subjects, such as air pollution ("Clearing the Air") and mineral waste reclamation ("Wealth Out of Waste"). Special publications also include certain long and detailed publications that do not fall into one of the other series, such as "A Dictionary of Mining, Mineral, and Related Terms," and "Automobile Disposal: A National Problem."

(8) Annual Reports of the Director or of the Secretary of the Interior describe research in progress and other activities of the Bureau of Mines reported by calendar or fiscal year.

B. Periodic Publications.

(1) Minerals Yearbooks summarize annually, on a calendar-year basis, the significant economic and technologic developments in the mineral industries. They present, by mineral commodity, the salient statistics on production, trade, consumption, and other pertinent data; review the U.S. mineral industries by States, island possessions, and the Canal Zone; and present for more than 130 foreign countries and areas the latest available mineral statistics and review their importance to the economies of these nations. Three separate volumes are issued each year as follows: Volume I, Metals, Minerals, and Fuels; Volume II, Area Reports: Domestic; and Volume III, Area Reports: International. Chapters in these volumes are issued separately as preprints or reprints from the bound volumes.

(2) Mineral Facts and Problems, issued every 5 years as a Bulletin, contains comprehensive information on all important metals, minerals, and fuels. Each commodity chapter covers industry patterns, technology, reserves, supply-demand relationships, consumption patterns, economic factors, environmental considerations, possible advances in technology, alternative future mineral supply-demand relationships, and future uses of commodities.

(3) Mineral Industry Surveys contain timely statistical and economic data on minerals and fuels. The surveys are designed to keep Government agencies and the public, particularly the minerals industry and business community, regularly informed of trends in the production, distribution, inventories, and consumption of minerals and fuels. Frequency of issue depends on the need for current data. For example, the bituminous coal report is issued weekly; other reports are issued monthly, quarterly, and annually.

(a) Preliminary annual data on commodities are published as soon as possible after the close of each calendar year and comprise statistics that are later finalized in the Minerals Yearbook.

(b) Preliminary annual area reports also contain data on mineral production by States, and final figures are published in Volume II of the Yearbook.

(c) Petroleum product surveys include data on properties of aviation gasolines and aviation turbine fuels produced in the United States, on burner-fuel oils manufactured for sale, on diesel fuels produced, and on motor gasolines sold by service stations in the United States. Usually about five reports are issued annually.

(4) Foreign mineral reports are issued to help domestic producers and consumers of mineral commodities keep abreast of developments in the mineral industries and markets abroad, and provide a brief summary of significant information from U.S. Foreign Service offices and other sources, which may otherwise not be made available to the general public.

(a) Mineral Trade Notes, issued monthly, provide selected news and economic items on production, consumption, distribution, and noteworthy industrial technological developments on various mineral commodities, except fuels, throughout the world.

(b) International Coal Trade, issued monthly, summarizes the latest statistical and economic data on worldwide coal trade.

(c) International Petroleum Annual presents statistics on crude petroleum and refined products, arranged according to country, and includes information on imports and exports.

(5) Lists of Bureau of Mines Publications, Journal Articles, and Motion Pictures.

(a) Monthly List of New Publications--Bureau of Mines. This list gives titles and abstracts of publications, open file reports, journal articles by Bureau authors, and reports placed in the National Technical Information Service. The list also shows where the reports can be obtained or inspected, and indicates the cost of the publication if it is for sale by the Superintendent of Documents, Government Printing Office, or the National Technical Information Service.

(b) Annual and 5-year Lists of Bureau of Mines Publications and Journal Articles. The annual list includes titles and abstracts of most reports, along with subject and author indexes. Every 5 years the preceding four annual listings are combined with the fifth-year listing into a 5-year list, complete with information on the various series, depository libraries, open file reports, outside publications, patents, and reprints, and with subject and author indexes.

(c) Film Catalog. Every 2 years the Bureau issues a new film catalog of educational motion picture films made in cooperation with public-spirited industrial firms and organizations. The catalog tells how to obtain the films on short-term loan from the Bureau's Pittsburgh office and gives distributing centers at educational institutions and libraries in States where the films are on deposit.

C. Outside Publications are journal articles, papers in proceedings and transactions of symposia and society meetings, and other non-Bureau publications published by technical and trade journals, scientific organizations, and publishing houses. Such publications must have at least one Bureau author to be included in the Bureau's listings of publications.

4. Contract Reports. These reports describe research and other work prepared for and funded by the Bureau of Mines under contract by an outside organization. A final report to the Bureau is usually approved by the Director for open filing in the Department of the Interior Library in Washington and in selected Bureau of Mines libraries. It is generally made available to the public through the National Technical Information Service, U.S. Department of Commerce, Springfield, Va.

5. Other reports. The Bureau occasionally performs work funded by another Government agency, which publishes the results. The Bureau also sometimes funds work by another Government agency, which publishes the results.

6. Policy on Sales and Free Reports. In keeping with the user charges policy of the Office of Management and Budget, the Bureau of Mines sells its reports to the general public through two major outlets. They are the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. (and regional sales offices), and the National Technical Information Service, U.S. Department of Commerce, Springfield, Va.

A. GPO Sales Reports. Reports that are sent to the Government Printing Office for printing by the Public Printer or by a private printer under a GPO contract include Bulletins, Minerals Yearbooks, certain Information Circulars such as mineral resource surveys, Handbooks, and certain Special Publications.

(1) These reports are offered for sale by the Superintendent of Documents, GPO.

(2) Many of these reports are also sold in microfiche, and when out of print at GPO in paper copy by the National Technical Information Service.

(3) The Branch of Publications Distribution, Pittsburgh, Pa., where the Bureau's main publication stock is maintained, and the Division of Technical Reports, Arlington, Va., receive some stock of all sales items for official use.

B. Free Reports. Reports that are sent to the Bureau's Pittsburgh printing plant for printing or to a GPO Regional Printing Procurement Office for printing by a commercial printer include Reports of Investigations, some Information Circulars, Technical Progress Reports, and Mineral Industry Surveys.

(1) Publications that present the results of research and that further the cause of science are generally offered to the scientific community and the taxpayer free of charge by the Bureau of Mines. These reports are also sold in paper copy or in microfiche by the National Technical Information Service, and remain available from that source when the publication itself is out of print.

(2) Publications that are designed to educate persons in the minerals and allied industries in health and safety practices are made available free of charge for this purpose. The recipients are engaged in nonprofit activity designed for public health, safety, or welfare. A few of these reports, such as "First Aid for the Mineral and Allied Industries," are also sold by the Superintendent of Documents.

(3) Reports on highly technical subjects of limited interest that would not be good sales items are issued as free publications.

(4) The Branch of Publications Distribution, Pittsburgh, Pa., maintains the Bureau of Mines official stock and distributes reports to the public from this location. The Division of Technical Reports, Arlington, Va., also receives a small supply for official use.

C. NTIS Sales Items. All free Reports of Investigations, Information Circulars, and Technical Progress Reports are placed in the information storage and retrieval system of the National Technical Information Service, U.S. Department of Commerce, Springfield, Va., publicized by NTIS, and made available for a fee to the public in paper copy or in microfiche. Certain Open File Reports and selected out-of-print reports are also sold to the public through NTIS. GPO sales publications usually are available in microfiche only.

7. Mailing Lists. Mailing lists for publications and press notices are centrally controlled by the Division of Technical Reports. All requests for the establishment of new mailing lists and for additions, changes, and deletions in the mailing lists should be made in writing to the Chief. The lists are physically located and maintained at the Pittsburgh printing plant and the Interior Departmental printing plant.

A. Mailing lists are broken down by subject for Bulletins, Reports of Investigations, Information Circulars, Technical Progress Reports, and press notices, and by commodity and State for the Mineral Industry Surveys and Minerals Yearbook chapters.

B. The Division also controls mailing lists for "New Publications--Bureau of Mines," "Mineral Trade Notes," "International Coal Trade," "International Petroleum Annual," and petroleum product surveys.

8. Distribution of Publications. Bureau of Mines reports are available from the following sources:

A. Free reports:

(1) The Bureau's Branch of Publications Distribution, 4800 Forbes Avenue, Pittsburgh, Pa. 15213, maintains the official stock of Bureau publications, both sales and free reports, and is the Bureau's main office of contact with the public in meeting requests. It receives the bulk shipments of all reports.

(2) The Bureau's Division of Technical Reports, U.S. Department of the Interior, Washington, D.C. 20240, keeps a small stock of all new publications to meet requests from the Congress, Secretary, Director, and other officials. This Division also maintains a single-copy Master File of all major publications published since 1910, and when warranted, the Division will Xerox a copy of an out-of-print report for official use.

B. Sales items:

(1) The Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, or another designated GPO sales outlet, sells Bureau of Mines reports to the public.

(2) The National Technical Information Service, U.S. Department of Commerce, Springfield, Va. 22151, also makes available for a fee Bureau reports placed in the information storage and retrieval system of that agency.

VI. National Aeronautics and Space Administration Session

Chairman: George P. Drobka
NASA

Materials Information in the NASA Scientific and Technical Information System

F. George Drobka
NASA Headquarters
Scientific and Technical Information Office
Washington, DC 20546

The NASA Scientific and Technical Information System is primarily organized to serve the aerospace community and does not specifically focus its coverage of the one-million items currently in the data base on materials information. Information on materials is highlighted in two specific categories as well as sprinkled throughout the remaining thirty-two subject categories. Information is controlled and made more useful by the NASA Thesaurus, a highly structured vocabularly listing. A prime method of access to the data base is via NASA RECON, an on-line interactive search capability. RECON permits flexible, simple or complex searching of the data base and is oriented for user hands-on operation. Findings from a recent system analysis study made by NASA show that the system is generally responsive to user needs, but that there are areas for improvement (e.g., speed-up of RECON response time, better visibility for the products and services available, better coverage of very current information).

Key Words

Aerospace; computer information system; International Aerospace Abstracts; materials; mechanical properties; metallic materials; nonmetallic materials; physical properties; RECON; Scientific and Technical Aerospace Reports; thesaurus.

The NASA Scientific and Technical Information System has existed in its present configuration, without basic change, since 1962. Today, the size of the information store numbers about 1,000,000 references under machine control. The system, by legislation and need, is limited to aerospace science and technology. This is a little like saying that Webster's Unabridged Dictionary is limited by words.

Because of the relative newness of aerospace science and technology a precise definition is difficult if not impossible. At best we can describe rather than define the scope. We have tried to do this in a brochure last published in March 1970 entitled, "The NASA Scientific and Technical Information System ... Its Scope and Coverage." Properly, I should have copies to give to each of you but anticipating a needed revision the 1970 edition is being permitted to go out of print.

In trying to describe aerospace science and technology we have divided the pie into thirty-four subject categories. As an aside I'll mention that these subject categories too are currently undergoing revision and expansion. These categories now range in content from biosciences and biotechnology to mathematics and computers; from masers and lasers to aerodynamics and aircraft; from space vehicles and space sciences to materials -- metallic and non-metallic with a significant amount of the classic disciplines of chemistry, physics and engineering sprinkled over the whole pie. And just to make sure we didn't miss anything we have a category that we use with some trepidation called "General."

The NASA Scientific and Technical Information System is not directly geared to, nor zeroed in on a comprehensive coverage of materials per se. Information on materials may be found in practically all of the subject categories. Our problem in NASA is much like the problem that all of us here face today regarding materials information -- what do we mean when we say "materials information" and once known, even in a cloudy fashion, how do we get it and from whom?

For NASA's purposes it was best for us to make a very simple distinction as a first cut at describing the field. We setup a category called "Materials comma Metallic" and a category "Materials comma Nonmetallic." Like fooling the people, this satisfied some people all of the time and others some of the time. However, we then took advantage of descriptive scope notes which layered or set a priority on our interest in or approach to materials. We have told those who wish to use the NASA system as a source of information on, for example, nonmetallic materials that we have tried very hard to give exhaustive coverage to "physical and mechanical properties, production, handling, testing, and evaluation of nonmetallic materials and compositions of demonstrated and direct interest to designers of aircraft, rockets, space vehicles, reentry vehicles, launch vehicles, and supporting facilities such as cryogenic tanks." We have further advised the user that we have given only selective coverage to "research and development on nonmetallic materials having potential aerospace applications, studies under extreme conditions, unusual applications, new synthesis and production methods, and weight saving materials." And just to show the user that there is some aspect of nonmetallic materials we don't care a whit about, we've gone on record saying we have negative interest in "routine developments in the plastics and ceramics industry." I should pass quickly over that last quote because the use of the word "routine" is an obvious red flag and is a beautiful and painful example of the problem we are facing. In the near infinite world of materials who's to say what's routine or non-routine, or who can say with a high degree of certitude that what's routine today may not be the basis for the exotic breakthrough tomorrow. How can we afford to have "negative interest?" Yet, how can we afford to have "exhaustive interest?" The answer is not easy.

We resisted the temptation to throw up our hands and say there is no answer. Our approach, in the NASA system, was to pursue the matter to another level of specificity and provide the user a list of concepts under each of our broad subject categories. I'll not bore you with more quotes but merely mention that the number of concepts under our nonmetallic materials subject category is forty. Such concepts, which appear under all of our categories, are not vocabulary or indexing terms as such. Some of them may by coincidence be, as thesaurians would say, "an accepted bibliographic descriptor." The purpose of the listing of concepts is to allow the user to sort of browse within a given subject category, albeit somewhat arbitrarily limited by the description we in NASA gave it. The list of concepts is to be used as a memory trigger, guidepost. It provides a sort of warm, wet assurance to the user that as he worries about certain specific nonmetallic aspects of a reentry vehicle for example the guys that run the information system have indeed picked up information on epoxy polymers and potting compounds.

To assist further -- hopefully not to confuse -- the managers of the NASA system determined and decreed that the terms used to describe the information in the store would come from a controlled, set, interrelated, structured vocabularly listing: The <u>NASA Thesaurus</u>.

For those of you who might be interested in examining it, I suspect a copy may already be available in your local libraries; if not, it's available for sale from the National Technical Information Service. Simply ask for NASA Special Publication (SP) 7040.

In constructing the NASA Thesaurus we meant no arrogance. We were not saying to our users that there is fire, water, earth, and air and that's it. Quite the contrary we constructed an elaborate list of terms, words, descriptors -- whatever you want to call them -- that a user may browse or search through and be certain that if he uses those words when he is looking for something in our abstract journals or in our continuing and special bibliographics or on NASA RECON he will find information.

I will in no way get into a discussion of the philosophy of indexing but suffice it to say indexing -- the best indexing -- is a subjective process. Your favorite words or nomenclature may not be mine. You are going to have a tough time searching my system unless you know and use my words. Here again the Thesaurus comes to the rescue. You can probably find your term in the Thesaurus but that does not necessarily mean that it is a term used in the NASA System. But you will be referred to the term or terms that are used in the NASA System and that you should use to structure your question or use as entry points.

Another feature of the Thesaurus is its term array. For example if a user is interested in "sizing" he will find it in the Thesaurus. He will also be admonished to use a more specific term and there will fowllow a list. For "sizing" one would find "size determination," "size separation," "sizing (shaping)," "sizing (surface treatment)," "sizing materials," and then as an added benefit a referral to a related term -- in this case "body measurement (biol.)."

The NASA system allows you to approach a massive subject like "materials" by first providing a description of what NASA means by the subject; then tells you in some detail where we have exhaustive interest, a selective interest, or no interest; lists concepts or subjects pertaining specifically to the prime subject category; and finally provides a list of terms that will allow you to pinpoint your area of interest either by going deeper or a referral to related areas.

A few minutes ago I mentioned NASA RECON. NASA RECON (standing for remote console) is our on-line interactive search capability which those of you who wish will see in operation at the NASA Scientific and Technical Information Facility in College Park tomorrow.

Although you will be told about RECON in as much detail as you'd like by our people in College Park, I would like to take a few moments now to talk about it, particularly for the benefit of those of you who will not attend the demonstartion.

RECON is a very powerful system. The interactive retrieval system with its associated file maintenance system is unusually flexible in several dimensions. It can accommodate a wide variety of file types and indexes to them. The system also allows for a variety of file combinations for searching. This feature makes it possible for the system planner to establish collections of files in such a way as to allow for many combinations. Indeed, any given file may be simultaneously designated as a separate collection for independent searching and assigned to any number of other collections in combination with other files.

Another feature of RECON is that it allows the user to search at his own level of sophistication or understanding of the system. Although only very basic operations are required to perform a full search, the number of available operations plus variations provide the more experienced searcher with increased search and refinement power. This is primarily because RECON is open in its command sequence. The system does not prompt and thereby restrict the user in the sequence of search steps. The user is in complete control at all times, and may make use of any information he has obtained at any time, even from the beginning of his search.

Of course when you do not have unlimited computing power (and we don't) there is a price to pay for this powerful software, and we pay it in response time. The response time currently varies between 5 and 80 seconds with the average being 15 seconds, the most· probable time being 8 seconds, with half of the commands (median) being less than 12 seconds.

The "command" may be anything from a complete search to a small part of a full subject search. It may be just a document citation look-up or a simple search for documents by a specific author or a part of a full-blown subject search which may take 40 or more such commands to complete. On the average, about a minute and a half will elapse between the time a user enters one command and the time he enters the next one.

As impressive as RECON is our users in the NASA Centers have told us in loud and clear terms that its too slow. And we must agree with them. We have very recently made some software changes that have given us a 40% plus decrease in time-lag but this gain will last only until we add more terminals. The only long term solution is a bigger computer.

I've talked about just a couple of aspects of the NASA system and as a member of the team that runs the system. Keeping in tune with the tenor of the times -- and not misleading you by any "little white lies" -- I'd like to tell you what our users say about our system.

This can be done with a relatively high degree of accuracy and currency since we have just recently completed a study aimed directly at evaluating our system. We were specifically interested in the usefulness of the system to those it is intended to serve -- engineers and scientists working in their professional roles; and to identify areas and ways in which the system can be made more effective. To get the answers we conducted over 100 in-depth personal interviews with mid-level scientists or engineers working in the NASA Centers and selected NASA contractor organizations. I might well also mention that the interviewees were picked by the Centers and contractors, not us.

We found that where the system was known it was used and in most cases heavily used. In a high percentages of instances what services and products we provided were responsive to user's, assisted in problem solving, saved money and manpower, assisted in avoiding duplication and were current enough for their needs. Very few found little of no value; a number made good suggestions for new products and services; and an almost equal number made suggestions for improvements to what was already available.

The one overriding plea -- it certainly was much stronger than a suggestion -- was to know what is here and now available. What tools are there that will help the guy that is dependent on information cope with the enormity of it all. "Information explosion" is trite, a badly worn old chestnut and also one helluva problem for the working scientists and engineers today. The help that we who are in the information business give to the users must be very, very carefully provided. We must give them well packaged good information on information without appreciably adding to the already unbelievable amount of information.

Another crying need voiced by the users interviewed was how can really current information be obtained. We at NASA publish two abstract journals -- Scientific and Technical Aerospace Reports (STAR) and in cooperation with the American Institute forAeronautics and Astronautics, the Journal International Aerospace Abstracts. We will brag on any given occasion that whatever we announce in either journal takes no longer than six weeks -- most times only four weeks -- from the time it hits the input desk until the journal is on the street. But how old is the information that we so rapidly and efficiently process -- about six to twelve months. The private sector journals face, in many instances, greater time lags. It is not at all unusual for a professional journal to have a two-year time lag from date of receipt of manuscript to date of journal publication.

Just a moment ago I said that one finding was that our users found information in the NASA System current enough for their needs. Well, yes, but only because the poor user can't get anything more current. It's a mildly defeatest attitude on the user's part. It falls to us in the information business to find a way to make things more current. We in NASA have some ideas.

I've purposely touched only lightly on the findings from our system evaluation study. I wanted to give you at least a flavor of the reaction. None of the findings really surprised us. They did confirm a number of things we suspected and thus, we have a valid basis for making necessary fixes, modifications or enhancements to existing products and services and, equally important, coming up with new products that are directly responsive to user needs.

I believe that the users of the NASA system hardly differ from the users of any other system. Therefore, those of us in the information business should remain mindful that whatever services and products we provide should be geared primarily to user needs and not simply system compatibility and convenience.

VII. Department of Commerce Session

Chairman: S. A. Rossmassler
National Bureau of Standards

The National Standard Reference Data System as a Materials Information Resource

David R. Lide, Jr.
Office of Standard Reference Data
National Bureau of Standards
Washington, D.C.

The National Standard Reference Data System provides reliable, accurate data on physical and chemical properties needed by working scientists and engineers. Operating since 1963 under instructions from the Federal Council for Science and Technology, the program functions as a decentralized group of data centers and projects with central management at the National Bureau of Standards Office of Standard Reference Data. Of the seven technical areas covered by the program, those of thermodynamics and transport data, solid state data, and mechanical properties are most relevant to materials information interests. The primary output of the program is compilations of evaluated data on specialized topics, published in the Journal of Physical and Chemical Reference Data.

Critical evaluation, numerical data, physical properties, chemical properties, thermodynamics, transport, mechanical.

The National Standard Reference Data System is an NBS program that has been in existence for about ten years. The objectives of the program are shown in Figure 1. The primary objective is to provide reliable, accurate data on physical and chemical properties which are needed by working scientists and engineers. In addition, the program attempts to upgrade the quality of data obtained in the laboratory and reported in the literature. Thus, we regard the program as serving as an interface between laboratory measurements of materials properties and the application of the resulting data to the solution of various national problems.

Compilation and critical evaluation of data is a long-standing NBS tradition. The International Critical Tables was edited by an NBS staff member, and many contributions were made by members of the National Bureau of Standards. In the 1940's, Rossini started the systematic compilation of thermodynamic data, and in 1945, the late Edward Condon began the atomic energy levels program. Both of these programs are still in existence, and they have proven their worth over many years.

The formal beginnings of the National Standard Reference Data System dates from 1963, when the Federal Council for Science and Technology issued a policy statement, the full text of which is shown in Figure 2. Briefly, it said, "There will be established a National Standard Reference Data System to provide on a national basis critically evaluated data in the physical sciences." NBS was designated as the focus for this system. In 1968 Congress passed legislation (PL 90-396, reproduced as Figures 3a and 3b) that specifically authorized such a program. The preamble to the act said that "The Congress hereby finds and declares that reliable standardized scientific and technical reference data are of vital importance to the progress of the Nation's science and technology." Under this legislation, the Department of Commerce was given primary responsibility for providing such data, with instructions to use the facilities of other Government agencies and of private institutions.

The central theme of the program is to provide accurate, reliable numerical data needed to answer technical problems. The program stresses the judgments of experts, who recommend the best values to use for given properties of specified materials, and who also make an assessment of the accuracy of these values. The need for this critical evaluation of published data is borne out by many examples of widely discrepant data found in the literature. Figure 4 shows one such example taken from one of the publications of the Thermophysical Properties Research Center at Purdue. The scatter of data on the thermal conductivity of copper is almost random; clearly an uninitiated user going to the literature has a small chance of coming up with a reliable value. Figure 5 shows a similar example from a recent publication on the elastic properties of iron-nickel alloys. Here again, there is a very wide scatter of reported data. The recommended curve, as selected by the authors after a very thorough analysis of all of the data, is indicated.

The Standard Reference Data Program is decentralized in its operation. The compilation and evaluation of data is done at data centers and other data projects that are scattered throughout the country. The central management office, the Office of Standard Reference Data, is at the Bureau of Standards. Functions of this office include monitoring of projects that receive direct financial support from the Bureau of Standards, and keeping close contact with other data projects within the scope of the program. At present, there are about 25 continuing data centers incorporated under the program. Figure 6 identifies a few selected examples of these centers. These are located at NBS, at other Government laboratories, at universities, and in industrial laboratories. By continuing data center is meant a group that systematically covers the literature in a particular field and generates compilations of data on some regular schedule. In addition to these continuing centers, there are active at any given time about 20 to 25 short-term projects that have a well defined mission in turning out a particular critical review or data compilation. Again, some of these are within NBS, and others at universities and elsewhere.

The Office of Standard Reference Data works closely with other Federal agencies that have similar activities. The relationship is particularly well defined with the Atomic Energy Commission, which has a long-standing tradition of data evaluation programs. OSRD provides joint support with the AEC for several data compilation projects in the nuclear area. OSRD also maintains membership in the U.S. Nuclear Data Committee which advises the AEC on needs for nuclear data from various segments of the user community.

OSRD interacts with professional societies, with private publishers, and with international organizations and other countries that have organized data programs. Figure 7 shows a list of organizations in which OSRD staff members are particularly active through holding offices or committee membership. There is a significant ongoing relation with groups in the Soviet Union that are concerned with property data. We receive most of their publications, and in many cases, have arranged for translation of these and distribution in the United States.

For convenience in management, the scope of the Standard Reference Data Program is divided into seven technical program areas, listed in Figure 8. The largest area at the present time is thermodynamics and transport properties. This perhaps reflects the fact that thermodynamicists were among the earliest of all scientists to recognize the need for systematic efforts to compile and evaluate data. There is also a sizeable program in atomic and molecular data; this includes spectroscopic data of all sorts, molecular structure, scattering cross sections, and the like. There are smaller programs in chemical kinetics and solid state data; at the moment, a very small program in colloid and surface data: and in nuclear data, we collaborate with the AEC as I mentioned previously. Mechanical properties is listed on the slide, although, in fact, we have only a little work in this area. However, a series of critical surveys of data sources on mechanical properties and other properties of commercially important materials has been started recently. The first of these surveys dealt with mechanical properties of metals and alloys and is now in press (NBS Special Publication 396-1). We have started a similar survey on mechanical properties of ceramics, and in the near future hope to initiate surveys on electrical and magnetic properties of metals and perhaps on plastics. In these surveys, we are attempting to locate the major sources of compilations of such data and to make some critical commentary on the quality of the data in each source.

Figure 9 presents some of the current projects that are of particular interest to this audience. One component of the system is a continuing data center that deals with properties of alloys. This center compiles from the literature an extensive list of properties and concentrates on a few of these in producing critical reviews and compilations. The Diffusion in Metals Data Center deals with diffusion in a variety of metals and alloys. The Crystal Data project has as its major output a widely known book, the Crystal Data Determinative Tables. The third edition of this compendium, published in the last year, contains data on approximately 24,000 single crystals. The project on elastic properties of metals has led to an exhaustive review of the iron-nickel system and this group is currently covering copper-zinc alloys. The Thermophysical Properties Research Center at Purdue, which has been discussed elsewhere on this program, is one of the external data centers associated with the Standard Reference Data Program. The part of their activities supported by NBS concerns thermal conductivity of metals and alloys. We also have a project on properties of superconductors and another on x-ray and gamma-ray attenuation coefficients. There are others which could be added to this list, but it provides a flavor of the current program.

For the future, we are attempting to get funds to expand the scope of the program to include more materials of commercial importance. Some of the areas which we are currently requesting money are given in Figure 10.

The primary output of the program has been in the form of printed books--compilations of data, critical reviews, and the like. For the first several years of activity, we published a series through the Government Printing Office, the so-called NSRDS-NBS series, which now has about 50 titles. More recently, we have gone outside of Government channels to establish the Journal of Physical and Chemical Reference Data, which is published jointly for us by the American Chemical Society and the American Institute of Physics. This quarterly journal is now in its third year. In addition to subscriptions to the journal itself, individual compilations are sold. At present, most of the content of this journal come from the Standard Reference Data Program; although it is open to contributions from the general public and we are doing all we can to encourage such outside contributions. We have also published a number of bibliographies, mostly through Government channels; although in the future we will probably go to commercial publishers for such bibliographies. Most of these bibliographies are highly indexed and annotated so that they provide an entry point in a detailed manner to the literature containing quantitative numerical data.

The individual data centers within the program receive many inquiries for specific data and they attempt to answer these to the extent that they can. We also have a limited inquiry service in the Office of Standard Reference Data itself. We maintain a library that contains not only our own publications, but a reasonably complete collection of data compilations from all sources throughout the world. We do not have the personnel needed to offer a formal consulting or advisory service; however, the library is open to use by anyone.

Finally, I should mention our plans for an on-line data bank. It is still in a pilot stage, but it has been given a name--NSR Data. Hopefully this data bank will become operational within the next year. For the immediate future, it will concentrate on thermodynamic data, rate constants of chemical reactions, and related data. The contents of this data base will be strictly numerical data, not references to documents containing data.

TO HELP SOLVE SCIENTIFIC AND TECHNOLOGICAL PROBLEMS BY:

(A) PROVIDING RELIABLE QUANTITATIVE DATA ON THE PHYSICAL AND CHEMICAL PROPERTIES OF SUBSTANCES FOR SCIENTISTS AND ENGINEERS TO USE IN THEIR EVERYDAY WORK,

(B) UPGRADING THE PRACTICES OF MAKING MEASUREMENTS IN THE LABORATORY AND REPORTING THEM IN THE LITERATURE.

Figure 1. Objectives of the National Standard Reference Data System

FEDERAL COUNCIL FOR SCIENCE AND TECHNOLOGY
COMMITTEE ON SCIENTIFIC INFORMATION
28 May 1963

Federal Policy on National Standard Reference Data System

There will be established a National Standard Reference Data System (NSRDS) to provide on a national basis critically evaluated data in the physical sciences. The NSRDS will consist of a National Standard Reference Data Center (NSRDC) at the National Bureau of Standards and such other Standard Reference Data Centers as may be required.

The National Bureau of Standards will be charged with the administration of the National Standard Reference Data System. This assignment will include the establishment of standards of quality, methodology including machine processing formats, and such other functions as are required to ensure the compatibility of all units of the NSRDS.

The National Bureau of Standards will be charged with funding and administering the National Standard Reference Data Center. This Center will be an identifiable part of the National Scientific and Technical Information System (NSTIS).

Standard Reference Data Centers covering certain specific areas of effort may be established by or be assigned to the various Departments and Agencies in accordance with their specific desires and capabilities. Such Centers will be financed and administered by the Department to which assigned but will meet the quality standards and other requirements of the NSRDS. Such Centers will be included as identifiable components of the NSTIS.

The NSRDS may also include Standard Reference Data Centers at universities, research institutes, and other appropriate non-Government activities. To be included in the NSRDS, such Centers will meet the quality standards and other requirements of the NSRDS and will be included as identifiable components of the NSTIS.

There will be an Advisory Board to review and recommend policy relative to the operation of the NSRDS. It will include among others, representation from the National Academy of Sciences, National Science Foundation, Federal Agencies engaged in research and development, and such other representatives of the scientific and technical community as the Director of the National Bureau of Standards may determine.

In establishing the NSRDS, the intent is to provide an articulated system of Centers and activities under such coordination and direction as to ensure an output meeting quality standards for national reference data in the physical sciences. The establishment of the System should not be construed as preventing the establishment of such Federal or Departmental Data Systems as are required for the collection of raw or evaluated data to serve engineering or operating needs of the Federal Government or various Federal agencies.

Figure 2. Federal Policy on National Standard Reference Data System

Public Law 90-396
90th Congress, H. R. 6279
July 11, 1968

An Act

To provide for the collection, compilation, critical evaluation, publication, and sale of standard reference data.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

Standard Reference Data Act.

DECLARATION OF POLICY

SECTION 1. The Congress hereby finds and declares that reliable standardized scientific and technical reference data are of vital importance to the progress of the Nation's science and technology. It is therefore the policy of the Congress to make critically evaluated reference data readily available to scientists, engineers, and the general public. It is the purpose of this Act to strengthen and enhance this policy.

82 STAT. 339

82 STAT. 340

DEFINITIONS

SEC. 2. For the purposes of this Act—

(a) The term "standard reference data" means quantitative information, related to a measurable physical or chemical property of a substance or system of substances of known composition and structure, which is critically evaluated as to its reliability under section 3 of this Act.

(b) The term "Secretary" means the Secretary of Commerce.

Collection and publication of standard reference data.

SEC. 3. The Secretary is authorized and directed to provide or arrange for the collection, compilation, critical evaluation, publication, and dissemination of standard reference data. In carrying out this program, the Secretary shall, to the maximum extent practicable, utilize the reference data services and facilities of other agencies and instrumentalities of the Federal Government and of State and local governments, persons, firms, institutions, and associations, with their consent and in such a manner as to avoid duplication of those services and facilities. All agencies and instrumentalities of the Federal Government are encouraged to exercise their duties and functions in such manner as will assist in carrying out the purpose of this Act. This section shall be deemed complementary to existing authority, and nothing herein is intended to repeal, supersede, or diminish existing authority or responsibility of any agency or instrumentality of the Federal Government.

Standards, etc. Publication in Federal Register.

SEC. 4. To provide for more effective integration and coordination of standard reference data activities, the Secretary, in consultation with other interested Federal agencies, shall prescribe and publish in the Federal Register such standards, criteria, and procedures for the preparation and publication of standard reference data as may be necessary to carry out the provisions of this Act.

Sale of reference data. Cost recovery.

SEC. 5. Standard reference data conforming to standards established by the Secretary may be made available and sold by the Secretary or by a person or agency designated by him. To the extent practicable and appropriate, the prices established for such data may reflect the cost of collection, compilation, evaluation, publication, and dissemination of the data, including administrative expenses; and the amounts received shall be subject to the Act of March 3, 1901, as amended (15 U.S.C. 271–278e).

31 Stat. 1449; <u>Ante</u>, p. 34.

U. S. copyright and renewal rights. 61 Stat. 655; 76 Stat. 446.

SEC. 6. (a) Notwithstanding the limitations contained in section 8 of title 17 of the United States Code, the Secretary may secure copyright and renewal thereof on behalf of the United States as author or proprietor in all or any part of any standard reference data which

Figure 3a. Standard Reference Data Act--PL 90-396 he prepares or makes available under this Act, and may authorize the reproduction and publication thereof by others.

(b) The publication or republication by the Government under this Act, either separately or in a public document, of any material in which copyright is subsisting shall not be taken to cause any abridgment or annulment of the copyright or to authorize any use or appropriation of such material without the consent of the copyright proprietor.

Appropriation. SEC. 7. There are authorized to be appropriated to carry out this Act, $1.86 million for the fiscal year ending June 30, 1969. Notwithstanding the provisions of any other law, no appropriations for any fiscal year may be made for the purpose of this Act after fiscal year 1969 unless previously authorized by legislation hereafter enacted by the Congress.

Short title. SEC. 8. This Act may be cited as the "Standard Reference Data Act."

Approved July 11, 1968.

LEGISLATIVE HISTORY:

HOUSE REPORT No. 260 (Comm. on Science and Astronautics).
SENATE REPORT No. 1230 (Comm. on Commerce).
CONGRESSIONAL RECORD:
Vol. 113 (1967): Aug. 14, considered and passed House.
Vol. 114 (1968): June 13, considered and passed Senate, amended.
June 27, House concurred in Senate amendments.

Figure 3b. Standard Reference Data Act (continued)

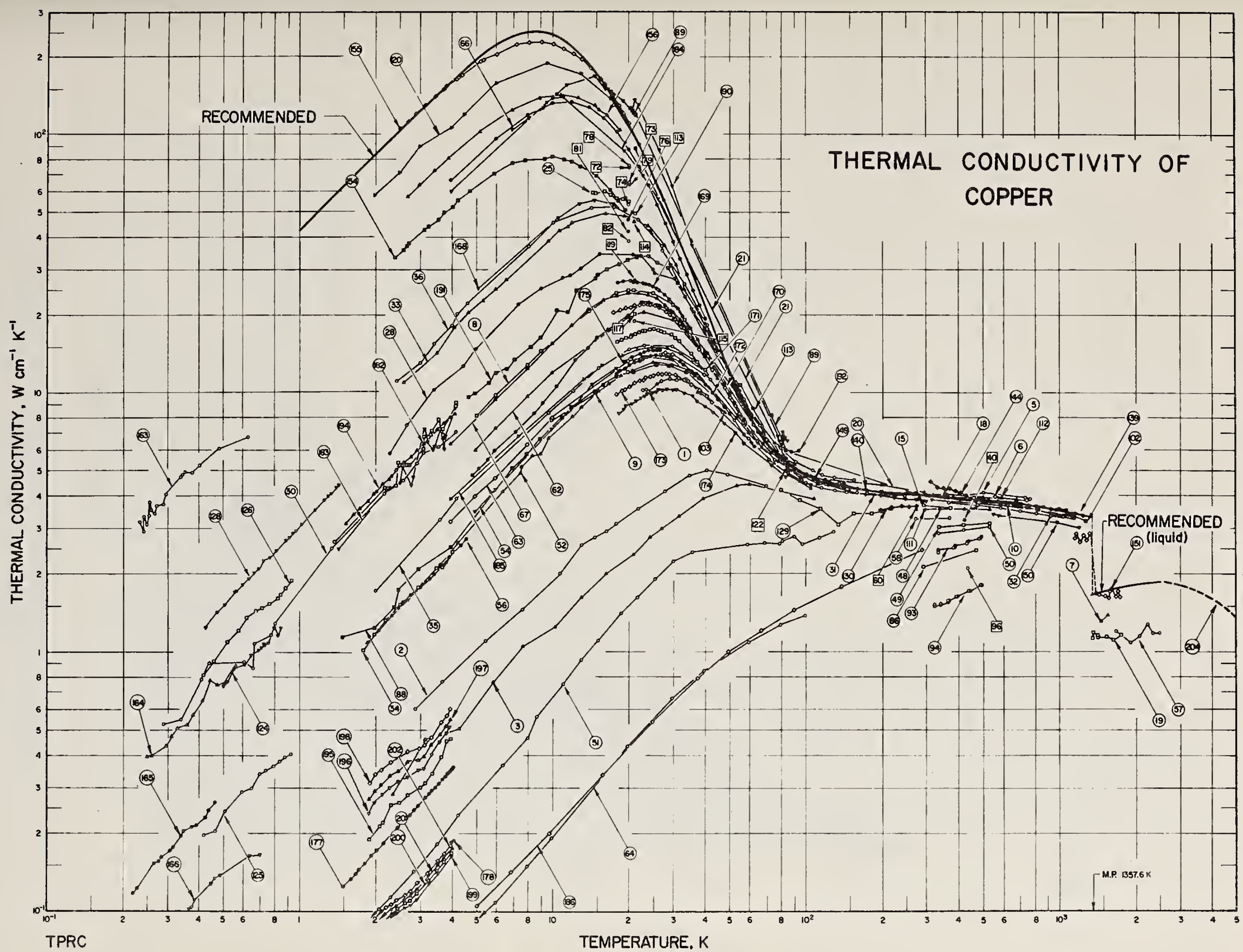

Figure 4. Why data evaluation is necessary--
Thermal conductivity of copper

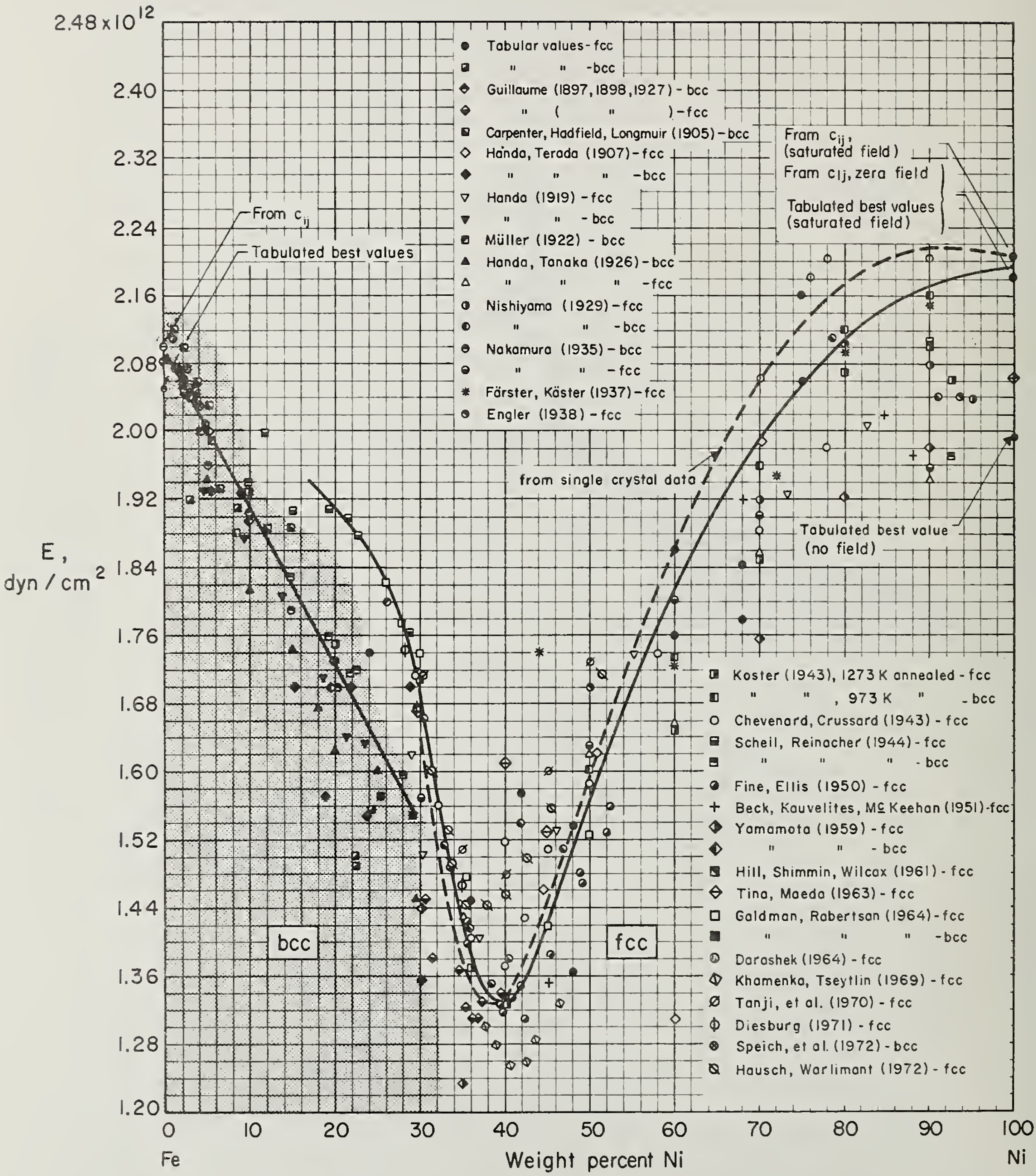

Figure 5. Why data evaluation is necessary--
Young's modulus for iron-nickel alloys

1. Chemical Thermodynamics Data Center (NBS)	-	Direct descendant of early (1940) Bichowski-Rossini project
2. Thermodynamics Research Center (Texas A & M)	-	Long-term API, MCA support
3. Thermophysical Properties Research Center (Purdue)	-	Automotive, aerospace industries are served. DOD, NASA, NSF, NBS support
4. Atomic Transition Probabilities Data Center (NBS)	-	Plasma diagnostics for fusion research
5. Fundamental Particle Data Center (Lawrence Lab)	-	Nuclear properties--AEC support

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NSRDS supports 26 centers

Other agencies (AEC, DOD, EPA, NASA) support 15 others

National needs--150 to 200 active centers in physical and earth sciences

Figure 6. Selected Data Centers in the National Standard Reference Data System

CODATA

International Union of Pure and Applied Chemistry

International Association on the Properties of Steam

ASTM

ANSI

American Institute of Physics

American Society of Mechanical Engineers

Joint Committee on Atomic and Molecular Physical Data

American Chemical Society

Figure 7. Representative organizations with which the Office of Standard Reference Data interacts

Thermodynamics and Transport Properties

Atomic and Molecular Data

Chemical Kinetics

Solid State Data

Nuclear Data

Colloid and Surface Properties

Mechanical Properties

Data Systems Design Activities

Information Services

Figure 8. National Standard Reference Data System Program Areas

Alloy Data

Diffusion in Metals

Crystal Data

Elastic Properties of Metals

Thermophysical Properties

Properties of Superconductors

X-Ray and γ-Ray Attenuation

Figure 9. Current data projects relevant to users of materials information

- FRACTURE AND FATIGUE PROPERTIES
- ELASTIC CONSTANTS (MICROSCOPIC AND BULK)
- PROPERTIES RELEVANT TO PREDICTION OF MECHANICAL BEHAVIOR (E.G., PHASE DIAGRAMS)
- SELECTED CONVENTIONAL MECHANICAL PROPERTIES (TENSILE STRENGTH, SHEER MODULUS, ETC.)

Figure 10. Areas proposed for expansion of Office of Standard Reference Data program in materials

The Flammable Fabric Accident Case and Testing System (FFACTS)

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The Flammable Fabric Accident Case and Testing System (FFACTS) is a computerized data system based on detailed case histories of accidental fabric fires and laboratory analysis of the fabric products involved in these fires. It was designed and implemented at the National Bureau of Standards under the mandate of the Flammable Fabrics Act, as amended in 1967. FFACTS data have been utilized in identifying candidate priorities for fabric flammability standards, establishing appropriate test methods for these standards, identifying possible safety design improvements for common ignition sources, and providing a general understanding of the many factors involved in fabric ignition incidents.

Key words: Apparel fires; burn injury; fabric flammability; FFACTS; flammability standards; Flammable Fabrics Act; ignition sources.

1. HISTORY

The Flammable Fabric Accident Case and Testing System (FFACTS) is a computerized system of fabric fire accident investigation reports which was designed and implemented in 1970 in the National Bureau of Standards (NBS), Department of Commerce.[1]

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[1] With the creation of the Consumer Product Safety Commission (P.L. 92-573, October 27, 1972) responsibilities under the Flammable Fabrics Act, including maintenance of FFACTS, were transferred to that agency.

The Flammable Fabrics Act, as amended May 4, 1967, [1][2] authorized the Secretary of Commerce to promulgate flammability standards for fabrics and related products when such standards were deemed necessary to protect the public against unreasonable risk of the occurrence of fire leading to death, personal injury, or significant property damage. Under the Act, each standard, regulation, or amendment promulgated has to be based on findings that it is needed to adequately protect the public from these unreasonable risks and that it is reasonable, technologically practicable, and appropriate.

It was to achieve these goals that the FFACT System was established. The Act further provided that the Secretary of Health, Education and Welfare (HEW) cooperate with the Secretary of Commerce in providing data towards meeting these goals. Thus, the Food and Drug Administration (FDA), HEW, investigated fabric fire accidents around the country and supplied reports and fabric remnants, whenever these were available, to NBS for analysis and incorporation into the FFACTS data base.

As of May 14, 1973, the Consumer Product Safety Commission (CPSC) took over the administration of the Flammable Fabrics Act [2]. Until December 31, 1974, CPSC investigators continued to supply accident reports and fabric remnants to the Office of Information and Hazard Analysis, Center for Fire Research (CFR), NBS, and NBS provided analysis and technical support to the Commission.

2. DATA COLLECTION AND PROCESSING

The vast majority of the fabric fire accident reports in FFACTS have been submitted by either FDA or CPSC investigators. While the FFACTS data base is not a statistically representative sample of all fabric fires in the United States, the incidents incorporated in FFACTS represent typical fabric fire hazards from all over the country. The geographic distribution of incidents recorded in FFACTS is given in table 1. The earliest case histories were received primarily from Burn Injury Study Units in the Boston and Denver areas, the University of Iowa Hospital Burn Unit (under contract with HEW) and the Lansing, Michigan, Fire Department. In order to include data from wider areas of the country in FFACTS, in late 1970 FDA investigators from district offices around the U.S. began following up and investigating fabric fire accidents reported through hospital emergency rooms, newspaper articles and other media. This procedure continued

[2] Numbers in brackets correspond with the literature references listed at the end of this paper.

Table 1. Geographic Distribution of FFACTS Fire Incidents (FFACTS, April 1974)

State	Number of Incidents	State	Number of Incidents
Massachusetts	299	Oregon	23
Colorado	294	Tennessee	23
New York	290	Alabama	18
Pennsylvania	266	Kansas	16
California	252	New Hampshire	14
Texas	197	Kentucky	10
Iowa	181	Connecticut	9
Michigan	162	North Carolina	9
Illinois	143	Wyoming	6
Washington	122	West Virginia	6
Florida	112	Maine	5
Ohio	109	Montana	3
Maryland	97	New Mexico	3
Missouri	63	Puerto Rico	3
Louisiana	40	South Carolina	3
Indiana	40	Vermont	3
Georgia	34	South Dakota	2
Wisconsin	30	Nevada	2
District of Columbia	28	Alaska	1
Arizona	27	Mississippi	1
Oklahoma	27	North Dakota	1
Utah	27	Nebraska	1
Virginia	25	Rhode Island	1
New Jersey	25	Unknown	56
Minnesota	23		
	Total 3,132		

through the transition to CPSC, which investigated fabric fires both through its nationwide network of inspectors and through private contractors. These investigations were reported on forms developed jointly by NBS and CPSC.

These reports, together with the remains of fabric products involved in the fires, were sent to the Office of Information and Hazard Analysis, CFR, for processing. Accident reports were screened for acceptance into the system based (1) on their relevance (a fire accident must have involved a fabric product which either contributed to the spread or retardation of the fire, the production of smoke, or the development of other fire hazards); and (2) on their adequacy in providing sufficient information to contribute to an understanding of fabric fire phenomena.

Accident data from accepted reports were coded using a coding manual developed at NBS. These data include details on the time and specific location of the fabric ignition; demographic information about persons involved in the accident; specific activities of persons which led to their involvement and special circumstances such as handicaps, intoxication, etc.; a detailed description of the ignition sequence from the initial heat source through possible intermediary materials to the fabric product(s); personal injury information, including detailed thermal burn data and treatment required; medical cost; work time lost; and property loss data.

Those fabric remnants received with the case histories which were of sufficient size were tested in the laboratory for fabric weight and construction, fiber content, and flammability (if an appropriate test exists). These data, together with data on the role of each fabric product in the fire, were encoded on fabric item coding sheets, along with the accident case data, then keypunched, formatted, and read onto magnetic tape.

3. ANALYSIS OF FFACTS DATA

As of April 1, 1974, the FFACTS data base contained 3,132 fabric fire incident case histories. Over the past three and a half years, analyses of FFACTS data has had four main areas of application: (1) to set candidate priorities for fabric flammability standards; (2) to determine appropriate test methods for these standards; (3) to indicate hazard associated with common ignition sources and possible areas for improving their design; and (4) to provide a general understanding of various accident parameters which may in turn lead to methods for reducing the hazards involved. Examples of each of these applications are presented in the following subsections.

While the FFACTS data are not derived from a statistically representative sampling of all fabric fires in the U.S., many indications, which began to develop in the earliest data, have continued to be consistent while the data base has doubled and tripled in size. These indications have remained consistent while the geographic areas sampled, the investigating organizations and the mode of data collection have all changed several times. Hence, it appears that the FFACTS data are reflecting the actual fabric fire experience in the country.

3.1. Candidate Priorities for Fabric Flammability Standards

The primary function of FFACTS since its inception has been to provide information which would identify hazardous fabric products and set candidate priorities for flammability standards. While the nonstatistical nature of the sampling has not permitted valid national estimates of the numbers of fires involving various fabric products, over-representation in the frequency of ignition of certain fabric items involving specific age-sex groups became apparent from the earliest data analyses.

One of the first fabric products in FFACTS to appear to be disproportionately involved in fire incidents was children's sleepwear. Efforts to reduce the hazard associated with the ignition of children's sleepwear culminated in the Standard for the Flammability of Children's Sleepwear for sizes 0 through 6X promulgated on July 21, 1972 [3]. This standard has been followed by a similar standard for sizes 7 through 14 issued on May 1, 1974 [4]. Though the need for the original standard was supported by only 37 sleepwear fire accidents involving children 0 to 5, the severe over-representation of children's sleepwear ignition incidents in FFACTS has continued over the years of data collection since 1971.

The highly represented garment-age-sex groups in FFACTS are shown in table 2 where relative incident frequency index numbers are displayed for each group. This table was excerpted from a 1972 paper "Current Status and National Priorities for Flammable Fabric Standards" [5]. In identifying garment fire hazards, the data sample was restricted to those garments which were not contaminated by flammable liquids in the ignition incident because the role of the garments themselves in such flammable liquid fires is clouded. Also, only the first garment ignited in each incident is included in the sample because first-to-ignite garments are generally considered to exert most of the influence on ignition and burn injury attributable to the garments ignited. The relative incident frequency index numbers were computed by dividing the number of non-contaminated first-to-ignite garments in a given age-sex group by the proportion of the U.S. population represented by that age-sex group. These indices show the relative frequency of various garment type ignitions for different portions of the population. The highest index numbers indicate the greatest hazard areas.

Table 2. Relative Incident Frequency Index Numbers* for Reported First-to-Ignite Garment Incidents by Age and Sex Compared with Age-Sex Distribution of the U.S. Population (based on 551 first-to-ignite incidents in the given garment-sex categories reported in FFACTS, December 1972)

		Age Groups					
Garment	Sex	0-5	6-12	13-20	21-45	46-65	66+
Sleepwear	Female	98	87	14	24	40	71
Dresses	Female	49	29	1	4	9	29
Shirts	Male	21	18	26	24	23	35
Sleepwear	Male	69	22	5	3	7	23
Pants	Male	13	8	4	7	11	13

*Index numbers rank garment-age-sex groups by relative hazard indicated in FFACTS.

The data in table 2 indicate the greatest hazards for children's sleepwear, ages 0 to 12; girls' dresses, ages 0 to 12; adult females' sleepwear; shirts for males of all ages; and nearly all garments for the elderly. These constitute the most recent candidate priorities for garment flammability standards. Some of these hazards can be addressed through flammability standards more easily than others. Apparel fires present an especially large hazard to the elderly, but there is no way for a flammability standard to isolate garments for the elderly by size, as can be done for children's clothes; thus, unfortunately, a standard for garments for the elderly is not currently feasible from a regulatory standpoint. The technological practicability of imposing a flammability standard on shirts may be questioned. For further information on this garment data analysis the reader is referred to the paper listed in reference 5.

FFACTS data have also been used in studies of the hazards associated with bedding and furnishings fabric products, such as mattresses, curtains and drapes, upholstered furniture, and blankets.

3.2. Appropriate Test Methods

Besides identifying hazard areas for which fabric flammability standards may be needed, FFACTS data on the ignition sources in fabric fires have been analyzed to provide information for the establishment of appropriate test methods for proposed flammability standards.

In order to fulfill the Flammable Fabric Act's requirement that a standard be appropriate, the test method used in a standard should approximate the real-life hazard associated with the fabric product being regulated. For example, the ignition sources for first-to-ignite sleepwear for children 0 to 12 are displayed in table 3. Most of these ignition sources involve a relatively small flame which came in contact with the sleepwear; for this reason it was decided that a small flame would be the appropriate ignition mechanism for the two sleepwear standards.

In another fire hazard, over 65 percent of the first-to-ignite mattresses in FFACTS ignited from cigarettes. Thus, the Standard for the Flammability of Mattresses, promulgated June 7, 1972 [6], requires that mattresses not ignite from a lit cigarette. Similarly, the test method being developed for upholstered furniture is also based on a cigarette ignition mechanism because cigarettes account for 80 percent of the upholstered furniture ignitions in FFACTS.

Table 3. Ignition Sources for First-to-Ignite Sleepwear Incidents Involving Children Ages 0 to 12 (FFACTS, April 1974)

Ignition Source	Number of Incidents	Percent
Matches	83	31
Electric Range	44	16
Gas Range	39	14
Space Heater	37	14
Lighter	23	9
Open Fire	19	7
Candle/Lantern	18	7
Fireworks	4	1
Other	2	1
Total	269	100

3.3. Ignition Source Design

FFACTS is primarily oriented towards fabric products; however, analyses of various fabric ignition sequence patterns have indicated that certain safety design features for some of the most common ignition sources could substantially reduce several fabric fire hazards.

A study of the role of matches and lighters in FFACTS fabric fires revealed that they account for one-fourth of the accidents in the data base for which the ignition source was known, with matches outnumbering lighters 6 to 1 [7]. One-third of these incidents involved children under six years old. Based on these and other statistics, the Consumer Product Safety Commission is investigating ways in which lighters and, especially, matches can be made "child-proof."

Kitchen ranges are another common ignition source in fabric fires. They account for 35 percent of the direct garment ignitions in FFACTS. Females under 16 and over 65 are particularly heavily represented [8]. Most of these accidents occurred when the victim reached or leaned over a hot burner while cooking, and a sleeve, apron or shirttail ignited. Several suggested design changes, such as placement of burners, location of controls and spring-loaded guards around burners to prevent exposure, are being studied to reduce this substantial flammability hazard.

A study of hazards associated with space heaters has been published [9]. Typical accidents studied in the hazard analysis involve children, dressed in nightgowns or robes, warming themselves in front of unprotected heaters.

Modification of these and other ignition sources could reduce the fire hazards which cannot currently be addressed through fabric flammability standards.

3.4. Understanding Fabric Fire Hazard Parameters

Recent analyses of FFACTS data have been directed toward understanding the roles of several major factors in the complex circumstances surrounding apparel fires [10,11]. It is hoped that an understanding of the mechanisms at work in apparel fires will lead to new approaches to reducing the hazards involved.

Among the factors which influence garment ignition and subsequent injuries are: (1) circumstances surrounding the accident, such as the size of the ignition source, the activity of the victim prior to the accident, and the presence of flammable liquids; (2) the flammability of the fabric items involved; and (3) the reactive capabilities of the victim to garment ignition. The first and third factors, in turn, are influenced by human factors, such as age and sex, handicaps, the availability of help, and the possible influence of intoxicants; the second is influenced by physical fabric and garment parameters such as fabric weight, construction, surface finish, fiber composition, and garment shape and fit. Apparel fire accidents represent complex interactions of many of the factors above and it is often difficult to establish which, if any, plays a dominant role.

FFACTS data, however, have shown some interesting relationships, including the following.

Among garment and fabric parameters, it appears that garment configuration and fit have more influence over burn injury severity than do such parameters as fabric weight, fabric burning rate, fabric construction and even fiber content [10]. (It should be noted that 90 percent of the fabrics in the sample contained cellulosic fibers; hence, data on all-thermoplastic fabrics were inconclusive.) As shown in figure 1, loose-fitting garments (dresses, night-gowns, and robes), which cover a large area of the body, yielded greater proportions of extensive burn injuries than did moderatly loose-fitting garments like pajamas; close-fitting garments (shirts and pants), which cover only half of the body, yielded the least extensive burns. This phenomenon has obvious implications for fabric flammability standards.

Burn injury severity also varies with age and sex of the victim. The very young and the elderly generally receive more serious injuries than middle age groups; females receive severe burns more frequently than males of the same age group. Analysis of the victims' reactions to garment ignition has shown that greater proportions of negative reactions (i.e., inappropriate or ineffective) predominate in these same groups [11].

FFACTS data tend to indicate that garment shape and fit, and age-sex related reactions exert strong influence over the nature of burn injury in apparel fires. The role of other parameters is not clear, because of the lack of independence between them.

4. REFERENCES

[1] U.S. Congress, Flammable Fabrics Act, 81 Stat. 568, 15 U.S.C. 1191, as amended and revised, December 14, 1967.

[2] U.S. Congress, Consumer Product Safety Act, 86 Stat. 1221, 15 U.S.C. 2064B, May 14, 1973.

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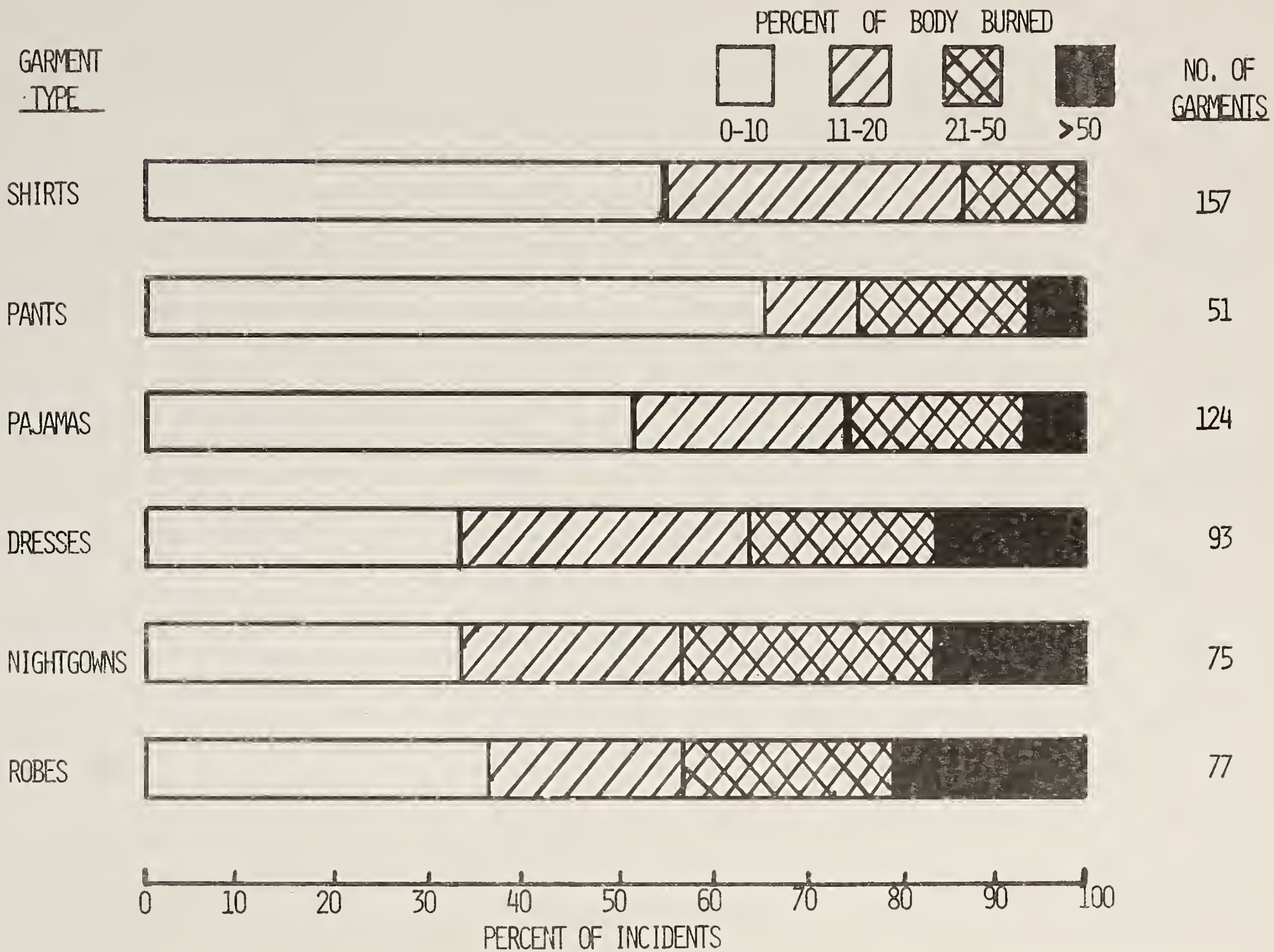
FIGURE 1. AREA OF BODY BURNED BY GARMENT CONFIGURATION AND FIT
(IN TERMS OF GARMENT TYPE)
(FFACTS, NOVEMBER 1973)



National Technical Information Service-- Its Products and Services

George K. Kudravetz
National Technical Information Service
Springfield, VA 22151

Established in 1970, NTIS is the central source within government for the dissemination of scientific, technical and engineering information. NTIS publishes and makes available on subscription 23 weekly newsletters, a comprehensive semi-monthly bulletin and a companion index. A new weekly newsletter is Government Inventions for Licensing which includes all new government-owned patents and patent applications arranged by subject. NTIS is also the national marketing coordinator for various Information Analysis Centers (IACs). The IACs are mainly concerned with the analysis and communication of highly specialized technologies

Keywords: Computerized information system; document dissemination; government reports; NTIS; patent licensing; technical reports.

Enabling Legislation and Mission:

NTIS was established by the Secretary of Commerce in 1970 with the purpose as stated in 15 U.S. Code 1151-1157 of making the results of technological research and development more readily available to industry, business and the general public by maintaining a clearinghouse for the collection and dissemination of scientific, technical and engineering information.

Program:

NTIS has become the central source for the public sale of government-sponsored research and development reports and other related analyses prepared by federal agencies or their contractors.

Through agreements with government organizations, NTIS receives over 60,000 new technical reports annually covering subjects from Agriculture to Space Technology. These include all of the unclassified technical reports resulting from research funded by AEC, NASA and DOD as well as the research reports and studies of the Department of Housing and Urban Development, the Department of Transportation, the Environmental Protection Agency and many other agencies. All of these reports are indexed, abstracted and announced to the public through a variety of publications including a comprehensive, semi-monthly abstract bulletin.

In addition to published bulletins and announcements, descriptions of the reports are stored in a computer data base which can be searched to retrieve all of the reports on a given subject or by a given author. This search service, known as NTISearch, provides users with ready access to more than 360,000 federally sponsored documents published since 1964 and the Smithsonian Science Information Exchange's file on 180,000 ongoing research projects.

In 1972 NTIS supplied the public with more than 2-1/2 million documents and microfiche from its collection of 813,000 different titles of which 100,000 are in current stock. NTIS answers more than 180,000 requests for information each year in addition to filling 5,000 orders a day.

NTIS is required by statute to price its products and services for cost recovery and is largely self-sustaining. Less than 20 percent of NTIS' funding is from direct appropriations. Annual sales income from products and services is $6 million. In addition NTIS received 1.7 million from other agencies for reimbursable services and $1.5 million in direct appropriations in FY 1973. Its central staff consists of 400 people of whom forty are professional.

The basic NTIS announcement vehicle is a series of bulletins known as the Weekly Government Abstracts. They reach over 20,000 subscribers with new government technical reports and new government inventions available for licensing. These weekly newsletters are easy to scan with front page highlights to alert you to reports with the best potential commercial use. Descriptive subcategory titles quickly identify specific areas of greatest interest to you. We are now publishing 23 weekly newsletters some of which are Materials Sciences, Industrial & Mechanical Engineering, Chemistry, Electrotechnology, Building Technology, etc.

NTIS is the national marketing coordinator for various Information Analysis Centers (IACs) sponsored and partially financed by DOD, AEC, HEW, NASA and the Department of Commerce. The IAC's are mainly concerned with the analysis and communication of highly specialized technologies. Several that are concerned with materials sciences are Metals and Ceramics Information Center (MCIC), Plastics Technical Evaluation Center (PLASTEC), Thermophysical and Electronics Properties Information Analysis Center (TEPIAC), etc.

IAC's generally provide the following three production services.

- o Technical Inquiry Services: The custom searching of data base for information relevant to specific queries; combined, by some IAC's, with analytical research and evaluation.

- o Data Books and Research Reports: Often these are state-of-the-art reports; that is, the best information available on subject. Also published in this category are annotated bibliographies, technical guides, and directories of terms and processes.

- o Current Awareness Bulletins: These reflect the latest technical achievements in brief as they are observed and recorded for subsequent detailed evaluation; usually available on a subscription basis.

Customers pay for NTIS services by check, or money order. Another method preferred by over 6,000 customers is the deposit account of $25.00 or more, against which charges are debited. Domestic customers also may be billed for material. At this time we are pleased to announce that NTIS and the American Express Company have signed a unique agreement permitting commercial credit card purchases of Government products. Anyone who needs Government reports or data should be able to buy them as quickly and conveniently as possible, and if he chooses, to charge them. Heretofore, the Government has not been able to extend credit. But now, the Comptroller General of the U.S. after finding that NTIS could provide its customers with more rapid and convenient service or credit, has made a new ruling permitting contracts such as this one between NTIS and American Express.

In early 1973 the General Services Administration at the direction of President Nixon issued new regulations for the licensing of Government-owned inventions. These regulations are intended to provide greater incentives for the licensing of government-owned patents. They allow for the first time the granting of exclusive licenses for a limited period of time on government-owned inventions. The interagency Committe on Government Patent Policy, which developed the licensing regulations, asked the National Technical Information Service to serve as the central point for processing and publishing information on government-owned inventions.

In response to this new charge NTIS is now making information available on new government-owned inventions, both patents and patent applications, from most agencies in the same manner as technical reports. These inventions are announced with abstracts in the Weekly Government Abstracts series.

NTIS has developed a new announcement service which is designed expressly for the prospective licensee of government technology: The weekly bulletin, Government Inventions for Licensing, includes all new government-owned patents and patent applications arranged by subject. Both abstracts of the inventions and drawings are included.

NTIS initiated a pilot program to attempt to identify those government patents which may have commercial potential and, further, to find an effective means of communicating these inventions to prospective licensees. NTIS contracted with two research organizations, Battelle Memorial Institute and the Illinois Institute of Technology Research, to aid in screening inventions to select those with commercial potential. The screening was performed by application oriented scientists and technologists who culled out any inventions of doubtful commercial value.

The reviewers also looked at the new technology broadly and suggested new applications, frequently quite different from the government application for which the invention was originally developed.

In addition to evaluating patents, NTIS asked Battelle to explore new ways of communicating the selected inventions to prospective licensees. The selected patents were packaged, not for direct publication, but rather for secondary publication through established channels such as trade magazines, newsletters and exhibits at trade shows. Articles describing particular inventions with heavy emphasis on the civilian application that the reviewers feel offer the most promise appeared in such publications as Design News and Industry Week. Over 800 inquiries have been generated by these articles.

Descriptions of selected inventions, with appropriate application orientation, have also been included in technical newsletters. For example, 16 inventions related to materials research and laboratory processing were described in a newsletter recently mailed to the 4,500 regular users of the Metals and Ceramics Information Center, an Information Analysis Center whose products are marketed by NTIS.

In the first tests, over 12 percent of those contacted asked for more information.

NTIS has initiated a number of efforts to assist in the dissemination to state and local governments the scientific and technical knowledge which has been developed at the Federal level. It has acquired and organized information developed or sponsored by the Federal Government so that is is easily accessible. Information acquired includes documented technology, computer software, computer simulation models, and data files.

Special catalogs describing the availability of Federally-developed data files and software packages have been developed, and through NTIS the Socio-Economic file maintained by the Economic Development Administration will not become available. In addition to these efforts, special marketing programs oriented to managers at the state, city, and local levels are being developed. Through this program NTIS will organize the information that may be used in the public sector as to applicability and utility. Regional seminars will be sponsored to demonstrate software potential by the use of computer simulation models. It is anticipated that five or six conferences will be sponsored over the next six months. Through seminars of this type, NTIS believes that it can promote understanding of this technology among both elected and civil service officials in the public sector. This should permit easier transfer of software packages that have applicability in the public sector in terms of offering improvements and efficiencies in the operation of government.

Standard Reference Materials - The Data and The Material

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The comparison between Standard Reference Materials to Standard Reference Data is discussed with descriptions of why SRM's are important and how they are certified and used to provide investigators with accuracy and precision and their measurements. A number of examples are given for route of certification and the relative merits of these routes.

Accuracy, certification, precision, SRM, Standard Reference Data, Standard Reference Materials

Basically, two ways exist for an individual to obtain data. The first is to look in a reference book, while the second is to perform some type of measurement. The most persuasive reason to measure is the need to determine a variable parameter. A simple but adequate example of this involves temperature measurements. In one case the temperature of the triple point of water must be known, this is found in a reference book. In another case the temperature of ambient air for a weather report must be known and in this case a measurement must be made. It is in such cases, where measurements must be made, that Standard Reference Materials are important.

Standard Reference Materials or SRM's are tools that help to make measurements accurate and have sometimes been referred to as "bottled data."

When thought of as "bottled data," Standard Reference Materials (SRM's) might be compared to Standard Reference Data. Standard Reference Data are the results of scientific investigations that have been critically evaluated and published by recognized authorities in a given field. Such data may then be used based on the reputations of the investigators and evaluators. For NBS-SRM's, a given material is carefully investigated for its chemical composition, or a physical property. The investigation or characterization of the material is performed following one of three routes that lead to certifying the material as an NBS-SRM. The results of the investigation, the data, are then certified by NBS. These data are condensed and issued as a certificate, a typical example of which is shown in figure 1.

Both the data (on the certificate) and the material are provided to SRM users to calibrate or evaluate their methods and instruments thus providing them with a base-line from which to launch new investigations on similar materials.

An NBS-SRM is defined as a well-characterized material that is produced in quantity with one or more properties certified by NBS for use in calibrating measurement systems and/or developing methods of measurement.

SRM's are easily transported to the site of the user, where the user may perform on-site calibration of his instrument or measuring process. This eliminates the need for the user to ship his instrument to a central standardizing laboratory for calibration. Time and money are saved and the possibility of damage to the instrument or having it become uncalibrated in transit is eliminated. That the values obtained by on-site calibration in widely separated points may be referred to a common, widely accepted value is one of the major advantages of SRM's.

Another major advantage of using NBS-SRM's is to help assure meaningful data---for data to be meaningful it should be both accurate and precise.

Figure 2 has been used with some success as an analogy to explain the difference between accuracy and precision:

Three imaginery marksmen fire a rifle at a target. In the top target, the marksman is both imprecise and inaccurate. The marksman is quite precise but inaccurate in the middle target, and in the bottom target, the marksman is both accurate and precise. Of course, the analogy in all cases is that the bull's eye corresponds to the target value or "true" value.

One of the most important facts built into most NBS-SRM's is known accuracy. The accuracy of an NBS-SRM is generally established by one or more of three routes to certification.

These three routes are arranged in order of preference and are: (1) reference method, (2) two independent methods, or (3) round-robin tests. The preferred route to certification is by a reference method, which is a method of known or proven accuracy. Its use assures the accuracy of the determination if personal bias is eliminated. This is eliminated by having the measurements made, when possible, by two or more analysts.

The second route to certification is used when a reference method is not available. This route requires the use of two or more independent methods. Each of these independent methods must have estimated systematic biases that are small relative to the accuracy goal set for certification.

The first two routes are subject to critical scientific review through statistical analysis of the data obtained. This, however, may not be the case for the third or round-robin route, which is subject to a somewhat less rigorous analysis of the data. The proof that this route is valid is that in a system under good quality control, it works.

The following examples illustrate the certification of NBS-SRM's using each of these three routes.

NBS has issued a series of glass SRM's certified for trace elements at levels from 0.02 ppm to 500 ppm. These SRM's have found widespread use in calibrations involving geological samples and lunar materials. The lead content of these SRM's was certified using isotope dilution thermal ion source mass spectrometry, which is a recognized reference method of known and proven accuracy for lead. Similar standard deviations were obtained using this method by the two analysts working 2,000 miles apart. These results are important as they signify that the system was under control. The certified value of 426 ± 1 ppm for lead is a conservative figure that provides for possible unknown sources of systematic error.

As an example of the second route, three independent methods of analysis were used to determine cadmium in SRM 1577, Bovine Liver. This SRM is certified for trace amounts of certain toxic metals. Isotope dilution spark source mass spectrometry (IDMS), atomic absorption, and polarography gave 0.28, 0.27 and 0.25 ppm, respectively. Based on these routes, 0.27 + 0.04 ppm was the value certified. In this case, IDMS is not a reference method as it was for lead because its systematic errors have not been exhaustively studied for Cd.

Figure 5 is an example of the third route to certification. Here, an interlaboratory test program, or round-robin, involved 6 different, highly competent laboratories in the determining the carbon content of a steel SRM used by steel mills to control the quality of steel production. Although 4 different methods and 6 different sample weights were used, highly satisfactory results were obtained. It should be noted, however, that a previously issued NBS-SRM, (certified by one of the other routes), similar to the material under study, was required for internal quality control in each laboratory. It should be noted that the round-robin approach should only be used for measurement systems or fields of science and technology that have already obtained good quality control. Several reasons exist for avoiding the round robin approach. First, a field may not be ready for it, as the field is not in good quality control. Secondly, the proper constraints, i.e., sampling procedures, statistical handling of data, etc., may not be uniformly applied. An illustration of the danger in the round-robin approach, can be seen in figure 6, which shows the wide range of values reported by different laboratories for various elements in the orchard leaves SRM. These data could not be used for certification! This SRM, which is used by both agricultural and environment laboratories, was actually certified using the second route.

For SRM's to be most effective, they need to be integrated into the U.S. measurement system or a similar system. Figure 7 shows the parts of the U.S. measurement system and how they tie together.

The SI base and derived units are the first link in this Measurement System, and form a common foundation for all quantitative measurement systems and fortunately have been agreed upon internationally.

Producing and distributing certified SRM's on a national basis is the next link to the measurement chain. In the U.S., this is mainly the job of NBS, as has been prescribed by Congressional legislation. Other organizations produce calibration materials in their particular field of science or technology. An example of this is the U.S. Geological Survey, which produces geological samples.

The next link in this System is reference methodology.

A reference method of measurement is defined at NBS as a method of known and demonstrated accuracy. In addition, the accuracy inherent in the method has been shown to be transferable by interlaboratory testing.

The base and derived units and SRM's are the direct responsibility of NBS. This is not the case for reference methods. NBS becomes involved in reference methods only when outside organizations have not or cannot develop reference methods by themselves. However, many collaborative efforts do exist between NBS and professional societies, standards bodies, trade associations, and other Government agencies to provide for SRM's and reference methods. An example of NBS involvement in such work in the development of a reference method for the determination of calcium in serum [1].

Primary SRM's and reference methods, do not find widespread daily use in measurement laboratories. But they tie directly to the next link in the system -- the field methods of test and working or everyday calibration standards.

When used together, reference methods and NBS-SRM's provide organizations with the means to evaluate their working standards and field methods of test. As a consequence they place measurements on the basis of accuracy.

From this network measurements are produced that are meaningful in terms of accuracy and precision. One more part is needed to insure that the system works smoothly and produces the desired results over a long period of time. A quality control assurance program involving interlaboratory testing with unknown samples and analysis of the results as evaluated against SRM's and reference methods fulfill this need.

Quality control assurance programs are sponsored in the U.S. by many different organizations. However, they are not always related to SRM's and reference methods! As a result, some of these quality assurance programs give a measure of between-laboratory precision only.

The first NBS-SRM's were issued in 1905, shortly after Congress established NBS. In the nearly seven decades since then, the NBS-SRM program has come a long way. Now over 850 SRM's are available from NBS; and last year some 30,000 of these were sold with about 20% of them going outside the U.S. Those 850 SRM's cover a wide variety of industrial, technological and scientific areas and are described in detail in 1973 SRM Catalog [2]. However a brief look at these areas shows the diversity of the program.

In the industrial sector, a very heavy concentration of SRM's exist for the ferrous and non-ferrous metals producers and users. Rubbers, cements, ores, and glasses are also well covered. In such areas of health and environment, the program has expanded over the past few years, and now includes SRM's for clinical chemistry, nuclear medicine, and pollution monitoring (both chemical and radioactive). SRM's of interest to the nuclear energy field include a wide range of materials certified for chemical and isotopic compositions. For metrology, the number of available SRM's has been growing slowly but steady and now includes SRM's for heat, optics, and density measurements. For the scientific community, NBS issued SRM's for Mossbauer spectroscopy, magnetic suscepti--- bility, vapor pressure, thermal conductivity, thermal expansion, and permittivity. In the area of agriculture, NBS offers several fertilizers, an Orchard Leaves SRM, and a Bovine Liver Standard.

The list of NBS-SRM's is not static; each year some 30-40 new SRM's are made available and a small number are discontinued. Current efforts for new SRM's are strongly focused on health and environmental areas, but not at the expense of traditional industrial areas.

This description of the NBS-SRM program is quite brief; a more detailed description can be found in The Role of SRM's in Measurement Systems [3].

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U. S. Department of Commerce
Frederick B. Dent
Secretary

National Bureau of Standards
Richard W. Roberts, Director

National Bureau of Standards
Certificate of Analysis
Standard Reference Material 989
Assay-Isotopic Standard for Rhenium

Absolute abundance ratio, $^{185}Re/^{187}$	0.59738 ± 0.00039
Rhenium - 185, atom percent	37.398 ± 0.016
Rhenium - 187, atom percent	62.602 ± 0.016
Atomic weight	186.20679 ± 0.00031

This Standard Reference Material is supplied as rhenium metal in the form of a ribbon approximately 0.003 cm by 0.076 cm x 1.90 cm. The purity of this metal is 99.9 percent based on impurities detected by isotope dilution spark source mass spectroscopy. The absolute abundance ratio of $^{185}Re/^{187}Re$ was determined by two analysts using two different mass spectrometers. Samples of known isotopic composition, prepared from nearly isotopically pure separated rhenium isotopes, were used to calibrate the mass spectrometers. The indicated uncertainties are overall limits of error based on 95 percent confidence limits for the mean and allowances for the effects of known sources of possible systematic error. The details of the measurements are described in a published paper: J. Res. NBS (U.S.), 77A (Phys. and Chem.), No. 6, 691-698 (Nov.-Dec. 1973).

Mass spectrometric measurements were made by J. W. Gramlich and E. L. Garner on samples prepared by T. J. Murphy.

The overall direction and coordination of the technical measurements leading to certification were under the chairmanship of W. R. Shields.

The technical and support aspects concerning the preparation, certification, and issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by W. P. Reed.

Washington, D. C. 20234
February 19, 1974

J. Paul Cali, Chief
Office of Standard Reference Materials

1. Certificate of Analysis

An inaccurate and imprecise marksman

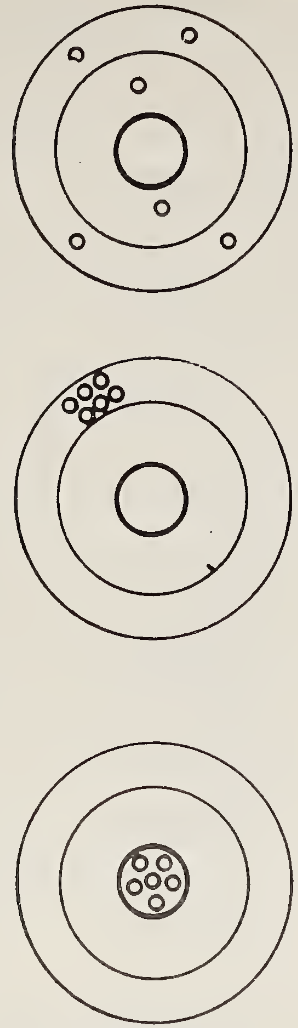
No statement of potential accuracy possible

An inaccurate but precise marksman

Potentially accurate
Find source of systematic error

An accurate and precise marksman

Accuracy cannot be attained until precision is first achieved



Bull's–eye corresponds to target value or 'true' value

2. Accuracy Versus Precision

LEAD IN 500 PPM GLASS

Rod No.	Analyst 1	Analyst 2
2	426.5	- - -
13	426.2	- - -
18	425.6	425.9
48	426.1	426.0
56	426.9	425.0
66	426.0	425.4
78	426.2	425.6
106	425.7	- - -
Average	426.15	425.58
σ	$\pm$0.41	+0.40

3. Lead in 500 ppm Glass SRM

CERTIFICATION BY TWO OR MORE INDEPENDENT METHODS

Cadmium in Bovine Liver

Concentration ($\mu g/g$)

Sample	ID–MS	Atomic Absorpt	Polarography
1	0.32 0.29	0.29	– –
2	0.26 0.27	0.24 0.26	0.26
3	0.27 0.27	0.26 0.27	0.16*
4	0.28	0.24 0.27	0.28
5	– –	0.30	0.28
6	0.26	0.26	– –
$\bar{X}$	0.28	0.27	0.25
2σ	0.04	0.04	0.11

Range (all results) 0.24 – 0.32

Recommended Value 0.27 ± 0.04

4. Cadmium in Bovine Liver SRM

CERTIFICATION BY CONSENSUS

SRM 337 – Basic Open-Hearth Steel

Carbon

ANALYST	METHOD/VARIATION (Note: Combustion step common to all)	% CARBON
1	Gravimetric – 1 g sample	1.08
2	Gravimetric – 3 g sample	1.06
2	Volumetric – 1 g sample	1.06
3	Gravimetric – Factor weight (2.73 g) sample	1.06
3	Gasometric – 1 g sample	1.07
4	Gravimetric – Half-factor weight (1.36 g) sample	1.06
5	Gravimetric – Half-factor weight (1.36 g) sample	1.08
5	Thermal Conductivity 0.7 g sample	1.08
6	Gravimetric – 0.7 g sample	1.07

Mean 1.07

5. Carbon in Steel SRM - Round-Robin

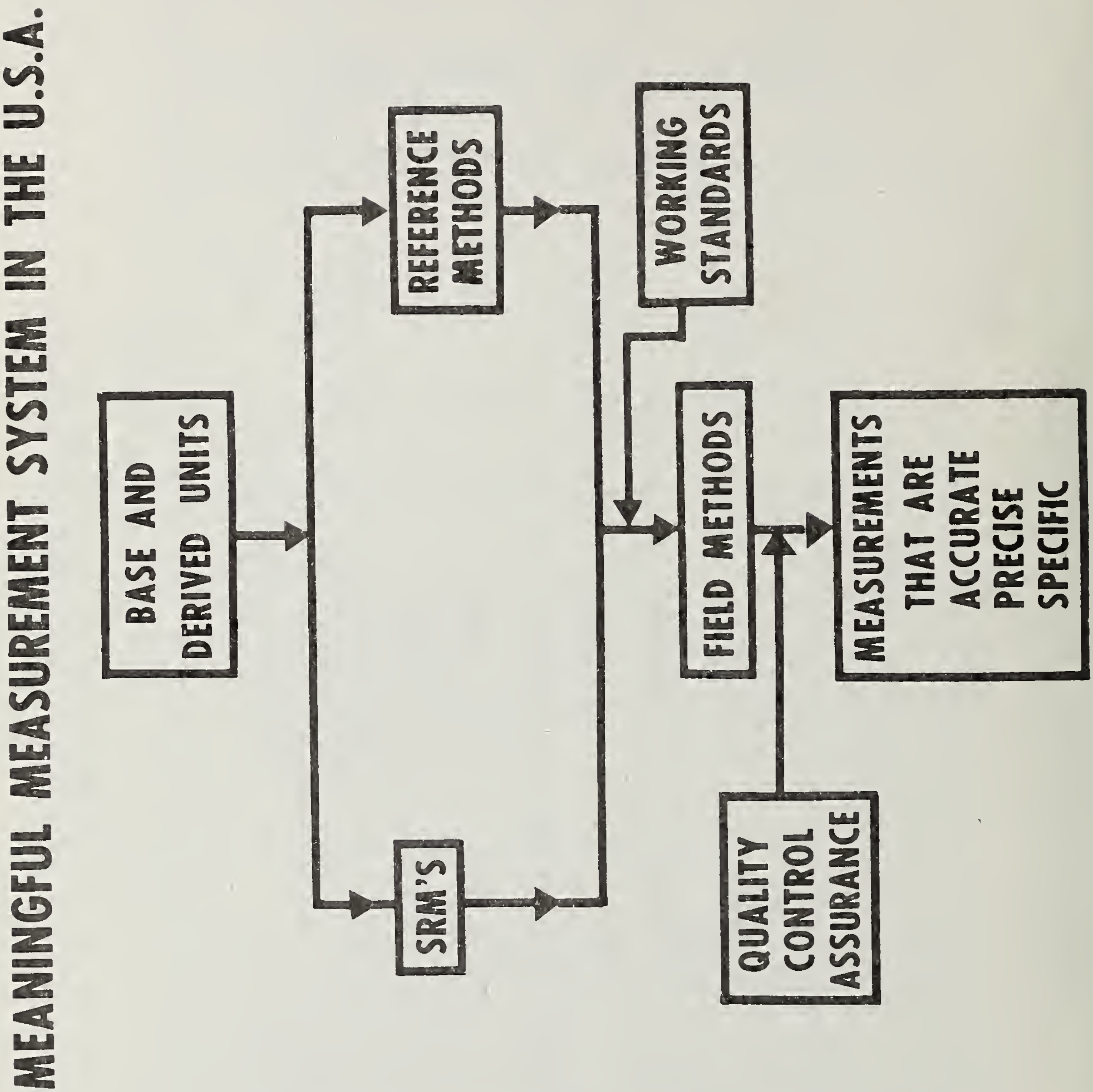
CERTIFICATION BY CONSENSUS

A DANGER

Orchard Leaves

Element Determined	No. of Labs	Mean $\bar{X}$	Range	$S/\bar{X}$ %
P	10	0.20%	0.14 – 0.24	25
Al	10	222 μg/g	99 – 401	36
Fe	11	239 μg/g	151 – 367	28
Mo	5	5.4 μg/g	2.3 – 10.5	59

6. Trace Elements in Orchard Leaves SRM



7. A Meaningful Measurement System Based on SRM's

NBS STANDARDS INFORMATION SERVICES

DESCRIPTION OF DATA, INFORMATION SYSTEM AND SERVICES

William J. Slattery

Keywords: American National Standards Institute; computerized information system; engineering standards; mandatory standards; national standards; plastics standards; standards; standards information service; voluntary standards.

Everyone looks to the National Bureau of Standards for standards information. By virtue of the name of the agency you are instinctively guided to it. To know what information you can derive from Standards Information Services (NBS-SIS) you must first understand what type of Standards NBS-SIS collects.

The collection is multidisciplined but most of the subjects fall within the category of engineering standards. The scope of the collection also encompasses automatic data processing, food, and drug standards. Now, without attempting to define "standards," you must have a clear understanding of what kinds of engineering standards exist. This explanation should further impress the type of standards information available from NBS-SIS. An engineering standard can be written for products, safety, performance, design, processes, installations, analyses, purchasing, materials, fabrication, systems, sizing, marking, classification and as guides of practice. Besides specifications and test methods, engineering standards can also be termed: analyses, assays, reference samples, recommended practices, nomenclature, symbols, grading rules, codes and ratings.

Most of the standards in the collection are voluntary in application. Voluntary standards are developed and promulgated by technical and professional societies and trade associations. (NBS-SIS does not collect company standards.) These voluntary standards represent their respective industries and are often considered national in scope. (Currently there are about 400 such standards-writing organizations.) The reason for this extraordinary number is that the United States does not have a governmental national standardizing body as do most foreign countries. To be converted to a national standard, however, a standard must undergo the rigorous examination and refinement of an American National Standards Committee, and undergo the development procedures of the system of the American National Standards Institute (ANSI), before it becomes an American National Standard.

Now we come to the mandatory standards. Regulations are very often regulatory standards or have standards written into them.

These are regulations which are either written by Federal Government standards or regulatory agencies or are voluntary industry standards, that through an act of Congress become public law, and are adopted as mandates after an adjustment and/or conversion to read as regulations.

Within the framework of the standards just described, and in addition to the industry and national standards, are government standards. NBS-SIS maintains in the system those of 35 States in addition to the Federal Government standards.

The Department of Defense with over 35,000 Military Standards and Specifications, is the largest Government standards-writing group in the U.S. (These standards are mandatory for military purchasing.)

Although NBS-SIS does not maintain a collection of these standards and specifications, the staff identifies appropriate documents, provides availability sources as well as possesses the capability of referring an inquirer to the correct custodial office or to the person or office actually responsible for the development of the standard or specification in reference. In addition, within a couple of hours, the staff can obtain and have in hand a reproduced copy of the requested specification or standard for reference purposes.

. The second largest standards writing Government agency is the General Services Administration, Federal Supply Service, which has over 6,000 documents. NBS-SIS does maintain a collection of these standards and specifications including their interims (but not the Qualified Products Lists). NBS-SIS staff is versed in the GSA Federal Supply Classification code and their system, and is qualified to answer any inquiry and/or direct an inquirer to the actual specifier (specification writer) and office responsible for preparation of the document.

The remaining Federal Government standards are those of Federal agencies. To date we have acquired approximately 3,500 such standards but have not yet attempted to establish a mechanical system for receiving updated material. Until this is accomplished, the documents, although in the system, will not be entered into the data bank nor be published as an index. The Code of Federal Regulations enables the staff to answer most inquiries regarding regulations and regulatory standards of the Government.

To date, the foreign standards in the NBS-SIS collection consist of those issued by foreign national standardizing bodies - there are 58 represented in the collection; and the international standards of the: International Organization for Standardization (ISO), International Electrotechnical Commission (IEC), International Commission on Rules for the Approval of Electrical Equipment (CEE), International Special Committee on Radio Interference (CISPR), and the International Organization of Legal Metrology (OIML).

At this time NBS-SIS is negotiating with ISO in Geneva, to be connected via a Telex terminal, along with the United Kingdom, U.S.S.R., West Germany and France, to collaborate in an international network as a "node" of the system. Through this system, NBS-SIS will have the capability of handling within hours, answers to inquiries based on international standards that cannot be provided by the catalogs and standards in the NBS-SIS collection.

This concludes the standards categories of the collection which are for the: national and industry organizations; Federal and State government agencies; foreign national bodies; and international organizations.

The second most important objective of NBS-SIS, the first being to serve as an information retrieval system and referral service, is to issue publications on standardization. A full description of publications issued and in process is provided in the text of the Proceedings that each of you will receive. To date all of the indexes have been published in Key-Word-In Context (KWIC) form.

When "An Index of U.S. Voluntary Engineering Standards," Special Publication 329 was published, it was the first time in nearly 25 years that industry was able to identify all existing voluntary standards for comparison and adoption purposes. This publication is being used around the world by all concerned professionals.

The Directory of United States Standardization Activities last issued in 1967, and currently being updated, provides information on active standards committees and new projects under consideration. Only through the use of these two NBS documents can standards writers prevent duplication of effort.

In addition, and of interest, is the consideration of a future document which, if published, will be at the request of the National Institute of Governmental Purchasing, Inc. (NIGP), for an index of limited local government unit standards and specifications. This effort will add municipal standards to the data bank.

All NBS-SIS indexes are printed with computer-assistance. The data is key punched on cards, converted to magnetic tape and then printed. Our data is already semiautomated but this continuous collection and input, this massive data system, obviously leads us to automatic data processing. NBS-SIS is on the verge of being totally automated. When the system is completed there could be (1) additional services such as Selective Dissemination of Information (SDI), and journal article abstracting; and (2) additional data input such as the standards of Federal Government agencies, foreign associations, treaty groups, tariff and trade groups, foreign regional bodies, and those of foreign standards committees; drafts of standards and specifications under development; and the Federal Government personnel serving on standards committees and the committees on which they serve. (NBS-SIS is already acquiring this data.)

Of course with a constant growth of input and an expansion of services, comes the possibility of service charges. Today all services are free.

Now that we have examined the type of standards information that can be expected of NBS-SIS, I will explain its services. Just what services can you expect from NBS-SIS?

1. The answer to any standards inquiry
2. Identification of existing standards for products, materials, systems, etc.
3. Complete bibliographic information (including price of documents when available)
4. Referral services - Since NBS-SIS is not a sales agent, inquirers are informed of available sources
5. Short bibliographies; with consent, extensive bibliographies
6. Information on existing certification programs (that which assures that a product, process, convention, or test method, or the physical functional performance characterisitic thereof, complies with a standard)
7. Legislative information on standards

NBS-SIS is a reference collection; the loan policy exception is made when there are two copies in the collection. The entire collection is in original copy; there are no microforms. Although NBS-SIS is semiautomated, the search continues to be manual until we become fully automated. The staff does not interpret or analyze the standards. NBS-SIS maintains a collection of journals and mongraphs on the subject of standardization and related disciplines. Many journals are received from standardization bodies all over the world.

A full description of the NBS-SIS collection and its services cannot substitute your test; so telephone or write for our services. Also, please relay and share awareness of this service with your colleagues keeping in mind that the library is open to tour groups as well as the public. I wish to extend a personal invitation to each of you to visit our library in Rooms B151-B159 of the Technology Building.

In conclusion, I might say NBS-SIS is a unique specialized library, holds the largest standardization collection of engineering, food and drug standards in the world, and serves as the national standards information center.

Handout: "Standards Information Services" a NBS-SIS descriptive brochure of collection and services.

Standards Information Services
Engineering and Product Standards Division
U.S. National Bureau of Standards
Room B163, Technology Building
Washington, D.C. 20234

Library Location: B151-B159 Technology Building

Telephone: (301) 921-2587

Acronym: NBS-SIS

Head of Unit	William J. Slattery, Chief.
Staff	1 management professional; 1 information and library professional; 2 technicians and 1 non-professional support.
Description of Services	The objective of the Standards Information Services Section is to identify the availability and source of standards, and to direct inquirers to the appropriate standards-issuing organizations. Standards Information Services maintains a reference collection of standards, conducts searches by means of computer-produced key-word-in-context (KWIC) indexes; and issues general and special indexes of standards.
Subject	Standardization; codes, engineering, food and drug standards, recommended practices, specifications, and test methods.
Input Sources and Holdings	Standards of: 23,000 U.S. national and industry organizations; 9,300 U.S. Federal and 6,000 State government agencies; 159,000 foreign national standards; and 2,700 international standards; over 100 reference books on standardization and related disciplines; and 100 periodical subscriptions on standardization.
Remarks	When the Information Section was first established in 1965, it was known as

the Standards Communication Center. Later it was known as the Engineering Standards Information Center. In 1966, it was redesignated the Information Section, Office of Engineering Standards Service; and was changed to its present name in 1972. Information and referral services - no charge. Open to the public for reference use only. Hours: 8:30 a.m. to 5:00 p.m. Monday through Friday. Restricted interlibrary loan service.

Publications

Title: NBS Special Publication 329, An Index of U.S. Voluntary Engineering Standards, March 1971; Supplement No. 1, 1972.

Abstract: An index of all existing U.S. industry and national standards, specifications, test methods, and recommended practices. These computer-produced Indexes contain the permuted titles of more than 23,000 voluntary specifications and standards issued by 380 U.S. societies, professional organizations and trade associations. The title of each specification and standard can be found under all the significant key words which it contains. These key words are arranged alphabetically down the center of each page together with their surrounding context. The date of publication or latest revision, the specification or standard number, and an abbreviation for each organization appear as part of each entry. A list of these abbreviations and the names and adresses of the organizations are found at the beginning of each index.

Title: NBS Special Publication 352, World Index of Plastics Standards, 1971.

Abstract: This computer-produced Index contains the permuted titles of more than 9,000 national and international standards on plastics and related materials which were in effect as of December 31, 1970. These standards are published by technical societies, trade associations, Government and military agencies and foriegn national standards bodies. The title of each standard can be found under all the significant key words which it contains. These key words are arranged alphabetically down the center of each page together with their surrounding context. The date of publication or last revision, the standard number, and an acronym designating the standard-issuing organization appear as part of each entry. A list of these acronyms and the names and addresses of the organizations which they represent are found at the beginning of the World Index.

Title: NBS Special Publication 375, An Index of State Specifications and Standards, 1973.

Abstract: This computer-produced Index contains the permuted titles of more than 6,000 State purchasing specifications and standards issued by 37 State Purchasing Offices thru 1971. The title of each specification and standard can be found under all the significant key words which it contains. These key words are arranged alphabetically down the center of each page together with their surrounding context. The date of publication or latest revision, the specification or standard number, and an abbreviation for each State appear as part of each entry. A list of these abbreviations and the names and addresses of the State Purchasing Officials are found at the beginning of the Index.

Title: NBS Technical Note 762, Tabulation of Voluntary Standards and Certification Programs for Consumer Products, 1973.

Abstract: This tabulation is a revised and enlarged version of NBS Technical Note 705, "Tabulation of Voluntary National Standards, Industry Standards, International Recommendations and Certification Programs for Consumer Products," issued December 1971.

Technical Note 705 was a revision of the Draft Tabulation compiled by the American National Standards Institute and issued in April 1970. The categories and products covered in the tabulation were originally based on those listed in the Consumer Product Safety Index (CPSI) of the National Commission on Product Safety, published in July 1970. The products and categories in the current revision are based on those developed for the National Electronic Injury Surveillance System (NEISS) of the Food and Drug Administration. The NEISS listings are an expansion and revision of the CPSI. NEISS product areas were slightly altered to conform to the scope of this tabulation.

The tabulation lists over 700 product areas and over 1,000 standards titles covering products found in and around the home. (The major consumer products areas not included are foods, beverages, and drugs.) The tabulation also indicates the applicable voluntary national, industrial, and international standards which deal primarily with either safety or performance or both aspects of the products listed. For some of the product areas, there are no applicable standards. Available information on certification programs and standards under development, and the Standard Industrial Classification (SIC) numbers for the products are also provided.

Title: NBS Special Publication 390, Index of International Standards (At press; expected issue date: May 1974).

Abstract: This computer-produced Index, based on the Key-Word-In-Context (KWIC) system, contains over 2,700 standards titles of the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), the International Commission on Rules for the Approval of Electrical Equipment (CEE), the International Special Committee on Radio Interference (CISPR), and the International Organization of Legal Metrology (OIML).

The purpose of this Index is to identify existing international standards for a particular product, the characteristics or parts of products, the safety or performance of products, any related materials, vocabularies, symbols, test methods, analyses, and other aspects of standards.

Title: NBS Special Publication (number not yet assigned) Directory of United States Standardization Activities (to be issued in 1974.)

Abstract: This directory serves as a guide to standardization activities in the United States. The activities include technical and trade organizations representing industry and commerce; other professional groups, nontechnical in character; and State and Federal Governments.

Criteria for inclusion was that the organizations have standardization activities as standards-writing groups, contribute toward the development of standards, or disseminate standards or their information. The Directory should be of particular value to manufacturers, market analysts, regulatory bodies, standards writers and others in need of information on standards.

Title: NBS Special Publication (number not yet assigned), Index of Foreign English-Language Standards (in process).

Abstract: Because of universal interest in world trade communications, an Index of English-language standards will serve to assist traders, exporters, manufacturers and all who are interested in foreign standards.

This computer-produced Index will contain the permuted titles of more than 19,000 foreign English-language standards and specifications from eight foreign national standards organizations.

The title of each specification and standard will be found under all the significant key words which it contains. These key words are to be arranged alphabetically down the center of each page (permuted) together with their surrounding context. The latest publication date, the specification or standard number, and an abbreviation for each organization appear as part of each entry. A list of these abbreviations and the names and addresses of these organizations will be found at the beginning of the Index.

All the above issued publications are available from:

The Superintendent of Documents
U.S. Government Printing Office
Washington, D. C. 20402

National Technical Information Service
Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151

VIII. Library of Congress Session

Chairman: Harold Bullis
Library of Congress

The Library of Congress MARC System

Lucia J. Rather
MARC Development Office
Library of Congress
Washington, D.C.

The MARC System consists of a data base containing over 400,000 bibliographic records for books, serials, maps, and films published from 1968 to the present. Weekly and monthly tapes are available on a subscription basis. Searches by subject, classification number, etc. can be made against the tapes to produce a variety of products.

Bibliographic information, data bases, information retrieval, library automation, machine-readable, MARC, standards

The Library of Congress has been a major distributor of bibliographic information in the United States since it began selling catalog cards in 1900. Since that time over 5 million titles have been cataloged and currently some 59 million catalog cards are sold a year.

In 1966, the Library began the MARC Pilot Project, a program to put the information on its catalog cards into machine-readable form. (MARC is an acronym for MAchine-Readable Cataloging). The project was successful and in 1969, the Library began an ongoing system. The current MARC Data Base contains records for books, serials, films, and maps. (Journal articles are not covered). The books data base contains over 400,000 records in English and French covering the period 1968 to the present. Approximately 90,000 new records are added each year. Current plans are to expand coverage to German and the other Roman alphabet languages in 1975. The serials data base was begun in June 1973 and includes over 6000 titles in all languages. Titles are added at the rate of about 10,000 titles a year.

The MARC program is primarily significant in two areas. The first area is that of standards. The structure of the MARC format has been adopted as a national and as an international standard. The format for book materials with some modification is the basis for MARC systems in most of the Western European countries, Australia and Japan. This standardization makes it possible for agencies in the United States to exchange bibliographic data and eventually will make such exchange possible internationally.

The second significant area is in the field of products from the machine-readable data base. The tapes, themselves, are available on a subscription basis to subscribers. The books distribution service provides weekly tapes to some 65 subscribers, each tape containing approximately 1600 records. This service costs $1300 a year-basically covering the costs of duplicating the tapes. The serials tapes appear once a month with each tape containing some 800 records. This service costs $400 a year. Subscribers supply their own programs for processing the tapes to produce many different kinds of products including catalog cards, book catalogs, and microform publications. In some cases a subscriber serves a single library; in others the subscriber serves a network of libraries.

At the Library of Congress, the tapes are used to produce catalog cards via a photocomposition device. At present, all film and map cards are produced in this manner and a significant number of the books cards are printed the same way.

The data base is also used for information retrieval. Access to the records is available through any field in the record. In the area of materials information, the primary access would be by way of the subject headings, the Library of Congress classification number, the Dewey Decimal classification number, or through any pertinent word in the title. Other factors that might be used in the search are date of publication, country of publication, subject geographic area, language, etc. Figure 1 shows a listing of books on engineering materials taken from the MARC data base.

The products from the data base are available in a number of forms, tailored to serve the needs of the user. The records can be arranged by author, title, subject, classification number, etc. They are available on cards or in book catalog form and each record can be printed either in full or abridged form at the specification of the user. Searches may be made against the entire data base or against the most recent month's records. Most of these runs are made for the staff of the Library of Congress. However, runs can be made for outside users on a cost and time available basis.

American Foundrymen's Society. Quality Control Committee.
Control of ductile iron through microexamination. Des Plaines, Ill. [between 1961 and 1965]
1 v. (unpaged) illus. 29 cm.
Cover title.
1. Cast-iron--Testing. 2. Cast-iron--Metallography. I. Title.
TA475 .A38 72-208929

Battelle Memorial Institute, Columbus, Ohio. Columbus Laboratories.
Corrosion potential of NTA in detergent formulations. Washington, [Environmental Protection Agency, Water Quality Office]; for sale by the Supt. of Docs., U.S. Govt. Print. Off., 1971.
x, 94 p. illus. 28 cm. (Water pollution control research series) $1.00
"[Prepared] for the Water Quality Office, Environmental Protection Agency ... [under] contract no. 14-12-913."
"16080 GPF 04/71."
Includes bibliographical references.
Supt. Docs. no: EP 2.10:16080GPF04/71
1. Corrosion and anti-corrosives. 2. Nitrilotriacetic acid. 3. Detergents, Synthetic. I. Title. (Series)
TA462 .B384 75-613915
620.1/1223

Broutman, Lawrence J.
Fracture and fatigue. Edited by Lawrence J. Broutman. New York, Academic Press [1974]
p. cm. (Composite materials, v. 5)
Includes bibliographies.
1. Fibrons composites--Fracture. 2. Fibrons composites--Fatigue. 3. Reinforced plastics--Fatigue. I. Title. (Series)
TA418.9.C6 B68 74-4301
620.1/1
ISBN 0121365050

Byars, Edward Ford, 1925-
Engineering mechanics of deformable bodies [by] Edward F. Byars [and] Robert D. Snyder. 3d ed. New York, Intext Educational Publishers [1975]
p.
Includes bibliographical references.
1. Strength of materials. I. Snyder, Robert D., joint author. II. Title.
TA405 .B92 1975 74-5143
620.1/12
ISBN 0700224602

Chou, Pei Chi, 1924-
Dynamic response of materials to intense impulsive loading. Edited by Pei Chi Chou and Alan K. Hopkins. [Wright Patterson Air Force Base, Ohio, Air Force Materials Laboratory, 1973]
v, 555 p. illus. 24 cm.
Includes bibliographical references.
1. Materials. 2. Strains and stresses. I. Hopkins, Alan K., joint author. II. Title.
TA407 .C6 73-600247
620.1/12

Figure 1. Sample page from a listing on engineering materials taken from the MARC Data Base

The National Referral Center

John F. Price
Science and Technology Division
Library of Congress
Washington, DC 20540

The National Referral Center of the Library of Congress has three basic tasks: to inventory all significant U.S. information resources in science and technology; to provide information regarding these resources to scientists and their organizations; and to compile and publish directories and other listings of scientific and technical information resources. Procedures for carrying out these tasks and evaluating their effectiveness are described, and a brief review is given of resources currently available in the field of materials information and data.

Computerized information system; directories; information resource; National Referral Center; referral; scientific and technical information; Thesaurus.

The National Referral Center, established in 1962, is currently operating as a functional part of the Science and Technology Division in the Library of Congress.

The National Referral Center has three basic tasks:

1. To inventory all significant U.S. information resources in science and technology;

2. To provide any organization or individual working in science and technology, on request, with information regarding these resources;

3. To compile and publish directories and other listings of scientific and technical information resources.

Regarding the first task, NRC defines "information resource" in the broadest possible terms to include any facility, collection, or service maintained on a continuing basis that provides data or material of any kind in any form that may help satisfy the information needs of members of the scientific community -- in short, any organization, group, service, library, center, or even individual from which or from whom authoritative technical information is available.

Regarding the second task, NRC acts as a clearinghouse; it does not provide substantive answers to questions, but instead serves as a kind of technical equivalent of the telephone directory's "Yellow Pages," directing inquirers where to go for reliable, expert information on particular topics.

The third task is actually an extension of the Center's referral services, although, in a sense, it competes with them. Publication and dissemination of directories were originally intended to increase general familiarity with existing services and thereby decrease reliance upon individual requests to the Center. Experience has shown referral requests are stimulated by the publication of directories.

The size of the database now exceeds ten thousand resources, with a transaction rate (additions, deletions, or changes) of several hundred resources per month. Preliminary steps have been taken to place the NRC Register of Information Resources in the AEC RECON System. Such an arrangement would be particularly advantageous since, at present, there is no disc space available in-house to provide on-line access to our files. Once this has been accomplished, hopefully within the next few months, it will permit a considerable improvement in the Center's direct referral service to the public.

In its efforts to bring together those who ask and those who know, the Center handles inquiries covering the widest possible spectrum of science and technology. Its aim is to establish the most direct contact possible between the person seeking the information and the places or people who can provide it.

The Center, which typically receives between 350 and 450 requests a month, has established a goal of answering all referral requests within five working days of their receipt. Some, of course, can be answered in minutes, particularly if the question, or one closely related, has been asked previously.

An important "extra" among the Center's referral capabilities derives from the general knowledge and familiarity that referral specialists have acquired concerning "informal" resources -- organizations or individual that for one reason or another are not formally registered with the Center, and are therefore not part of its database. Included in this category are a number of specialists in various subject areas who may have been reluctant to register for fear of being swamped with inquiries too peripheral or marginal to their subject specialty. This special kind of "invisible college," built up by the Center's referral specialists through a decade of experience, is often resorted to in providing a first-rate referral service. Normally, the referral specialist will call such an expert in advance, explaining to him the nature of the inquirer's problem, and securing his permission to refer the inquirer in that specific instance.

To evaluate the effectiveness of its referral services, the Center conducts a feedback program, using a follow-up letter that asks what results were obtained from the referral points cited and if the answer was satisfactory. The rate of response is about 50 percent; of the respondents, 82 percent rate the Center's effort as successful, 11 percent are equivocal, and 7 percent indicate that the Center failed to be of help.

For the past several years, much of the Center's efforts have been devoted to the conversion of the information resources database to machine-readable form and to the production of revised and updated general directories with the use of the Library of Congress IBM 370-145 computer and the Linotron high-speed photocomposition equipment of the Government Printing Office.

These directories, compiled by the Center and published by the Library of Congress under the general title A Directory of Information Resources in the United States, are available through the Superintendent of Documents. The latest and last of our general directories to be revised is the one on the Federal Government. Advance copies were recently received by LC and should now be available from GPO.

A recent innovation on the part of the National Referral Center is the compilation and issuance of what, for lack of any jazzier name, we called Selected Lists. Since the Center's register files have been put into the computer, we have had the capability of generating special listings of information resources on a selective basis, and in the past several years have had many requests for "quick-and-dirty" services of this kind. These requests often came from the National Science Foundation Office of Science Information Service or from the Congressional Research Service of the Library of Congress, or from one of the federal research and development agencies of the COSATI community. Such inquiries usually took the form of: "Can you give us a quick reading as to what you've got on so-and-so?"

It was not difficult to grind out such lists, but there were always problems of subject indexing, or incompleteness of the record, or duplicate entry that made us reluctant to have these lists shown around without considerable editing effort, which we felt we could ill afford. (I might point out that the Center classifies its files by the COSATI categories and headings, and bases its indexing on the Thesaurus of Engineering and Scientific Terms (TEST) issued by the Department of Defense in 1967 and resulting from Project LEX of the Office of Naval Research.) In time we found that we were putting so much work into these one-shot compilations that we decided to make them publicly available. Quite a number have now been issued, and several are related to the area of materials: hazardous materials; wood products; and polymers, elastomers, and plastics, etc.

Future plans call for a series of mini directories to be published on subjects of current interest. These would be somewhat larger than the selected lists and considerably smaller than the present directories.

Also due for publication in June of this year is a revised edition of the Directory of Federally Supported Information Analysis Centers. This directory is being published in-house by the Library and will be made available to the public through NTIS.

A complete list of NRC publications and selected lists is available along with copies of the NRC brochure. Anyone wishing to visit NRC or desiring additional information may contact me at any time.

IX. Summary Session

Chairman: S. A. Rossmassler
National Bureau of Standards

Increased Demand for Data and Information in the Materials Cycle

E. Horowitz

The natural resources on our planet are limited and the national and international policies and programs that will be required to ensure efficient use of these resources to maintain and indeed improve the quality of life are related to the effective management of the total materials cycle (Figure 1)*. Effective management of the materials cycle requires materials information and data that are accurate, meaningful, timely, and readily available to scientists, engineers, technologists, company presidents, government policy makers, legislators, and the general public. However, as you have heard over the last day or two, and as we all are aware, there are certain problems in the materials information and data system. I would like to focus my attention on these problems because they are intertwined with another set of problems resulting from materials shortages and limited supplies of materials resources. Here, I am referring to the onset of a materials-limited society. In addition, the importance of the role of ecology and the restraints on the materials cycle due to pollution abatement measures is not fully understood. Likewise, shortages of energy curtail the processing of materials and their fabrication and transportation. Today we are faced with increasing dependency on foreign supplies of vital materials which further affects the way in which we deal with the materials cycle.

In dealing with the materials cycle we are dealing with a system that involves materials, environment, and energy (Figure 2). To understand the interactions in this complex matrix, we require an adequate base of materials information and data, and a mechanism for providing the information and data in a timely and efficient manner. The needed data not only are of the scientific and engineering type dealing with properties and performance of materials, thermodynamics, and kinetics, but also of the supply-

*Materials and Man's Needs, Summary Report of the Committee on the Survey of Materials Science and Engineering (COSMAT), National Academy of Sciences, Washington, D.C. 1974.

demand kind for materials and materials resources. Some of the latter data have been used to develop projections for materials consumption. The two curves in Figure 3 indicating projected materials consumption in billions of tons and projected minerals trade deficit in billions of dollars forecasts a problem of major consequence for the United States. Now the available data and information are not entirely adequate to permit us to predict with certainty whether a change in the slope of the projected lines will occur. Will the decision makers and policy makers have adequate information to make the proper choice of a number of possible alternatives, each with its own set of consequences? The curve for the projected minerals trade deficits in billions fo dollars -- that is, dollars flowing out of the United States to purchase minerals and materials that are not indigenous to the United States -- follows the form of the materials consumption curve. Thus, these curves indicate that we are faced with increasing demands for materials and more of our raw materials are expected to be imported from abroad. It is the view of many that we do not have an adequate information and data base to develop plans and policies for dealing with this situation.

At this time, I want to call your attention to three rather significant reports that have been published in the past year. The first I have already alluded to. That is the Report of the National Commission on Materials Policy, and I will have more to say about this report shortly. The second report is the Annual Report of the Secretary of the Interior, which deals with the minerals deficit question and the shortage question. In addition, there is the COSMAT Report, known as the Committee on the Survey of Materials Science and Engineering. Let us go through these reports very briefly. There were many recommendations in the National Commission for Materials Policy Report, but one particular recommendation stated that to achieve coordinated and integrated materials, energy, and environment policy planning and execution, the Federal Government must be prepared to cope effectively with the changing interactions in the total materials cycle. It is a dynamic system and the important parameters of the system are continually undergoing change. Therefore, in order to deal with it effectively one needs up-to-date and reliable information. In one section, the Commission Report deals directly with information and data and I would like to quote from this section. "...Almost every aspect of policy work in this area is handicapped by inadequate, inaccurate, or inaccessible information...." Some strong words are used here followed by a further harsh admonishment. "...Much data that are available is structured in ways that serve past needs...."

In turning to the Interior Report, we find general recommendations which call for an acceleration of technology and transfer of technology (and this, of course, means information and data as well) in areas of exploration, mining, processing, use, recovery, and recycling.

The COSMAT Report dealt essentially with four areas: the importance of the materials cycle concept; research approach, which is largely inter-disciplinary; research priorities, where certain areas of materials research requiring attention are identified (i.e., composites, adhesives, surface science, etc.); and, finally, attention is directed to materials information activities. One of the important parts of this report deals with the concept of the "total materials cycle." In the beginning of the cycle, ores, oil, and wood are respectively mined, drilled, and harvested from the earth and then converted into raw materials which are extracted, refined, and processed into bulk materials ready for use by industry. Industry converts these bulk materials into engineering materials such as textiles, concrete, etc., and finally they are converted into the products that we deal with in our every day life. At this point in the cycle, we become concerned with performance, service, and the use of materials. After they have served their purpose, or often prematurely because of failure or unreliability, we discard the materials and they are disposed of in landfills, incinerated, or recycled. The early part of the materials cycle is largely the concern of the Department of Agriculture, the Department of Interior, and the latter part of the cycle is of prime concern to a number of government departments including the Department of Commerce, AEC, NASA, and DoD.

Under the total materials cycle are a number of very important sub-systems. There is a materials research system, which I do not have time to discuss today. There is also a materials data and information system depicted by the schematic shown in Figure 4 which is comprised of data generation, compilation, evaluation, publication and dissemination. It is at the front end and the back end of the materials data and information system that I want to devote my remaining remarks this morning. One current need is for fuller utilization of available data and information through improvements in the dissemination mechanism; packaging and repackaging, and coupling between producer and user.

At this time I want to go through a number of examples (about a half-dozen in number) to indicate several sets of problems where the materials data and information system can interact with the total materials cycle at critical leverage points. The first example (Figure 5) is a case of under-utilization of corrosion protection information. A study (Report of the Committee on Corrosion and Protection - a survey of corrosion and protection in the United Kingdom) conducted in Britain and published in 1971, reported to the British Ministry of Technology that the technology for corrosion protection is already available, but was not being used adequately. This was a Delphi type experiment, where, in addition to scientists in academia and government, more than 800 companies were included in the study. One of the conclusions stated that there was a need for better dissemination of data and information on corrosion. In fact, a recommendation to the Ministry of Technology called for a budget item which would assure the proper use of existing data on corrosion protection and could lead to a 22% saving in the cost of corrosion in Britain. The estimated annual cost of corrosion in Britain amounts to more than $5 billion. In the United States the cost of corrosion has been estimated between $10 and $15 billion a year and one can see that if this study has any validity, a well-managed corrosion data and information dissemination system could have a major impact in this country.

The second example (Figure 6) is a case of repackaging where, for example, thermodynamic-type data that one finds in NBS Circular 500 (Selected Values of Chemical Thermodynamic Properties) needed to be converted into a form that was useable in the gas fuel industry. The original data we are told was not in a form that was readily useable, and so 54 hydrocarbons were converted to the temperature and pressure ranges common in this industry. The former mass basis for the thermodynamic data was converted to a volumetric basis, and finally a condition known as water saturation in the fuel-energy generation business was dealt with specifically to meet the needs of the industry.

A third example (Figure 7) is a case of adequate coupling and is in the area of electroplated copper. It appears that the electroplaters of this country found that in the area of copper they needed data on the properties of the deposited copper; such data as density, strength, hardness, and so on, and that these data were not available. It was felt that the availability of systematic data of this type would make it possible for designers and producers of items incorporating deposited copper to select and control optimum operating conditions for their plating processes which would lead to wider applications and superior performance requirements. Because the electroplating industry is a relatively small and fragmented industry with little R&D, the American Electroplaters Association sent one of their employees to the National Bureau of Standards as an industrial research associate to survey the literature and find out what sorts of data were available and what data were missing. After several years of work he published his findings in the Platers Journal and because this journal is directly coupled to the electroplating community, his information had a considerable impact on the industry. This is a very good mechanism for affecting rapid transfer of the information and the data. Hire a specialist, put him in direct contact with the potential user, let him generate the needed data, and you can be assured that there will be a good transfer of information.

Another example of coupling between a data center and a customer was the one involving the American Society of Mechanical Engineers and the NBS Thermodynamic Data Center (Figure 8). The incinerator engineers of this Society found that with all the current emphasis on incineration and the reduction in pollutants and effluents, they did not have the required thermodyanamic and combustion data on various components in the trash stream. Therefore, the enthalpies of combustion were calculated and put in a form that was readily useable to these engineers and to the designers of incinerators.

Yesterday I heard a question raised in the audience about when are data obsolete. Here is a case where the data are not only obsolete, but in many cases, inaccurate (Figure 9). The intrinsic viscosity equation for polymers in solution enables one to obtain the molecular weight of a polymer, in this case polyethylene, in particular solvent. If you have good values for K and a in the intrinsic viscosity equation, one can calculate the crucial property of the polymer by simply measuring the viscosity. First, a survey of the literature disclosed that there were very large discrepancies in the values of K and a found in different laboratories where measurements were made at the same temperature, in the same solvent, using polyethylene. As a result, the buyer and seller could not agree if they used values from different workers in the polymer field. This problem then led to a study which related the intrinsic viscosity directly to the molecular weight for polyethylene in a particular solvent under prescribed conditions of measurement. The laboratory-generated data (Figure 10) have been published and the values 0.055 ± 0.0064 for K and 0.684 ± 0.010 for a are widely accepted and resolved the discordant data in the literature. The previous literature values for K ranged from 0.018 - 0.138 while the values for a covered the range 0.58 - 0.78, respectively. This is a case where a very large industry, the plastics industry, producing billions of pounds of polyethylene resin each year, gained improved quality control through improved data for the viscosity test.

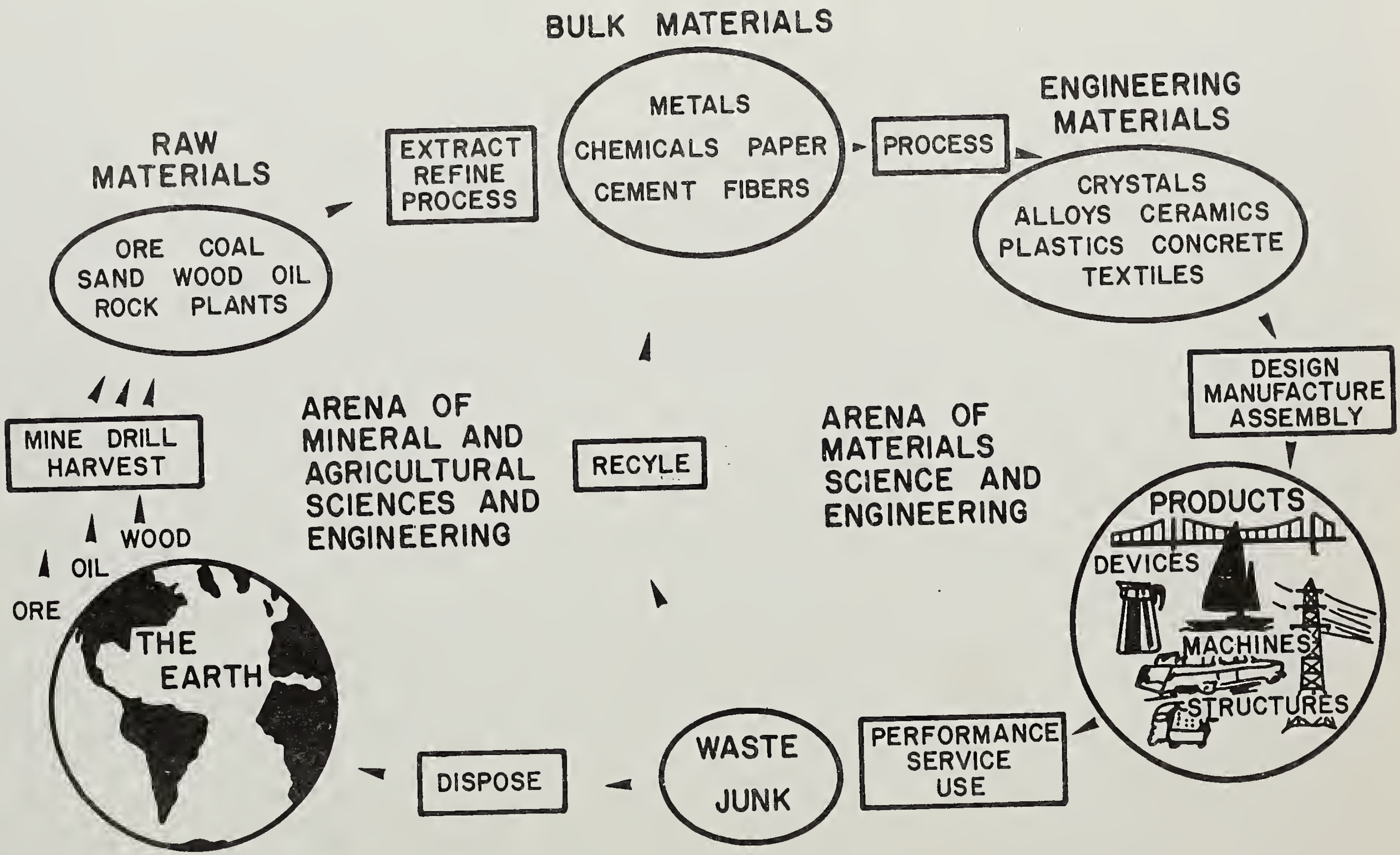
Another example is a case of where data really responded to a materials catastrophe. The Silver Bridge over the Ohio River between Point Pleasant, West Virginia, and Gallipolis, Ohio collapsed suddenly in December, 1967 killing 46 people (Figure 11). The cause of the collapse was traced to the failure of one of the 54-foot eyebars which formed part of the network from which the bridge was suspended. But the real question was "how did the materials fail?" A closeup of the critical 54-foot eyebar (Figure 12) indicates that this eyebar was unique of all of those examined after the bridge collapse because it had both a brittle and a ductile fracture. I want to concentrate on the brittle surface where the crack actually grew. Looking at the left hand corner of that surface one sees something that looks like an oyster shell. That is actually a crack in that eyebar that was measured to be 1/8 of an inch. Both at Battelle Memorial Institute and at NBS, it was calculated that for this particular type of steel at the temperature that prevailed that day and the estimated load on the bridge the piece would fail catastrophically if a crack existed and grew to 1/8 of an inch. That is what happened. It broke in a brittle manner and tore the other segment of the eyebar in a ductile tear but the data were not really available to answer the question as to why that bridge failed. The laboratory data that were obtained on analysis and characterization of the brittle surface provided the necessary information to answer the question. One of the techniques employed was microprobe analysis of the surface which revealed the presence of sulfur-containing compounds that contributed to the corrosion of the metal via a process known as stress corrosion, causing a micro crack to grow to a critical size when failure of the piece occurred. The vital data consisted of the nature of the compounds on the crack surface and their relative concentrations. These data were quickly transferred to the two States, Ohio and West Virginia, and a sister bridge over the Ohio River was torn down on the basis of these data and additional information obtained on the second bridge from nondestructive tests. Here is a case of where, in response to a materials failure, laboratory-generated data led to the answer of how the bridge collapsed and to a decision to remove the second bridge before it failed.

The final example deals with the question of the possible destruction of the ozone layer in the stratosphere through chemical reactions with the effluents coming from supersonic aircraft (Figure 13). The chemical species present in the effluent would be expected to react with ozone (O_3). One school proposes that the ozone layer would be damaged and depleted irreversibly allowing large amounts of harmful ultraviolet to reach the earth. Another school of thought holds that the chemical reaction would involve an equilibrium reaction and that the ozone will be replenished. At this time, no one knows the precise answer to the problem because more than 100 potential chemical reactions have been identified for this chemical system, the available data on these reactions are being evaluated, and the missing data have been identified and are being obtained. As quickly as the data are generated, they are being dispersed to the users or recipients and will be the basis of technical recommendations to policy makers. Whether the SST will fly will depend to some extent on the chemical data available and the outcome of this study.

The efficient use of technical data requires a variety of coupling mechanisms between the producer and user and this subject has been discussed earlier at this symposium. We at NBS have found that working directly with trade associations who are materials-oriented is a very effective way of disseminating data and information. I want to mention again the value of having an association employee in your data centers for a specified period of time to work on a subject of concern to the association. Working with professional societies, as many of you do, is another good mechanism, but perhaps in an even more interactive and aggressive manner. Symposia involving producers and users is a key mechanism for disseminating information. We are now at a meeting largely of managers of data centers and data generators, and hopefully the Interagency Council for Materials Working Group will arrange for some meetings in the near future that will have a larger number of data users. Such meetings will bring us closer to the point that Dr. Frank Huddle talked about yesterday in terms of informing and training the user. In addition, more attention needs to be devoted to specialized publications, and specialized techniques for materials data and information dissemination dealing with the whole range of visual aids, magnetic tapes, hard copy, etc. A better view of the materials data and information system that I have in mind is shown in Figure 14 in which the user is intimately linked into the system, where he has a direct input into the type of data that are generated, and where he also has an open and direct link to the output end of the system.

Finally, we return to the total materials cycle and we see more clearly how materials data and information can be brought to bear very effectively on the problems confronting the materials community and the nation. Some examples have been presented earlier in this discussion. I want to point to one final path in the materials cycle, the recycling path. A National Materials Conservation Symposium, which deals principally with the recycling problem is scheduled for this auditorium in the near future (Figure 15). The driving force for organizing this conference was the need, as stated by the National Center for Resource Recovery, by the industry involved in the recycling business, for more information and data to promote the development of specifications and standards as well as test methods for evaluating the recycled materials. We found that the materials data information base on the properties and performance characteristics of recycled material was largely lacking.

That is my message for today. The next phase of the activity of the Working Group on Materials Data and Information is to carefully examine the links between the data centers and the potential users and to strive to improve the effective utilization of available information, to make a better case for the importance of the materials data and information, and to perfect our ability to forecast the needs in the future.



From COSMAT Study

Figure 1. The Total Materials Cycle

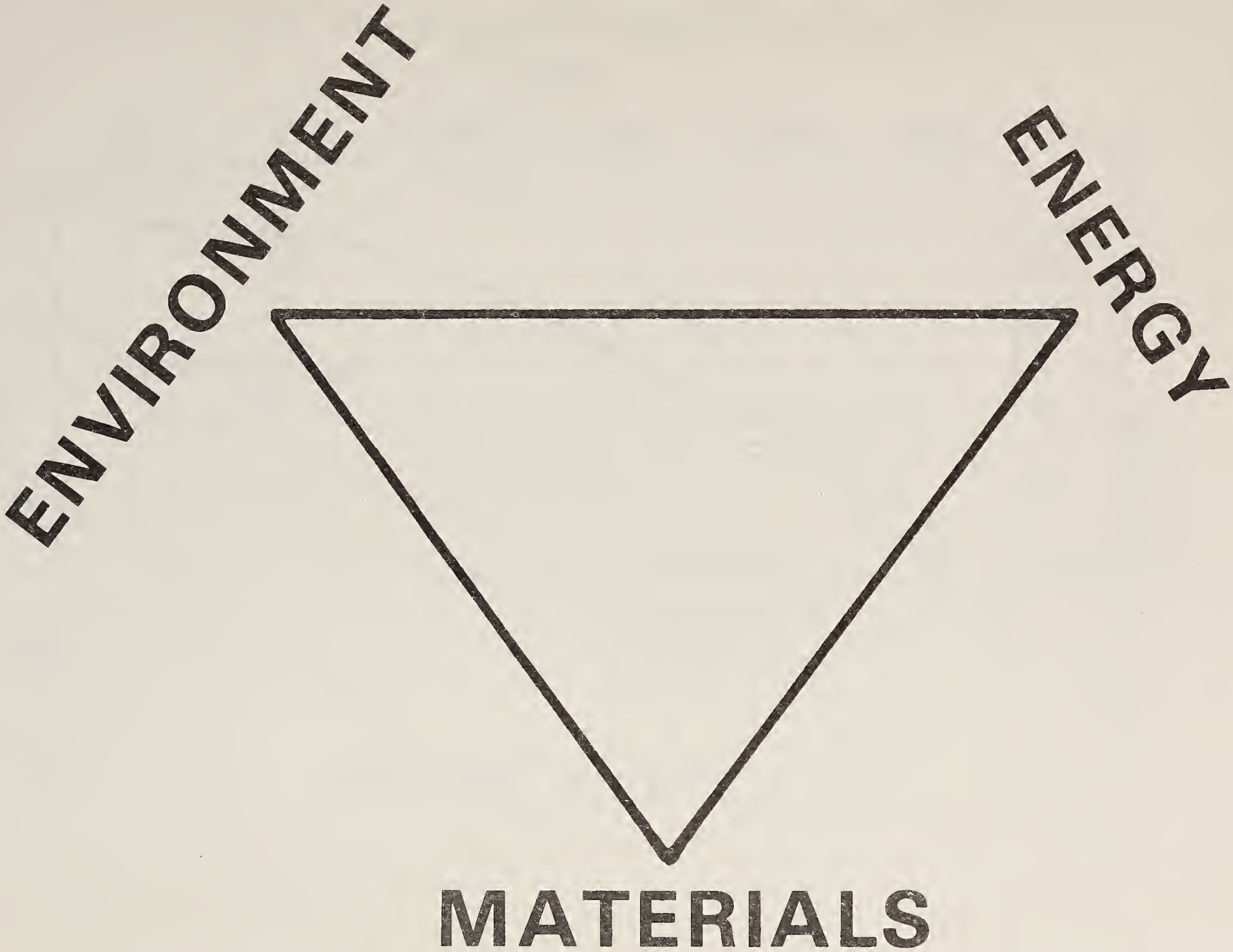


Figure 2. The Materials-Energy-Environment Triad

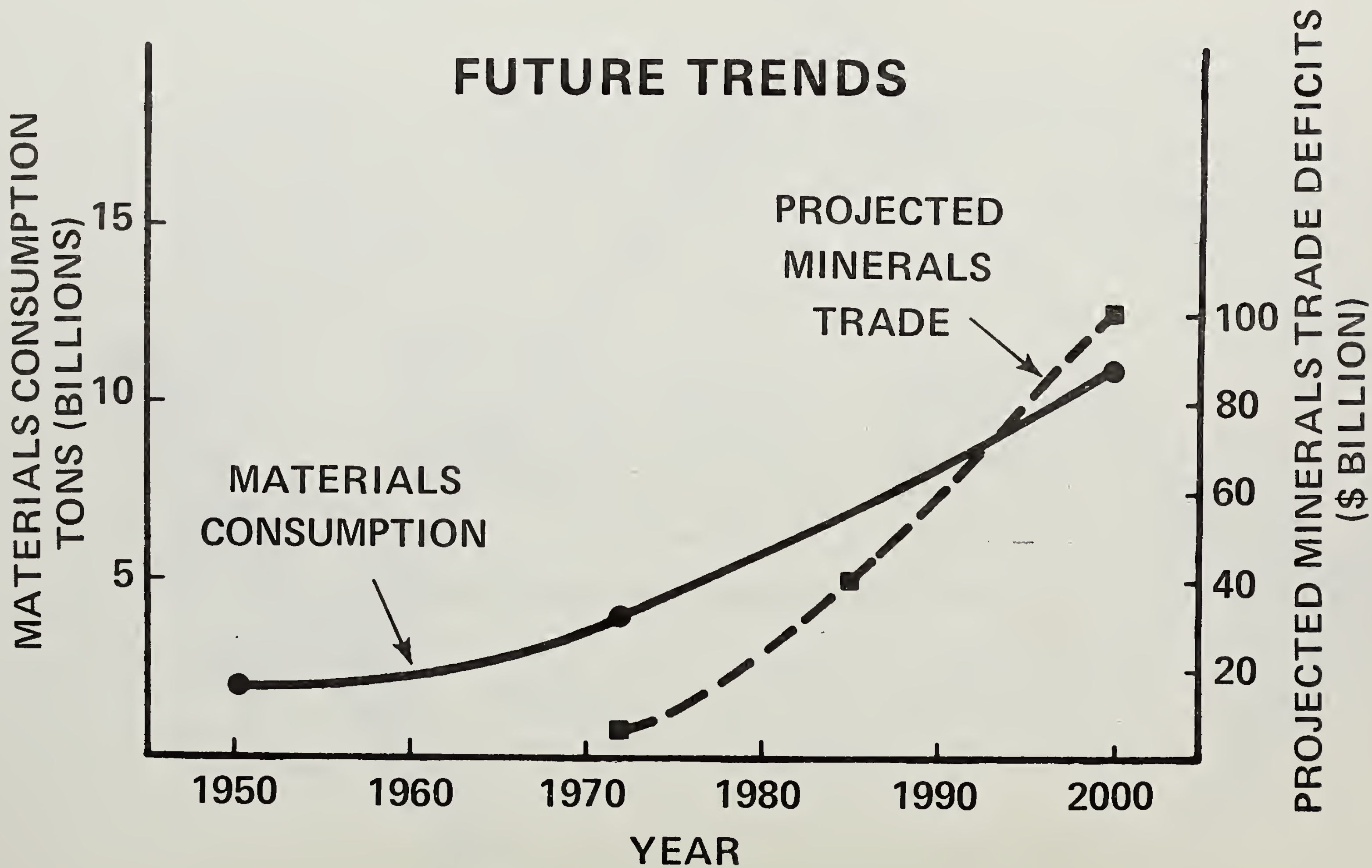


Figure 3. Future Trends for Materials Consumption and Mineral Trade

Figure 4. The Materials Data and Information System

- STUDY FOR BRITISH MINISTRY OF TECHNOLOGY (1971)
  - FINDINGS:
    - TECHNOLOGY AVAILABLE; NOT BEING USED ADEQUATELY
    - NEED FOR BETTER DISSEMINATION OF DATA
    - USE OF EXISTING DATA COULD ACHIEVE 22% SAVINGS

Figure 5. Example of Need for Improved Dissemination of Corrosion Protection Information

- NEEDED: COMBUSTION DATA FOR USE BY GAS FUEL INDUSTRY
  - ORIGINAL DATA NOT IN READILY USEABLE FORM
- SUPPLIED: DATA ON 54 HYDROCARBONS CONVERTED TO:
  - TEMPERATURES AND PRESSURES COMMON TO INDUSTRY
  - VOLUMETRIC RATHER THAN MASS BASIS
  - CONDITIONS OF WATER SATURATION REQUIRED IN INDUSTRY

Figure 6. Example of Repackaging: Fuel Gas Data

- Needed Data:
  - Properties as Dependent on Plating Conditions
  - E.G., Density, Strength, Hardness, Etc.
- Sponsor:
  - American Electroplaters Association (Industrial Research Associate)
- Data Dissemination:
  - Directly to User Through Publication in "Plating", Journal of the Trade

Figure 7. Effective Coupling: Electroplated Copper

- Sponsor
  - American Society of Mechanical Engineers
- Respondent
  - Chemical Thermodynamic Data Center
- Result
  - Selected Values of Pertinent Data on Trash Components of Direct Use to Design and Operations Engineers

Figure 8. Effective Coupling: Thermodynamic Data for Incinerator Design

LITERATURE VALUES OF MARK-HOUWINK PARAMETERS LINEAR POLYETHYLENE IN 1-CHLORONAPHTHALENE

$$(\eta) = KM^a$$

TEMP.	K(ml / g)	a
125°C	1.8×10^{-2}	0.78
125	13.8	0.58
125	4.3	0.67
130	2.7	0.71
135	4.0	0.68

Figure 9. Mark Houwink Equation

VALUES OF MARK-HOUWINK PARAMETERS LINEAR POLYETHYLENE IN 1-CHLORONAPHTHALENE

$$(\eta) = KM^a$$

	K(ml / g)	a
NBS VALUES	.055 ± .0064	.684 ± .010
LITERATURE	.018 - .138	.58 - .78

Figure 10. Laboratory Data on Viscosity of Polyethylene

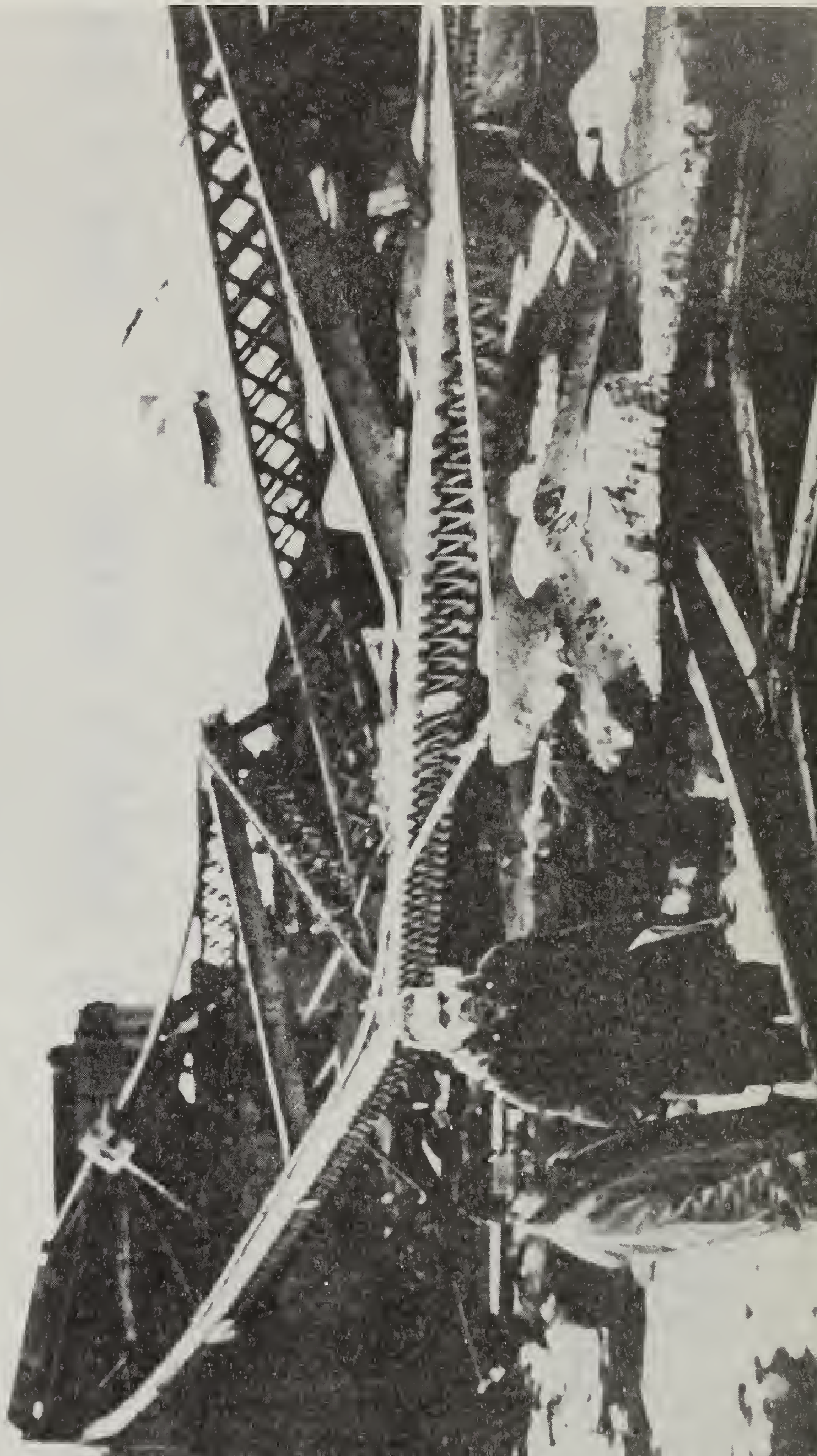


Figure 11. Scene of the Silver Bridge Collapse

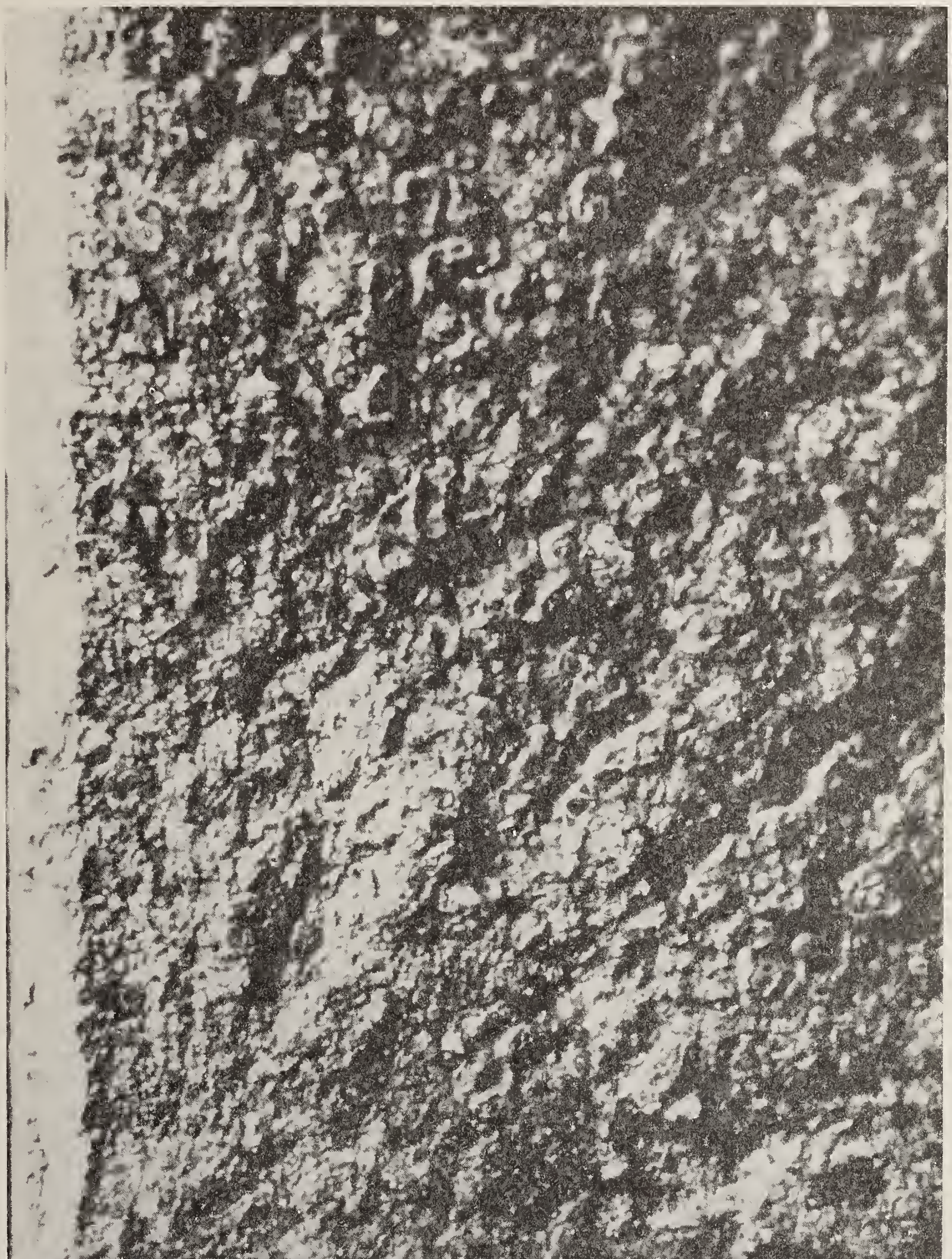


Figure 12. Surface of Bridge Eyebar

NEEDED: RATE DATA ON REACTIONS BETWEEN OZONE AND SST EFFLUENTS (E.G., H_2O, CO_2, NOx)

SPONSOR: CLIMATIC IMPACT ASSESSMENT PROGRAM, DoT

RESPONDENT: CHEMICAL KINETICS DATA CENTER

RESULTS: 130 POTENTIAL REACTIONS IDENTIFIED; AVAILABLE DATA EVALUATED; MISSING DATA BEING DETERMINED; INFORMATION SENT TO 1000 SPECIAL RECIPIENTS

Figure 13. Stratosphere Chemistry

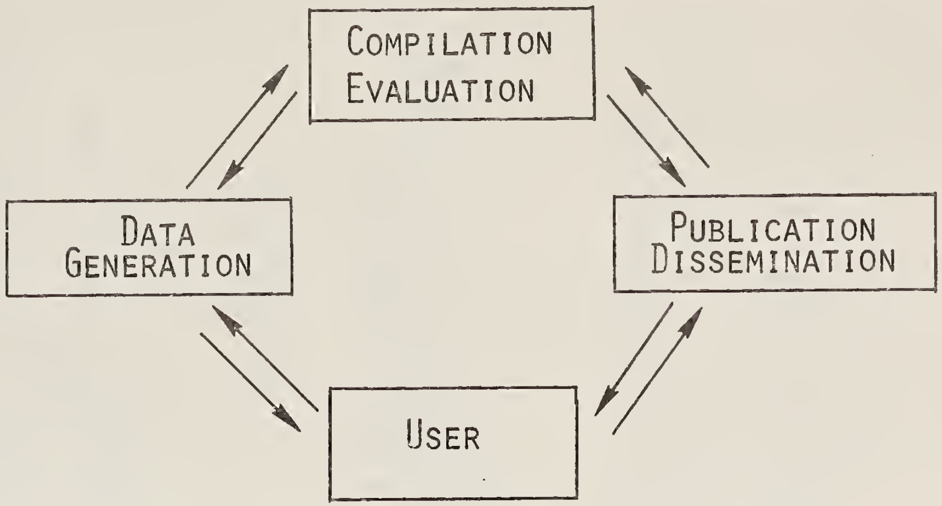


Figure 14. Materials Data and Information System

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I. Resource Recovery and Utilization

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NATIONAL CENTER FOR RESOURCE RECOVERY

AMERICAN SOCIETY FOR TESTING AND MATERIALS

April 29-May 1, 1974

GREEN AUDITORIUM

National Bureau of Standards
Gaithersburg, Maryland

Figure 15. National Materials Conservation Symposium

APPENDIXES

1. Index
2. List of Participants

INDEX

The Index provided below derives from the keywords which authors (or the editor) have used to characterize the content of their papers. Since the depth of keyword assignment varies, some index terms are referenced too seldom. In addition, some slightly different terms may imply distinctions which the reader will consider unnecessary. It is hoped that, in spite of such weaknesses, the index created in this way will prove useful. Numbers following each index term refer to the session (by agency) and the individual paper within that session, as listed in the Table of Contents.

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16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

The Conference on Materials Information Programs was held on April 16 and 17, 1974, at the National Bureau of Standards, Gaithersburg, Maryland. It was planned, with sponsorship by the Interagency Council for Materials (ICM), as an interagency review of Federal agency activities on technical information about materials. The program was organized by the ICM Working Group on Materials Information and Data. The intent of the review was to develop a common awareness, among operators and sponsors of information activities, of opportunities to help each other solve problems and to improve their services to users. Federal agencies which took part in the Conference, and whose materials information programs are covered in this report, include U.S. Department of Agriculture, Energy Research and Development Administration (formerly A.E.C.), Department of Defense, Department of Interior, National Aeronautics and Space Administration, Department of Commerce, and Library of Congress. Dr. Franklin P. Huddle, of the Congressional Research Service, was the Keynote Speaker; Dr. Emanuel Horowitz, of the National Bureau of Standards, gave the Summary address.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*

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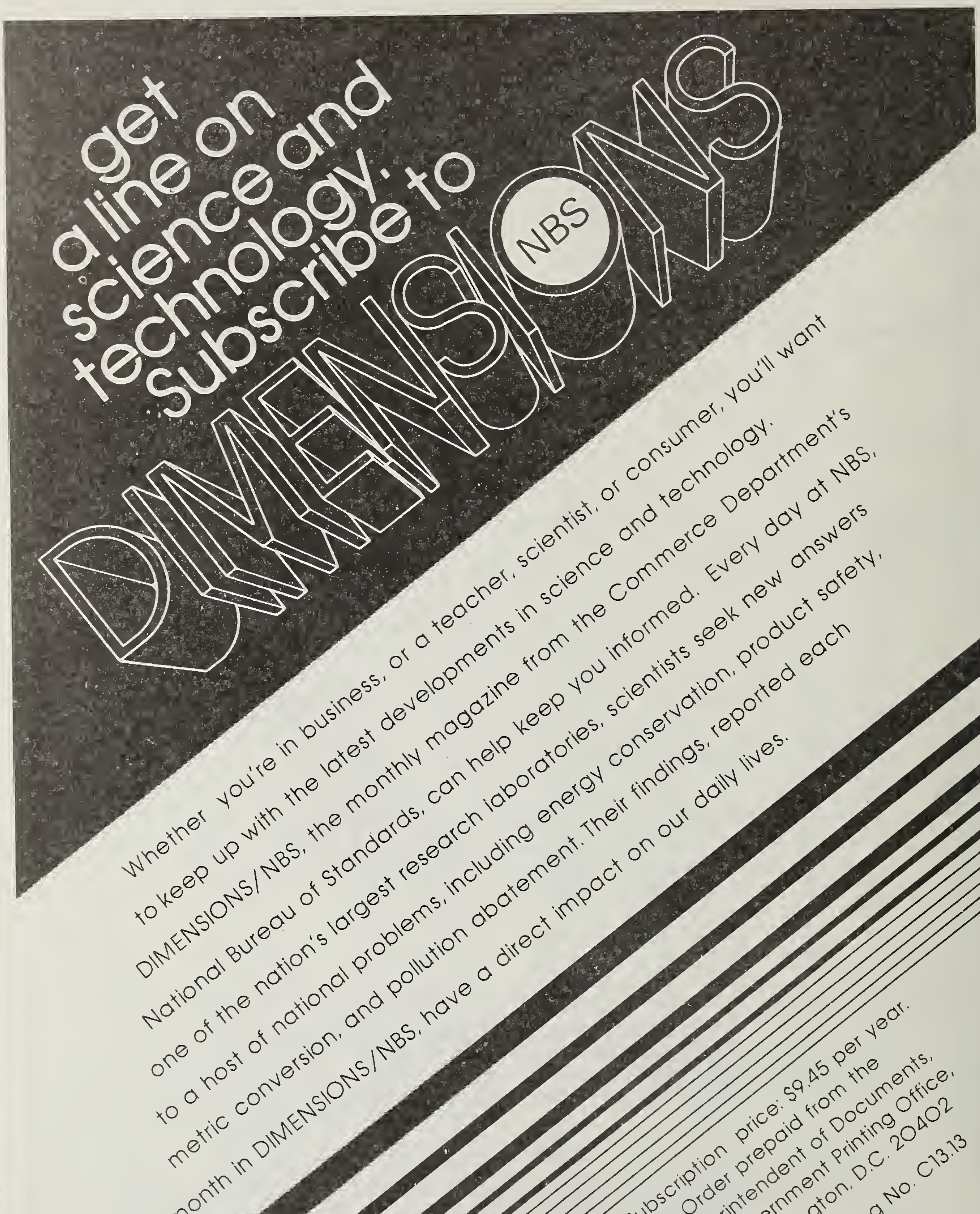
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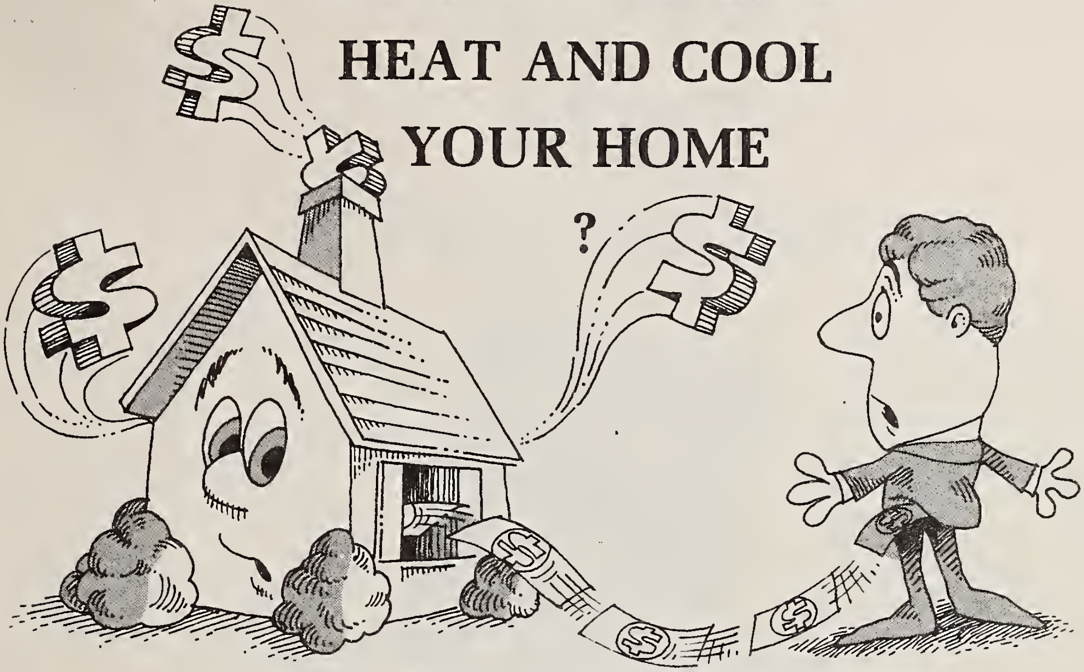

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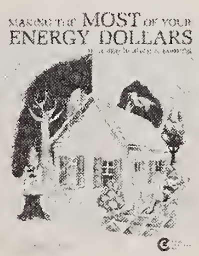

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