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ON-LINE INFORMATION RETRIEVAL SYSTEMS FOR ENERGY STUDIES

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January 1975

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ON-LINE INFORMATION RETRIEVAL SYSTEMS FOR ENERGY STUDIES

INTRODUCTION

As part of a study of energy-related research and development in foreign countries, it was decided to evaluate the new computerized information-retrieval services to determine their ability to provide pertinent information. The purpose of this report is to compile current information about the on-line information systems accessible at LLL, to discuss their search capabilities and the available data bases, and to outline a search strategy most likely to provide the maximum of useful information at reasonable cost.

There are four systems currently operational at LLL, one in-house (Master Control) and three off-site services accessible by remote consoles (AEC/RECON, Lockheed DIALOG, and SDC ORBIT^{*}). Searches in the energy field tend to require the occasional use of many data bases and to be retrospective searches. Since the off-site services are optimized for these types of search, they are most economical and effective for the purpose. The in-house system is very effective in searching, but it is necessary to procure the data bases to be used, and the cost is most difficult to justify when the same data base is available on the off-site services.

The usefulness of these on-line retrieval systems is constrained by the kinds of files available for searching. At the present time, these are mostly bibliographic data bases prepared from the text of current scientific abstract journals. The time lag between initiation of research and the publication of findings is a problem inherent in abstract journals. Other kinds of data bases, such as research-project files and evaluated information compilations, are not currently accessible because of the high cost of preparation, both in money and in time; however, it is probable that these will be of more importance in the future.

Coverage of the bibliographic data bases now available tends to underrepresent foreign literature. A project of the AEC Office of Information Services, the Energy Data Base, is planned specifically to fill this gap and other gaps in the coverage of the present services.

*Reference to a company or product name in this report does not imply approval or recommendation of the product by the University of California or the U. S. Energy Research & Development Administration to the exclusion of others that may be suitable.

SUMMARY

Computerized on-line information retrieval systems are an important new source of information about energy research and development. These research tools permit quick and complete searches of recent technical information. However, they do not completely replace more traditional sources of information, such as abstract journals and reference books, particularly in very specialized areas or for older work.

In the past several years these systems have become widely available. There are two types: systems containing bibliographic citations to material of interest; and data systems, which provide direct access to the information itself.

Data systems are a major step forward in making information truly useful. The best ones have great search power -- not only can one find specific information, but it is possible to make combinations as well. For instance, one materials data system contains physical and chemical properties of organic materials, and it is possible to specify a combination of desired properties and to retrieve all of the materials within a range of the specifications. Unfortunately, the high cost of data collection has retarded development of these systems.

A number of specialized data systems, listed in the Appendix, have been developed at LLL. Unfortunately, none of them is of direct use in energy studies. One data system, operated by the U.S. Geological Survey, does provide information important to energy studies: the system contains information on worldwide fuel and mineral resource bases. It is possible to select information and to perform some analyses of it, including tabular formatting of the data. This system is in-house at the USGS, but access probably could be negotiated if necessary.

Bibliographic systems first became widely available in 1972, although a number of systems were in operation earlier. Both Government agencies and commercial facilities offer these services. The major ones available contain information about the published technical literature, both so-called "open" literature -- books and journals -- and the report literature. Coverage of these systems typically extends from about 1968 up to the present, while average lag from date of publication to appearance in the service varies from two to six months, depending upon the particular data base. Searching techniques are much the same in the systems currently operating: word-matching in such data elements as author, keywords, corporate source, country, and sometimes title is standard. This technique does not analyze the results of the word-matching; this is left to the final user, who selects the most appropriate citations from the machine results. Searching can be for a single word, or for combinations of words using the Boolean operators AND, OR, and NOT.

These systems' reliance on the technical literature carries with it one disadvantage: since the literature reports research already completed, there is a time lag on

the order of one to two years between the time a project begins and the appearance of a report covering it. There is a second kind of bibliographic data base which contains information about research projects -- names of the lead scientists, objectives, source of funding, etc. For the same reason that there are so few numerical data systems, there are only a limited number of project-information systems -- the cost of compilation is high, and, unless it can be justified on other grounds than information retrieval, the compilation will very likely not be done. One such justification is large-scale research management; thus the U.S. Government sponsors two such systems concerned with its research programs. One of these is operated by the Department of Defense (Defense Documentation Center) and the other by the Smithsonian Institution. Neither of these offers any wide coverage of foreign activity.

Currently, a number of bibliographic systems are in operation, each with its own set of data bases. Thus a selection problem arises, both of service and of data base. LLL currently has access to four of these systems, with a fifth to be installed early in 1975. One of these is LLL's in-house system Master Control, which offers unusually high search power; a number of bibliographic data bases are available. If others were desired they would have to be purchased and converted. The RECON system, provided by the AEC, has several data bases of interest; the AEC's plans to offer a major energy-data package on RECON are detailed later in the report. LLL's RECON terminal is installed in the TID Library. LLL also has contracts with two commercial services, Lockheed/Palo Alto's DIALOG and System Development Corporation's (SDC) ORBIT. Each of these offers a different package of data bases of interest on very attractive terms. A terminal compatible with the systems is operational in the TID Library. DoD's system, which provides access to military-sponsored research, including classified information, will be available on-site early in 1975.

If occasional use of many data bases is required, then RECON and the commercial services (DIALOG, ORBIT) are very attractive. Their costs are low for one-time use, and the systems have good search power. If the data base is presently available at LLL, Master Control allows very intensive searches at very competitive computer time costs. However, if the data base is not available on-site, it must be purchased. If the data base desired is already operational on one of the off-site services, such a cost--on the order of \$1500 to \$5000--is difficult to justify. In a case where the data base is not available elsewhere, it is reasonable to purchase it if the need is sufficient. Petroleum Abstracts may be such a case.

Table 1 shows the availability and a brief description of the services recommended for studies of energy research and development. These particular ones were chosen on the basis of greatest relevance to this particular field. For completeness, all data bases available at LLL are listed in the Appendix.

These computerized systems are relatively new; they are effective in searching the

Table 1. Energy-related data bases available for search.

Data base	Source	Coverage	Scope	Availability			
				RECON	DIALOG ^a	ORBIT ^b	Master Control
AEC Energy Data Base	AEC Office of Information Services, Germantown, MD	New project; to cover energy-information needs	International	●			
COMPENDEX	Engineering Index, New York, NY	General engineering. 1970+	International		●	●	●
GEOREF	American Geological Institute, Falls Church, VA	Geology 1967+	International			●	
Nuclear Science Abstracts (NSA)	AEC Technical Information Center, Oak Ridge, TN	Nuclear science, AEC research, recently nonnuclear energy. 1968+	International	●			●
APILIT, APAPAT	American Petroleum Institute, New York, NY	Petroleum refining. 1964+	International			●	
Petroleum Abstracts ^c	University of Tulsa, Tulsa, OK	Petroleum exploration and production. 1965+	International				
INSPEC	Institute of Electrical Engineers (England); U.S. agent: IEEE, New York, NY	Three data bases: Physics Abstracts, Electrical & Electronics Abstracts, and Computer & Control Abstracts. 1969+	International		●		
Chemical Condensates	Chemical Abstracts Service, American Chemical Society, Columbus, OH	Chemistry 1970+	International		●	●	
PANDEX/TRANSDEX	Crowell-Collier-Macmillan, New York, NY	Science and technology, current titles; TRANSDEX covers translations. 1970+	International		●		
Government Research Abstracts (GSA)	National Technical Information Service (NTIS), Springfield, VA	U.S. Government-sponsored research. 1964+	U.S. only		●	●	
DDC	Defense Documentation Center, Department of Defense RDT&E	Military research not in GSA. 1964+	U.S. only				d
INFORM	ABI, Inc., Portland, OR	Business: energy economics. 1971+	International		●	●	

^aLockheed Missiles & Space Co., Palo Alto, CA.

^bSystem Development Corp., Santa Monica, CA.

^cOff-line telephone service.

^dAvailable about April 1975.

information available, and costs are reasonable. The one major factor which restricts their effectiveness is the amount of information available for searching--and that is a major restraint. Generally available coverage today is limited to the text of technical abstract journals, supplemented only by contract information on U.S. Government-sponsored research. The technical abstract journals suffer in timeliness from the inherent lag between initiation of research and final publication of reports or articles describing it; since this lag frequently is greater than one year, the delay is substantial. Production costs have thus far constrained the compilation of more current and more detailed kinds of data bases. As the effectiveness in searching and the moderate costs of computerized information systems become more widely known, it is expected that production of useful data bases will follow.

DATA SYSTEMS

Data systems currently in operation are relatively few, primarily because of the prodigious amount of professional labor required to collect and evaluate the data. The nuclear-cross-section data base at LLL represents numerous man-years of work, for instance. There are several other data systems at LLL containing numerical data, none of which is related to energy studies. There are also off-site systems, of which we know of only one that is related to energy work.

This system, operated by the U.S. Geological Survey, has up-to-date numbers about worldwide resource bases in such things as oil and gas, coal, and mineral resources. The data includes imports and exports, reserves, and amounts consumed for a number of countries. In addition to retrieving the data, the system can perform simple analyses of the data and can be used to prepare statistics and to construct and display charts of selected data. The data included in this system is evaluated by Geological Survey experts.

BIBLIOGRAPHIC SYSTEMS

By far the largest number of currently operational information systems are used to process bibliographic data--i.e., citations to documents likely to have desired information, but not the information itself. Two technical innovations have made this development possible: the advent of computer typesetting in the production of abstract journals, and the development of retrieval operating systems.

Computer typesetting came into use for preparation of abstract journals about 1968. A necessary intermediate in the process is a magnetic-tape version of the copy, which can be used not only to produce the journal but also for computerized retrieval. The publishers of the journals were reasonably quick to recognize this new market, and most have made the tapes available at a reasonable cost, which helps defray their expense of preparation. Prior to this development, only special-purpose data bases could justify

the cost of preparing computer-readable copies, and in practice only Governmental agencies, primarily military and diplomatic, built bibliographic data bases.

Meanwhile, retrieval systems had been designed and were operational, but they needed relatively cheap data bases to come into their own. The newly available abstract-journal copy was reasonably inexpensive, and by 1972 a number of effective operations were available. Several of these can be had through both Government and commercial sources. The Government-sponsored services are inexpensive to those who qualify for using them, and the pricing policy of the commercial services makes them very attractive; a search can be performed at a cost of \$25-50. These low costs make such services a most attractive alternative to in-house systems, especially when the use of a large number of data bases on an intermittent basis is the requirement.

On-line Operating Systems

While there are a relatively large number of information retrieval systems, the ones discussed here are basically alike, though they may vary considerably in operational detail. In computer terminology, they are "on-line, interactive, information retrieval systems." If we look at each of the adjectives in this description, we will begin to have a feeling for what the systems are and do.

"On-line" systems are those in which the user's terminal is connected directly to a computer and is able to process commands and to respond immediately. In the systems we are considering, the terminals are remote from the computer center, and many are connected by telephone lines.

"Interactive" systems are those designed so that the user can formulate his query, submit it to the central processing unit, and receive feedback in such a way that he can modify and resubmit it immediately. The alternative is batch mode, where typically a query is submitted one day and comes back the next. Query modification which can be done on-line in a few minutes can take literally days in batch mode.

"Information retrieval" systems depend upon word-matching in specified data elements, such as authors, index terms, corporate source, and country; one can search these elements singly or in combination. Some of the systems are beginning to provide title-searching. Although some systems could search abstracts, current techniques of data-base preparation and searching make this uneconomical. However, abstracts are often provided in displays of retrieved citations.

A search may request all citations available containing a selected term. Additionally, all the systems discussed here use the Boolean logical operators AND, OR, and NOT to permit combination of terms. A combination of terms may be simple: Term A AND Term B; A OR B; A NOT C. More complicated combinations are also possible: A AND (B OR C) NOT D. For small data bases, such searches can be performed linearly; the computer compares the data elements in each citation to find the match which satisfies the search

formulation. In larger data bases--and some now have more than 800,000 citations--this technique is prohibitively slow.

One technique commonly used to reduce search time is the construction of an "inverted table." This is a list of all unique words in a given file, each associated with all locations at which it occurs. A concordance, for example, of the type compiled to allow location of every word in the Bible, is a form of inverted table designed to allow user lookup. The retrieval system can be programmed to search the computer inverted table; the same techniques are used as for the entire file, but it is necessary to search only the table of unique words and then to match the locations of the desired search terms. Since even for very large data bases the inverted table seldom includes more than 20,000-30,000 unique words to represent, say, 2,000,000 words which may occur in the basic file, the savings in search time clearly can be quite large.

The systems available through Government and commercial channels nationwide reflect a great deal of thought about the way in which the system responds to the user at the console. As a result, the systems are reasonably easy to use; with most of them, it is possible to perform a simple search in half an hour. To get the most out of the systems, however, requires extensive training, for which many scientists and engineers have neither the time nor the inclination. Therefore, it probably is best in practice for the end user to work with a skilled operator who can handle the mechanics of the search.

A typical console arrangement is shown in Fig. 1. There are many variations in hardware, but the basic components are the same: a typewriter-like keyboard, a television-type CRT viewing screen, and an optional on-line printer. Thus it is possible to display search results either on the screen or on the printer. Off-line printing, where substantial numbers of citations are recovered and a listing is desired, is available on all systems. The printout resulting is mailed to the user.

Table 2 shows currently operational information-retrieval systems which have information about energy problems in substantial amounts. Following are some comments about these systems.

AEC/RECON--Today the AEC/RECON system offers Nuclear Science Abstracts, Water Supply Abstracts, and several ORNL in-house data bases, some of them valuable for U.S. energy studies. In the future, this service will become of far greater importance because of the development of the AEC Energy Data Base, which will use RECON. This data base will cover the energy field comprehensively; it is expected to be fully operational in about two years. Meanwhile, material obtained for the final system will be made available piecemeal on the RECON system. Details about the Energy Data Base are presented later in the paper.

AEC/RECON, which operates on ORNL's IBM 760/75 computer, is available to AEC contractors for a fixed yearly charge, currently \$1600/year. This charge allows unlimited use of the system. The user must purchase the terminal hardware and pay charges on a

Fig. 1. Typical console arrangement for an on-line information-retrieval system.

Table 2. On-line information-retrieval systems.

AEC/RECON Oak Ridge National Laboratory, Oak Ridge, Tennessee

- Nuclear Science Abstracts, specialized data bases (U.S. coverage)
- Terminal at LLL (CCI buffer, keyboard and CRT display, TI printer)
- AEC Energy Data Base will be available.

DIALOG Lockheed Information Systems, Palo Alto, California

- Nine energy-related data bases (14 total)
- Searching technique similar to RECON
- Terminal at LLL (LSI ADM console, acoustic coupler, local telephone dialup)
- Cost varies between \$25 and \$55 per contact hour.

SDC ORBIT System Development Corporation, Santa Monica, California

- Six energy-related data bases (11 total)
- Sole source for three important data bases
- Cost varies between \$40 and \$100 per contact hour.
- Terminal at LLL (same equipment as for DIALOG, dialup via Tymshare network)

LLL Master Control LLL Computation Department

- Five energy-related data bases
- Capable of greater search depth than other systems
- Uses LLL in-house computer facilities.

Defense Department RDT&E File

- Contains all military-research reports not in Government Research Abstracts, including classified.
- LLL terminal to be operational spring 1975

telephone line to the nearest network access point. The LLL equipment, installed in 1972 in the TID Library, comprises a CCM 301 Display Controller and a CCM 303 Keyboard and TV Display. There is also a TI Silent Printer. The terminal is connected to ORNL by a Bell Telephone 2400-baud C-2 conditioned line; LLL pays the line charges to Oakland. Front-end equipment recently installed at ORNL makes it possible to use a voice-quality phone line and a less expensive terminal for future installations.

RECON is quite easy to use and has high search power. It is possible to search titles on some of the data bases, where that has been allowed for in preparation of the data base. Of note is the fact that ORNL has developed an excellent teaching package that makes learning the mechanics of the system easy.

Lockheed DIALOG and SDC ORBIT--These commercial services are quite similar in function, though they differ appreciably in operational detail. Both offer a number of data bases, which together cover much of the energy information available in computerized form. Both systems can be accessed with the same computer hardware. LLL has the Lear Siegler LSI Model ADM-1 console with acoustic coupler allowing voice-grade telephone-line dialup access. This equipment cost LLL approximately \$3000 in the spring of 1974. Figure 1 shows the LSI terminal in operation. There are several other consoles commercially available, with approximately the same configuration and capability at much the same cost, which are compatible with both systems.

Once a contract has been established (LLL has contracts with both Lockheed and SDC) one can search their data bases, paying only for actual console time used. This charge, varying between \$20 and \$75 per hour, includes all charges for computer and peripherals plus an appropriate royalty to each data-base supplier. Off-line prints are furnished at a cost of 5¢ or 10¢ each, depending upon the data base. There are a few exceptions, mostly in petroleum-industry-related data bases: one must subscribe to the hard-copy service to be permitted access to the machine file. Since most searches take between 15 and 30 minutes of actual console time, the average cost per search runs between \$10 and \$38. This is moderate when compared with the cost of purchasing and operating a data base, or relative to the high-priced professional man-hours involved in a manual search.

The Lockheed DIALOG system has many similarities to the AEC/RECON system, which would be expected because of their common ancestry; RECON was designed by Lockheed and modified by ORNL. This gives a user experienced with one an advantage operating the other.

System Development Corporation's ORBIT has a somewhat different approach to operating commands, though much the same functions are accomplished. ORBIT is easy to learn and is fully comparable in search power and effectiveness to RECON and DIALOG. SDC offers some data bases not available elsewhere that are especially important in energy information.

Master Control--LLL has a very good information system, Master Control, available in-house.¹ Begun primarily to manage neutron cross-section data, the system was designed with sufficient generality to handle bibliographic and numeric data of most types. Currently it is used by several groups at LLL in addition to the Physical Data Group of T-Division. The TID Library uses Master Control in processing four purchased bibliographic data bases (Nuclear Science Abstracts, AIP's SPIN, Engineering Index, and Chemical Titles) to provide both a current awareness service and specialized searches.² Other groups have used the system to process numerical data: M.C. MacCracken in G-Division uses Master Control to store and supply meteorological data for the Bay Area micrometeorological model, and C.F. Bender in Chemistry uses the system to manage several biological and chemical data collections.

Master Control was designed with somewhat different goals than the information retrieval systems previously discussed (RECON, DIALOG, and ORBIT). The latter are optimized for basic information retrieval from large data bases. Information management systems like Master Control maximize retrieval power and versatility at the expense of large data capacity. As a result of these choices, systems such as RECON can search a relatively limited number of data elements (author, keyword, corporate source) but can search very large data bases in one pass. Master Control, on the other hand, can search each and every data element present in very sophisticated ways but cannot handle as much material in a single pass.

Since Master Control resides in the main LLL computers, it is operated through the OCTOPUS system. This control system was designed for frequent computer users, and a significant amount of training is necessary to use it. An additional problem for infrequent users is Master Control's keyboard interface--the programmed responses for on-line users. Because it works reasonably well in its present form, and because programming manpower has been short, the interface is not as fully developed as those of the national systems.

In order to use Master Control it is necessary to obtain a computer-readable version of the data base desired and to write a conversion interface for it. The conversion itself takes a significant amount of computer time.

Defense Department RDT&E System--This system is due to arrive at LLL sometime early in 1975. Involving as it does access to classified information, the hardware is appreciably more complex than the other systems described here. LLL's equipment has arrived and is being installed. The system interface--the way the user sees the system at the on-line terminal--is basically similar to the other systems, with the usual variations on a

¹V.E. Hampel and J.A. Wade, "Master Control--A Unifying Free-Form Data Storage and Retrieval System for Dissimilar Data Bases," in Proc. Amer. Soc. Info. Sci., 32nd Annual Meeting, San Francisco, 1969 (Greenwood Publishing Co., Westport, Conn., 1969), vol. 6, p. 159.

²S.J. Buginas and N.B. Crow, "The Computerized File Management System--A Tool for the Reference Librarian," Special Libraries 64, 12 (1973).

standard theme. The RDT&E system offers some special features, such as provision for on-line ordering of documents. For details of the system and of current status, TID Library personnel should be consulted.

Bibliographic Data Bases

The characteristics of a number of data bases recommended for energy-related studies are summarized in Table 2. In the paragraphs following, more detail about these selected data bases is given. There are other data bases which contain lesser amounts of useful information. Therefore, a list of all data bases accessible on the systems available at LLL is included in the Appendix to this report.

AEC Energy Data Base--In July 1974, the AEC Office of Information Services, Germantown, began developing a comprehensive energy data base, using the facilities and expertise of Oak Ridge National Laboratory and AEC's Technical Information Center, also located in Oak Ridge. It is intended to obtain all the pertinent commercial and Government services, with the purpose eventually to create a master energy-information file with remote access via the RECON system. It turns out that this will be a fairly slow process, involving more negotiation for data bases and more software development than might be expected. Meanwhile, the data bases will be made available piecemeal on RECON. A second aspect of the energy file is the AEC's effort to obtain material missed by the available services. According to a study conducted for preparation of the proposal covering this system, something like 10% of the material, much of it foreign, is missed by the services. The AEC has begun acquiring, indexing, and inputting as much of this material as it can. This material is being published as Energy Policy Abstracts. The data will also be available on the RECON system. Clearly, this service will be a valuable addition to the presently available ones, and, if development is successful, it may supersede a number of the services now in use.

COMPENDEX--Engineering Index produces this service; it is the copy for the monthly issues of Engineering Index abstract journal. Its scope is worldwide; coverage includes the entire engineering open literature--books, conference proceedings, and journal articles. There is much information about energy here. Searching may be done on the standard data elements; however, it is not easy to search by country. Coverage is from 1970 to date; the lag between publication of the item and appearance is about five months. The citations include abstracts; while it is not possible with operational systems to search them, they can be printed with the citations found in a search. COMPENDEX is available at LLL for use with Master Control; it also is accessible on both the Lockheed and SDC services. Lockheed has 1972 to date, with 200,000 citations; SDC has 1971 to date, with 300,000 citations.

GEOREF--Produced by the American Geological Institute with some support from the U.S. Government, GEOREF is the monthly copy for the Bibliography and Index of Geology. It provides worldwide coverage of the geological literature; emphasis is on the

scientific aspects of that field, but nevertheless many important items in the energy field are covered. Citations do not include abstracts, but do display keywords, which are applied liberally and give a good idea about the topic of the article. Production lag is reasonably short. Some 200,000 citations, 1967 to date, are available through the SDC service.

Nuclear Science Abstracts (NSA)--NSA, produced by the AEC's Technical Information Center at Oak Ridge, has for many years covered primarily the nuclear science field. However, it has always included all AEC-sponsored research, some of it unrelated to the nuclear field. Additionally, in the past two years it has expanded its scope to include nonnuclear energy research. The coverage is worldwide. The usual data elements may be searched, including country of origin but not titles. The citations displayed do not include abstracts, but keywords are plentiful and informative. Lag is 3 to 6 months, depending upon the country of origin--foreign material is later. NSA is available only on the AEC/RECON system. NSA began appearing in the present format in 1968; RECON now has nearly 900,000 citations available for search.

APILIT, APIPAT--These services are offered by the American Petroleum Institute (API), and limit their coverage to the worldwide petroleum-refining literature. APILIT covers the literature, APIPAT the patents, with some 220,000 citations total. These services are provided primarily for the petroleum industry, and policy has been to have users provide substantial support for the service. APILIT and APIPAT are available on the SDC service, but it is necessary to subscribe to the hard-copy journal to gain access to the service. API quoted a price of some \$19,000 per year for both journals to LLL.³ While the petroleum refining literature is valuable in energy studies, much of the coverage in the API services appears elsewhere. At the price quoted, I do not believe it would be justified to try to get the service.

Petroleum Abstracts--This service, operated by the University of Tulsa with oil industry support, emphasizes petroleum exploration and production research, thus complementing the API service. Unlike the API, Tulsa seems willing to share with non-oil people at a reasonable charge. LLL has the hard-copy version and was charged the minimum fee of \$100. This group offers a search service, using a tape version of the data base. For this reason, undoubtedly, they do not make the tape available to the commercial services. However, the tape version is supposed to be available for purchase to be used with in-house services. LLL could probably procure the service and use Master Control to process queries if interest were high enough. Coverage of this data base is from 1965, with approximately 125,000 citations.

INSPEC--This service, offered by the British Institute of Electrical Engineers, comprises three separate data bases: Physics Abstracts, Electrical and Electronics

³J. Verity, Lawrence Livermore Laboratory, private communication.

Abstracts, and Computer and Control Abstracts. These are tape versions of the corresponding abstract journals, and have proven to be very useful search tools for energy R&D, especially Physics Abstracts and EE Abstracts. Coverage runs from 1969 to the present. Physics Abstracts has 400,000 abstracts; EE Abstracts, over 200,000.

Chemical Condensates--This is a machine-readable version of Chemical Abstracts journal. While the main emphasis is on chemistry, the CA people interpret their mandate widely enough to include a great deal of energy literature, particularly in refining and processing of petroleum, as well as some geochemistry. The scope is worldwide. Chemical Condensates gives full indexing and the abstract. Both Lockheed and SDC offer coverage from 1972 to date, and SDC offers 1970-72 coverage separately. This is a very large data base, with 600,000 citations for 1972-74.

PANDEX, TRANSDEX--These services are offered by Crowell-Collier-Macmillan (CCM) of New York City. PANDEX is a quick-coverage service in which only the titles and authors are searchable. The data base can be prepared quickly and mechanically. PANDEX is supposed to have some "title enrichment," where uninformative titles are supplemented by a phrase more descriptive of the content. In practice, this seems to be quite limited. The coverage is worldwide science and technology, with a rather heavy emphasis on biology. The time lag has been fairly long for this type of service, averaging 2 to 3 months. TRANSDEX is a similar service based on the Government's Joint Publication Research Service (JPRS) listing of translations to English. JPRS used to publish a hard-copy version of their list, but this has been discontinued in recent years. The services are available from Lockheed, and coverage is from 1971, with 900,000 titles in PANDEX and 150,000 citations in TRANSDEX.

Government Research Abstracts (GRA)--The National Technical Information Service (NTIS) prepares this data base, which includes all U.S. Government-sponsored unclassified research reports. This scope limits coverage of foreign technology. GRA is a high-quality service, and much easier to use on-line than in the corresponding hard-copy version. These files date back to 1964, much earlier than most others. This data base is available both from Lockheed and SDC, at probably the lowest cost of any data base. Some 400,000 citations are available.

Defense Department RDT&E File--The Defense Documentation Center (DDC) provides the data base for this DoD system. The file contains citations to military research reports characterized as classified or limited-access unclassified material; coverage is from 1969 to date. All unclassified military research reports are released to NTIS and are included in the Government Research Abstracts data base, discussed immediately above. The RDT&E terminal is to be installed at LLL early in 1975 and will permit access to classified material. Although the major thrust of military research is not in the energy area, there is a great deal of applicable material, particularly in hardware development. About 250,000 records, from 1969 to date, are available.

INFORM--Produced by ABI, Inc. (Abstracted Business Information), of Portland, Oregon, this data base undertakes to cover the literature of business, finance, and economics. Although at first glance this would not seem an important area, many good reviews and news stories about energy matters appear in the business press. Coverage is from 1971 and includes some 14,000 abstracts. Both Lockheed and SDC offer the file.

Other Data Bases--The NASA file of aerospace abstracts was begun in 1964. Despite their rather wide scope, they contain little of direct interest to energy studies. The file is available on-line through a Southern California NASA contractor, and, while the Library's computer hardware is supposed to be compatible, a contract would have to be negotiated. Furthermore, direct negotiations between AEC and NASA are underway, and the NASA data base may soon be available on the RECON system.

One of the virtues of the commercial services is that they allow experimentation with data bases not normally considered likely to have much information of value. For instance, it turns out that NAL/CAIN, produced by the National Agricultural Library, has some material of considerable interest. While this would not justify a large expenditure, the low cost and easy access on the commercial systems makes it practicable to use this file for whatever value it has. The Appendix to this paper contains a complete listing of all the data bases accessible through LLL's facilities, so that one can pick possible candidates for exploration.

Additionally, new data bases become available from time to time. It is recommended that TID Library personnel, who keep current with new developments, be consulted to learn of any such new sources.

CONCLUSIONS

Computerized information-retrieval systems are valuable new tools for access to technical information. They have high searching power and are economical to use. The main constraint on their usefulness is the kinds of information available for searching in computer-readable format; obviously, what is not present in the data bases cannot be retrieved. At this time, almost all of the files available are the text of current American and British abstract journals, dating from the middle and late 1960's. Foreign literature is underrepresented in these sources. Improvements in coverage are coming; in the near term, the AEC Energy Data Base is specifically planned to fill some of the gaps identified. This service should be providing significant amounts of material within a year and a half to two years.

Other kinds of data bases, such as contract information files and collections of evaluated data, do not at the present time have wide enough coverage to be very helpful. In the future, it is believed that these kinds of files will be available in greater numbers and will make it possible to exploit the capabilities of the information-retrieval systems more fully.

APPENDIX

DATA BASES ACCESSIBLE AT LLL

Table A1 lists the data bases that are available at LLL through the Master Control system. Following that are reprints of material from Lockheed Missiles & Space Co. and System Development Corp. describing the bases accessible through the DIALOG and ORBIT systems.

Table A1. Data bases available through the Master Control system.^a

Data base	Approx. No. of records	Approx. No. of characters
Nuclear Science Abstracts, 1968 -	375,000	2.7×10^8
Nuclear Science Abstracts, Modified Subject Headings (RESPONSA), 1962-1967	217,000	1.6×10^8
Air Quality Data, California, 1970	171,000	4.1×10^7
Chemical Titles, 1971 -	270,000	1.9×10^8
Engineering Index, July 1971 -	260,000	5.6×10^8
Air Quality Data, Basin-2, Bay Area, 1963-1971	109,000	6.5×10^6
Searchable Physics Information Notices, 1971 -	165,000	4.5×10^8
World-Wide Earthquake Data, 1961-1971	39,000	9×10^6
Nuclear Safety Information, NSIC, 1971	35,000	2.5×10^7
8-Peak Mass Spectroscopic Data	17,000	2.5×10^7
Mass Spectroscopic Data, Low Resolution	8,000	1.2×10^7
Personnel Data Base, LLL, LBL, Site-300, and NTS	10,000	1.9×10^8
Plutonium Bibliography	3,500	2.5×10^7
Nuclear Constants Bibliography	3,400	2.4×10^7
Information Retrieval Bibliography	3,000	2.1×10^7
Physical Properties of Isotopes, Masses, Binding Energies, etc.	2,400	4.8×10^6
Technical Information Department Reference Group, Administrative Data Base	4,000	2.9×10^6
Autistic Children, 165-Parameter Data Base, Institute of Child Behavior Research	2,400	5.8×10^5
Integral Neutron Experiments, Bibliography	2,500	5×10^6
Laser Bibliography	2,000	1.5×10^6
USAEC and LLL Patent Cases	1,000	2.7×10^6
Textual Data Base (~ 8000,000 English words).	31,102	2.5×10^7
Reaction Rate Constants, Atmospheric Kinetic Data	2,000	4.8×10^5
Vacuum Technology Bibliography		
Computer Sciences Bibliography	15,000	1.1×10^7
"Newsline" Monthly LLL Publication Subject Index.	2,000	2.4×10^6
Personal and Administrative Data Bases	10,000	2.2×10^7
Thermophysical Properties, TPRC Bibliography, through 1971.	65,000	3.7×10^7

Table A1. Data bases available through the Master Control system.^a (Continued)

Data base	Approx. No. of records	Approx. No. of characters
Thermophysical Properties, TPRC Material Index, through 1971. .	180,000	4.3×10^7
Solar System, Position Vectors, Outer Planets, 40,000,000 yrs. (Heliocentric Coord.)	20,000	2×10^7
Solar System, Position Vectors, Outer Planets, 40,000,000 yrs. (Barycentric Coord.)	20,000	2×10^7
Computer Performance, LLL Time-Sharing Network	10,000	2.4×10^6
Material Properties, TRUMP, UCRL-50589	2,000	4.8×10^5
Plant Engineering, LLL, Equip. Data Base Maintenance for Work Scheduling	6,000	7.2×10^7
Car-Pool Matching Personnel Data Base	5,500	9.5×10^7
Car-Pool Permit Data Base	800	1.9×10^5
Affirmative Action Data Base	5,500	9.5×10^7
Continuing Education Data Base, UCRL-51040.	5,500	3.8×10^8
Biomedical Department, Bibliographic Data Base, UCRL-50163 . .	13,000	9.6×10^6
Prediction of the Max. Dosage to Man from Nuclear Device Fallout, UCRL-51013. 1-5	5,000	2.4×10^6
Information on Elemental Concentration in Human Organs.	4,800	3.3×10^6
Atomic Masses, Q-Values, and Separation Energies.	2,400	2.9×10^6
Evaluated Gamma-Ray Transitions, G.N. Rao	2,337	1.5×10^6
Experimental Gamma-Ray Transitions, G.N. Rao	13,297	1×10^7
Radioactive Decay Gammas, Atomic and Nuclear Data Tables, 13, Feb. 1974	19,415	1×10^7
Bibliography in Support of Gamma-Ray Transitions, G.N. Rao, et al.	8,500	5×10^6
Physical and Chemical Compatibility of Materials	2,000	1×10^6
Security Department Data Base, Administration of Manuals, etc.	5,500	1.3×10^6
Budget Office, Miscellaneous Reimbursable Accounts	2,000	4.8×10^5
Topography of California	10,000	2.4×10^6
San Francisco Bay Area Atmospheric Pollution Model Data Base, Seven Agencies	100,000	1×10^9
Fire Prevention	2,000	1.5×10^6
Bibliography of Geothermal Phenomena, from New Mexico Institute of Mining and Technology	15,000	1.5×10^7
Abstracts on Health Effects of Environmental Pollutants, HEEP, BA-Previews, 1975 -		
Chemical Abstracts Registry File, Subset of Carcinogenic Substances	1,000	
Quantitative Data Base of Geothermal Data, USGS ^b		

Table A1. Data bases available through the Master Control system.^a (Continued)

Data base	Approx No. of records	Approx. No. of characters
Library Book Catalogue, LLL Technical Information Dept. (28,000 are unique) ^b	35,000	
Library Document Shelf List, Technical Information Dept. (80,000 are unique) ^b	140,000	
INSPEC, Computer and Control Aspects, 1975 - ^b		
Maintenance and Preventive Maintenance Records of Electronic Instruments ^b	30,000	
Total	~2,500,000	~3.0 x 10 ⁹

^aSource: V.E. Hampel, Lawrence Livermore Laboratory, memorandum of January 20, 1975.

^bIn the process of being merged.

A Brief Description
 LOCKHEED MISSILES & SPACE COMPANY'S
DIALOGTM INFORMATION RETRIEVAL SERVICE
 Online, Fingertip Access to Major Data Bases of the World

Keeping pace with today's exploding volume of knowledge has been almost impossible.

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- INSPEC (SCIENCE ABSTRACTS) – Abstracts from the Institution of Electrical Engineers; covers from 1969 to present. INSPEC data bases include:
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- COMPENDEX (ENGINEERING INDEX) (\$55/hr) – Over 200,000 citations and abstracts from 3,500 journals, publications of engineering organizations, and selected government reports and books; published worldwide. File growth is at a rate of 84,000 citations and abstracts per year. Covers 1972 to present.
- PANDEX (\$35/hr) – The Macmillan Information Company's Current Index to Scientific and Technical Literature, including extensive biomedical coverage. Over 900,000 titles and bibliographic citations from some 2,400 journals. Covers 1971 to present.
- TRANSDX (\$35/hr) – Some 150,000 citations to document translations from U.S. Joint Publications Research Service (Macmillan Information Company).
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 - Current Index to Journals (CIJE) – 68,000 abstracts of journal articles in education.
- EXCEPTIONAL CHILDREN ABSTRACTS (\$25/hr) – 12,000 abstracts of material of particular interest in this field. This file is produced by the Council for Exceptional Children; the file dates from 1966 to present.
- ABSTRACTS OF INSTRUCTIONAL AND RESEARCH MATERIALS (AIM/ARM) (\$25/hr) – 7,000 abstracts of instructional and research materials, indexed by the Center for Vocational and Technical Education, Ohio State University; covers 1966 to present.
- PSYCHOLOGICAL ABSTRACTS (\$50/hr) – Over 150,000 abstracts to journal articles in psychology, dates from 1967. Issued by the American Psychological Association.
- ABSTRACTED BUSINESS INFORMATION (ABI/INFORM) (\$45/hr) – Over 14,000 abstracts from business and financial journals in the areas of management, administration, finance, etc. Covers 1971 to present.
- NAL/CAIN (\$25/hr) – The complete Bibliography of Agriculture file from the National Agricultural Library, including the contents of the NAL catalog as well. Over 475,000 citations of agriculture-related material. File growth is at a rate of 140,000 citations per year. File coverage is from 1970 to present and includes the recently added Food and Nutrition file.
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SEARCH SERVICE FILES

Data Base Name	Literature Field	Coverage From	Total No. Citations (to date)	Updates	
				Number of Citations	Frequency
IDC/LIBCON	Library of Congress Cataloging	JAN 1965	800,000 *	7,000	Weekly
POLLUTION	Pollution and Environment	JAN 1970	32,000	1,000	Bimonthly
MATRIX	Communications, Ecology, and Urban Planning	MAY 1973	15,000	1,000	Monthly
SCISEARCH	Life Sciences	APR 1972	460,000	16,000	Monthly
COMPENDEX	Engineering	JAN 1970	330,000	6,000	Monthly
GEO-REF	Geosciences	JAN 1967	227,000	3,000	Monthly
INFORM	Business Management	AUG 1971	18,000	900	Monthly
CHEM7071 CHEMCON	Chemistry Chemistry	JAN 1970 JAN 1972	600,000 850,000	-- 15,000	-- Biweekly
NTIS	Government Res. & Dev.	JAN 1970	250,000	2,300	Biweekly
CATN	Agriculture and related areas	JAN 1970	475,000	12,000	Monthly
ERIC	Education	JAN 1966	180,000	2,500	Monthly
PMA/MEDLINE PMA/MEDCOMP	Medicine Medicine	JAN 1970 JAN 1974	600,000 100,000	-- 20,000	-- Monthly
**APILIT	Petroleum (literature)	JAN 1964	161,000	1,500	Monthly
**APIPAT	Petroleum (patents)	JAN 1964	85,000	670	Monthly

*IDC/LIBCON will eventually become a base file of over 3 million citations, some of which will date back to the 1800's or earlier.

**These data bases have special conditions for access.

USER EQUIPMENT REQUIREMENTS

To access the SDC system, a user needs only to have a computer terminal, a coupler device, and a telephone. A wide range of terminal types and models is compatible with the SDC system, including ASCII-, Correspondence-, and EBCDIC-code terminals, at 10, 15, or 30 characters-per-second. Some of the terminals that are popular among current Search Service users are:

Anderson-Jacobson	Hazeltine	Novar
ASCIISCOPE	IBM 2741	Teletype
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Datapoint	NCR	Texas Instruments
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Users of SDC's On-Line Search Service may dial directly to the 213 area code in Santa Monica, California, or may take advantage of the reliable, inexpensive, long-distance communications provided by the nationwide TYMSHARE communications network. SDC clients dial a special number in their own city, or in the nearest city with a TYMSHARE entry point, to connect their terminals directly to the SDC computer in Santa Monica. Arrangements for use of the network are made by SDC.

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ARIZONA: Phoenix; CALIFORNIA: Cupertino, Inglewood, Los Angeles, Mountain View, Newport Beach, Oakland, Oxnard, Palo Alto, Riverside, Sacramento, San Diego, San Francisco, San Jose; COLORADO: Denver; CONNECTICUT: Darien, Hartford; DISTRICT OF COLUMBIA; FLORIDA: St. Petersburg, Tampa; GEORGIA: Atlanta; ILLINOIS: Chicago, Freeport; LOUISIANA: Baton Rouge, New Orleans; MARYLAND: Baltimore; MASSACHUSETTS: Boston, Cambridge; MICHIGAN: Detroit; MINNESOTA: Minneapolis; MISSOURI: Kansas City, St. Louis; NEW JERSEY: Englewood Cliffs, Union, Wayne; NEW YORK: Buffalo, New York City, Rochester, Syracuse; OHIO: Columbus; OKLAHOMA: Oklahoma City; OREGON: Portland; PENNSYLVANIA: Philadelphia, Pittsburgh; TEXAS: Dallas, Houston, Midland, San Antonio; WASHINGTON: Seattle; WISCONSIN: Milwaukee.

Overseas Cities

BELGIUM: Brussels; FRANCE: Paris

Search Service users are advised immediately when additional TYMSHARE service becomes available in their geographical area.

SEARCH SERVICE RATE SCHEDULE

There are no minimum charges or subscription fees of any kind. The rates for each data base follow:

<u>Data Base</u>	<u>Hourly Rate</u>	<u>Off-line Printing</u>	<u>TYMSHARE Hourly Communications</u>
IDC/LIBCON	\$120.00	\$.25/citation	\$10.00
MATRIX	120.00	.25/citation	10.00
POLLUTION	90.00	.15/citation	10.00
SCISEARCH	90.00	.25/citation	10.00
COMPENDEX	90.00	.20/citation	10.00
PMA/MEDLINE	80.00*	.15/citation	10.00
PMA/MEDCOMP	80.00*	.15/citation	10.00
GEO-REF	60.00	.15/citation	10.00
INFORM	45.00	.10/citation	10.00
CHEM7071	45.00	.08/citation	10.00
CHEMCON	45.00	.08/citation	10.00
NTIS	45.00	.10/citation	10.00
CAIN	30.00	.08/citation	10.00
ERIC	25.00	.08/citation	10.00
APILIT**	35.00	.05/citation	10.00
APIPAT**	35.00	.05/citation	10.00

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If you are interested in seeing a demonstration of the system, or obtaining more information, please call or write to one of our offices:

SDC Search Service
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Santa Monica, California 90406
(213) 393-9411, Ext. 7277/7313

SDC Search Service
5827 Columbia Pike
Falls Church, Virginia 22041
(703) 820-2220, Ext. 442/218

October 1, 1974

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