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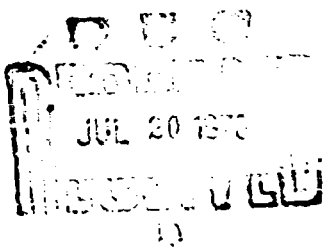
THE ELECTRONIC PROPERTIES INFORMATION CENTER (EPIC)

SHELDON J. WELLES

HUGHES AIRCRAFT COMPANY

TECHNICAL REPORT AFML-TR-70-120

MAY 1970



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AFML-TR-70-120

THE ELECTRONIC PROPERTIES INFORMATION CENTER (EPIC)

SHELDON J. WELLES

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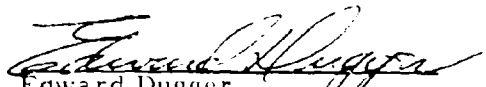
FOREWORD

This report was prepared by Hughes Aircraft Company, Culver City, California under Contract Number F33615-68-C-1225. The contract was conducted under "Materials Information Development, Collection and Processing," Project No. 8975, "Materials Information Analysis Centers," Task No. 897503, "Electronic Properties Information Center." The work was administered under the direction of the Air Force Materials Laboratory, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio, with Messrs B. Emrich and R. F. Klinger, MAAM, Project Engineers.

This report covers the period 1 February 1968 through 28 February 1970. The report was submitted by the author in March 1970 for publication.

The work described is credited to the collective efforts of the entire Electronic Properties Information Center staff.

This technical report has been reviewed and is approved.



Edward Dugger
Chief, Materials Information Branch
Materials Support Division
Air Force Materials Laboratory

ABSTRACT

This final report describes the activities of the Electronic Properties Information Center during the period 1 February 1968 through 28 February 1970. The Center has expanded its scope to include increased coverage of the optical properties of materials, revised and expanded its indexing system to accommodate this expansion, acquired 10,000 carefully reviewed documents, bringing EPIC holdings to 42,000 items, and delivered to the Air Force a complete index to these holdings. Over 15,000 copies of 39 technically competent publications, prepared during this period, were distributed to EPIC users. The use of the Center has increased dramatically during this period, 2861 requests were received by the Center, an increase of 65 percent over a similar 1966-67 period, and over 1000 individual scientists and engineers currently avail themselves of the Center's services on a regular basis, an increase of 73 percent since January 1968. The EPIC publicity and sales programs, aggressively pursued during this period, and the Center's future plans are reviewed in this report.

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SECTION 1
INTRODUCTION

The Electronic Properties Information Center (EPIC) is a designated Information Analysis Center of the Department of Defense authorized to provide information to the entire DoD community. The Center was established in 1961 at Hughes Aircraft Company, Culver City, California. It is operated under contract with the Air Force Materials Laboratory, Wright-Patterson Air Force Base, Ohio.

Within Hughes Aircraft Company, the Center is located in the Research and Development Division of the Aerospace Group. The Center thus is able to draw on significant laboratory research and development capabilities. In addition, since the Center is administered and operated at the section level in the Components and Materials Laboratory, strong support is obtained from Hughes scientists and engineers working in the field of materials development.

The purpose of the Electronic Properties Information Center is to provide a highly competent source of information and data on the electronic, optical and magnetic properties of materials of value to the Department of Defense. Its major function is to evaluate, compile and publish the experimental data from the world's unclassified literature concerned with the properties of materials. All materials relevant to the field of electronics are within the scope of EPIC: insulators, semiconductors, metals, superconductors, ferrites, ferroelectrics, ferromagnetics, electroluminescents, thermionic emitters and optical materials. The Center's scope includes information on over 100 basic properties of materials; information generally regarded as being in the area of devices and/or circuitry is excluded.

The Center provides a technical answering service in which the technical staff responds to inquiries ranging in complexity from simple requests for data point values to requests for comprehensive reviews of the literature. This service is available to U.S. Government agencies,

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their contractors, subcontractors, suppliers, and those in a position to support the defense effort. Inquiries may be directed to:

Electronic Properties Information Center
Hughes Aircraft Company
Bldg. 6: E-148
Centinela & Teale Streets
Culver City, California 90230
Telephone: (213) 391-0711 Ext. 6596
TWX: (213) 871-5210

The EPIC Bulletin, published quarterly, announces new publications and current activities of the Center. Users may request receipt of the Bulletin on a regular basis.

This Annual Report covers work performed by the Electronic Properties Information Center from February 1, 1968 through February 28, 1970.

SECTION II
EPIC PUBLICATIONS

The Electronic Properties Information Center has developed seven publication types whose content and format are as varied as the needs of EPIC users (Table I). The preparation of each requires varying degrees of technical evaluation, each contains varying amounts of information outside the scope of the EPIC document files, that is, information in addition to the basic electronic and optical properties of materials.

The "Data Table" publication type represents a completely new EPIC format. This was developed in 1969 after the brief EPIC Interim Report, Silicon Carbide Data Table and Supplementary Bibliography (IR-62, August 1969), was so well received by participants of the 2nd International Conference on Silicon Carbide (held in May 1968 at Pennsylvania State University), that it was included in the Conference proceedings. In 1969, the Data Table format was applied to the II-VI and IV-VI semiconducting compounds; the most reliable data point values for every property, physical, mechanical, crystallographic, electronic, optical, magnetic and thermal, were presented for each compound. Of particular value to users of the Tables, is the fact that, unlike the usual tabular data presentations found in review articles and textbooks, each data point value is accompanied by a complete bibliographic reference to the primary source of the data.

During this 25-month reporting period, the Center prepared and distributed to its users 38 publications. Table II illustrates that the preparation of these works have more than satisfied the requirements of the EPIC contract. Data collection was started for a Survey Report, Silicon Nitride for Microelectronic Applications using royalty funds derived from the EPIC Sales Program (See Section VI).

As shown in Table III, the content of these works may be described in terms of five major materials technology areas of interest to the Do... Two of the five areas, optical materials and microelectronic materials

Table I. Description of EPIC Publications

Publication Type	Description	Degree of Technical Evaluation Required			Use of Information Outside the EPIC Files		
		High	Medium	Low	High	Medium	Low
Data Sheets	Comprehensive compilations of "best" or most representative data on the properties of one material or a class of materials	X				X	
Survey Reports	Applications oriented, state-of-the-art compilations on the properties of a class of materials	X			X		
Data Tables	Tabular presentations of data point values for a class of materials	X				X	
Glossaries	In-depth definitions of materials properties	X			X		
Bibliographies	Citations, carefully prepared abstracts, and indexes to documents on the properties of materials		X			X	
Interim Reports	Brief compilations of data and bibliographic information, usually prepared in answer to a technical inquiry, when the subject is of general interest to EPIC users		X		X		
Bibliographic Supplements	Supplements to EPIC Data Sheets and Survey Reports listing citations and brief abstracts, and serving as a current awareness mechanism			X			X

Table II. Type and Number of Publications

Publication Type	Number of Publications	
	Contractual Requirement	Actually Released
Data Sheets	1000 (pages)	1128
Survey Reports	2	2
Data Tables	2	2
Glossaries	1	1
Bibliographies	4	4
Interim Reports	10	10
Bibliographic Supplements	0	12

Publication Type	Title	Authors	Date	Pages	EPIC Report No.
Data Sheets	Niobium Tin (Part II)	D. L. Grigsby	July 1968	158	DS-160
	Chemical Composition and Electrical Resistivity of Aluminum Alloys	J. T. Milek S. J. Welles	April 1969	28	DS-161
	Silicon	M. Neuberger S. J. Welles	October 1969	237	DS-162
	Magnesium Oxide	M. Neuberger D. B. Carter	October 1969	99	DS-163
	Lead Telluride – Tin Telluride	M. Neuberger	January 1970	200	DS-164
	Superconducting Thin Films of Group II & III Elements	D. L. Grigsby	February 1970	168	DS-165
	Refractive Index of Optical Materials in the Infrared Region	L. A. Moses	January 1970	238	DS-166
Survey Reports	Epitaxial Silicon and Gallium Arsenide Thin Films on Insulating Ceramic Substrates	J. T. Milek	August 1968	146	S-9
	Linear Electrooptic Modulator Materials	J. T. Milek S. J. Welles	January 1970	260	S-14
Data Tables	IV-VI Semiconducting Compounds	M. Neuberger	October 1969	102	S-11
	II-VI Semiconducting Compounds	M. Neuberger	October 1969	156	S-12
Glossaries	Glossary of Optical Properties	R. L. Akawie J. C. d Haenens S. J. Welles	February 1969	83	S-10
Bibliographies	Niobium-Titanium, Data Table and Supplementary Bibliography	D. L. Grigsby	October 1968	31	DS-148(S1)
	A Bibliography on Select Properties of Aluminum	D. L. Grigsby S. J. Welles	April 1969	54	–
	Silicon	M. Neuberger S. J. Welles	October 1969	28	As part of DS-162
	Bibliography of III-V Semiconducting Films	M. Neuberger	December 1969	42	S-13
Interim Reports	Thick Film Conductor Functional Inks and Pastes for Microelectronics	J. T. Milek	February 1968	27	IR-66
	Thick Film Resistor Functional Inks and Pastes for Microelectronics	J. T. Milek	February 1968	67	IR-61
	Silicon Carbide Data Table and Supplementary Bibliography	M. Neuberger	August 1968	45	IR62 and DS-145(S1)
	Thin Film Dielectrics for Microelectronics	J. T. Milek	July 1968	31	IR-63
	Failure Mechanisms Modes in Microelectronics	J. T. Milek	March 1969	23	IR-64
	Reliability of Hybrid Microelectronic Circuits	J. T. Milek	March 1969	7	IR-65
	Hybrid Thick and Thin Film Microcircuits	J. T. Milek	March 1969	6	IR-66
	Dielectric Constants of Rubbers, Plastics and Ceramics – A Design Guide	R. L. Akawie J. T. Miles	May 1969	17	IR-67
	Antiferroelectricity and Antiferroelectric Materials	J. T. Milek	January 1970	7	IR-68
	Cuprous Sulfide and Cuprous Sulfide-Cadmium Sulfide Heterojunctions	M. Neuberger	January 1970	35	IR-69
Bibliographic Supplements	Germanium	EPIC Staff	June 1968 March 1969 September 1969	200** 100 100	DS-143(S3) (S4) (S5)
	Zinc Oxide		June 1968	100	DS-133(S1)
	Silver Halides		July 1968	150	–
	Gallium Arsenide		September 1968 May 1969 September 1969	350 175 75	DS-144(S1) (S2) (S3)
	Indium Antimonide		July 1969	300	DS-121(S1)
	Niobium		August 1969	250	DS-141(S1)
	Silicon Carbide		August 1969	50	DS-145(S2)
	Epitaxial Silicon and Gallium Arsenide Thin Films on Insulating Ceramic Substrates		September 1969	50	S-9(S1)

*Prepared using royalty funds derived from Sales Program (see Section VI).
**Approximate citations, rather than pages, are given for Bibliographic Supplements.

Table III. Publications Prepared During This Reporting Period

	Authors	Date	Pages	EPIC Report No.	Materials Technology Covered				
					Semi-conductor	Insulator – Ceramic	Metal and Super-conductor	Optical	Micro-electronic
	D. L. Grigsby	July 1968	158	DS-160			X		
Aluminum Alloys	J. T. Milek S. J. Welles	April 1969	28	DS-161			X		
	M. Neuberger S. J. Welles	October 1969	237	DS-162	X				
	M. Neuberger D. B. Carter	October 1969	99	DS-163		X			
	M. Neuberger	January 1970	200	DS-164	X				
	D. L. Grigsby	February 1970	168	DS-165			X		
Region	A. J. Moses	January 1970	238	DS-166	X	X	X	X	
Insulating Ceramic	J. T. Milek	August 1968	146	S-9	X	X			X
	J. T. Milek S. J. Welles	January 1970	260	S-14		X		X	
	M. Neuberger	October 1969	102	S-11	X				
	M. Neuberger	October 1969	156	S-12	X				
	R. J. Akaule I. J. d'Haenens S. J. Welles	February 1969	89	S-10				X	
ography	D. L. Grigsby	October 1968	59	DS-148(S1)			X		
	D. L. Grigsby S. J. Welles	April 1969	59	–			X		
	M. Neuberger S. J. Welles	October 1969	23	Appears as Part of DS-162	X				
	M. Neuberger	December 1969	42	S-13	X				
Microelectronics	J. T. Milek	February 1969	2	IR-e2					X
Microelectronics	J. T. Milek	February 1969	67	IR-e1					X
ography	M. Neuberger	August 1968	45	IRe2 and DS-145(S1)	X	X			
	J. T. Milek	July 1968	31	IR-e3		X			X
	J. T. Milek	March 1969	23	IR-e4					X
	J. T. Milek	March 1969	9	IR-e5					X
	J. T. Milek	March 1969	6	IR-e6					X
nics – A Design	R. J. Akaule J. T. Milek	May 1969	17	IR-e7		X			
s	J. T. Milek	January 1970	7	IR-e8		X			
de Heter junctions	M. Neuberger	January 1970	35	IR-e9	X				
	EPIC Staff	June 1968 March 1969 September 1969	200[S2] 100 100	DS-143(S3) (S4) (S5)	X				
		June 1968	100	DS-133(S1)	X				
		July 1968	150	–	X				
		September 1968 May 1969 September 1969	350 175 75	DS-144(S1) (S2) (S3)	X				
		July 1969	300	DS-121(S1)	X				
		August 1969	250	DS-141(S1)			X		
		August 1969	50	DS-165(S2)	X	X			
Insulating Ceramic		September 1969	50	S-9(S1)	X	X			X

Section VII
raphic Supplements

represent areas of increased scope for the Center during this reporting period. Expansion of the EPIC scope into the optical materials area was specifically called for in the EPIC contract; expansion into the area of microelectronics was a natural consequence of increased user interest in this rapidly evolving technology.

Expanded optical materials coverage by the Center in 1968-69 emphasized the acquisition of documents dealing with infrared transmitting materials, electro- and magneto-optic materials, and solid-state laser materials, including semiconductors and doped glasses and crystals. To accommodate this expansion, the Center increased the number of optical property descriptors used in indexing (see Section IV). The Glossary of Optical Properties (S-10), published in February 1969, carefully defined these new descriptors and, at the same time, defined, in a more comprehensive manner, the optical property descriptors included in the Center's earlier Glossary of Electronic Properties (S-7, January 1965). Two major publications on optical materials, Refractive Index of Optical Materials in the Infrared Region (DS-166, January 1970) and Linear Electrooptic Modulator Materials (S-14, January 1970), further established EPIC as a center of excellence in optical materials technology.

The entrance of EPIC into microelectronics technology began early in the contract period in February 1968 with the publication of two Interim Reports on thick film conductor and resistor functional inks and pastes (IR-60 and 61). These reports, which have proved to be extremely popular, satisfy a definite need in an area where no textbook yet exists by detailing the composition and properties of all available thick film inks and pastes. However, the most significant contribution by the Center to microelectronics technology is represented by Epitaxial Silicon & Gallium Arsenide Thin Films on Insulating Ceramic Substrates (S-9, August 1968). This comprehensive Survey Report presented for the first time a master flow chart identifying each variable of the film/substrate preparation and resultant device fabrication processes. A series of charts clearly identified to what

extent each variable has been investigated for each Si- and GaAs-ceramic substrate combination. This type of data presentation resulted in a true state-of-the-art overview of the technology with gaps in the current knowledge being clearly evident.

Semiconductor materials continued to be of prime interest to EPIC during this contract period. For the first time, the Center prepared major publications on broad classes of semiconducting compounds. In addition to the Data Table publications on the II-VI and IV-VI compounds described above, the highly annotated Bibliography of III-V Semiconducting Films (S-13, December 1969) covered an entire class of important binary compounds, and detailed all available literature on the properties and preparation techniques of these important thin film materials. Since silicon continues to dominate the field of semiconductor device technology, a complete revision of an earlier EPIC publication on this material (DS-137, May 1964) was undertaken. The resultant major work, Silicon (DS-162, October 1969), covered all electronic and optical properties of the material and, for the first time in an EPIC publication, included solubility and diffusion data. An additional major semiconductor publication prepared during this period was Lead Telluride-Tin Telluride (DS-164, January 1970). The interest in this material centers around its potential as a photovoltaic detector. Both Silicon and Lead Telluride-Tin Telluride contain a Data Table reviewing key data point values for the physical, mechanical, electronic, optical and thermal properties of the materials. Of course, additional semiconductor materials continue to be of major importance to the electronics community (e.g., Ge, GaAs, InSb, etc.). The Center, due to time and effort limitations during this contract, was unable to revise earlier EPIC publications on these materials. However, as a current awareness service, several Bibliographic Supplement publications on these and other semiconductor materials were made available to EPIC users.

As indicated in Table III, the Center devoted more effort to ceramics during 1968-69 than to any other class of materials except

semiconductors. EPIC publications in this area emphasized specific electronic and optical applications of ceramic materials. Ceramics used in microelectronics technology as capacitors, substrates and passivating dielectric materials were emphasized in two EPIC Survey Reports, S-9 and S-15, and the Interim Report Thin Film Dielectrics for Microelectronics (IR-63, July 1968). The ceramics, quartz, alumina and the Irtran family of materials, were treated as optical materials in Refractive Index of Optical Materials in the Infrared Region (DS-166, January 1970). A particularly useful publication on ceramic and insulator materials was Dielectric Constants of Rubbers, Plastics and Ceramics — A Design Guide (IR-67, May 1969). The purpose of this work is to enable engineers and designers to readily select a common material with a desired dielectric constant; the range of dielectric constants for over 180 materials is presented in bar graph form, arranged by ascending value of dielectric constant. The Center's coverage of ceramics is best represented by Magnesium Oxide (DS-163, October 1969), a comprehensive review of the electronic and optical properties of this important ceramic material, emphasizing its dielectric properties and energy band structure.

In the area of superconductors, the release of Niobium-Tin (Part II, DS-160, July 1968) and Niobium-Titanium Data Table and Supplementary Bibliography (DS-148(S1), October 1968) completed a series of EPIC publications on superconductor materials presently in use for high field magnet applications. Current interest in superconductivity centers around thin film research in the continued search for higher transition temperatures and for the purpose of studying the basic nature of film properties. The Center responded to this current emphasis in superconducting materials research by preparing Superconducting Thin Films of the Group II & III Elements (DS-165, February 1970).

SECTION III
USE OF EPIC

The use of the Electronic Properties Information Center by the scientific community has increased substantially during this 1968-69 reporting period. Compared with a similar period in 1966-67,[1] the Center has experienced

- A 65 percent increase in the number of requests from the scientific community,
- A 20 percent increase in the number of organizations submitting requests,
- A 73 percent increase in the number of individuals receiving EPIC publications on a regular basis,
- A 50 percent increase in the number of EPIC publications distributed.

These impressive statistics describing increases in requests, users and publications distributed are detailed in the following sections.

---

1. Hughes Aircraft Company. The Electronic Properties Information Center (EPIC). February 1966 through January 1968. By S. J. Welles. Tech. Rept. AFML-TR-68-33. March 1968.

Note: Previous EPIC contracts of 12 or 24 months duration have run from February 1 to January 31. Thus, for example, "1966", for the purpose of this final report, will refer to the period February 1, 1966 to January 31, 1967. However, the current reporting period of 25 months runs from February 1, 1968 to February 28, 1970. For the purpose of comparing this period with previous EPIC contracts, "1968" will refer to the period February 1, 1968 to January 31, 1969, and "1969" will refer to the 13-month period February 1, 1969 to February 28, 1970.

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1. REQUESTS

The Electronic Properties Information Center received 2861 requests from the scientific community during 1968-69, representing a 65 percent increase over the number received during a similar period in 1966-67. As indicated in Table IV, these requests may be divided into three types:

- General Information Requests include all inquiries of a non-technical nature, such as requests for introductory information describing EPIC services and publications and requests for the two EPIC Glossaries defining the electronic and optical property indexing terms used by the Center.
- Publications Requests include requests for EPIC Data Sheets, Survey Reports, Data Tables, Bibliographies, Interim Reports and Bibliographic Supplements.
- Data and Information Analysis Requests include all inquiries requiring data analysis or literature search by a member of the technical staff; answers to these inquiries may appear as specific data, bibliographies, either manually prepared or computer-generated, or general advice and information similar to that provided by a technical consultant.

Table IV. Distribution of Requests by Request Type

Request Type	Requests			
	1966-67		1968-69	
	No.	%	No.	%
General Information	273	16.0	367	12.8
Publications	1026	60.0	1824	63.8
Data and Information Analysis	411	24.0	670	23.4
Totals	1710	100.0	2861	100.0

Replying to Data and Information Analysis Requests is the most valuable service the Center provides. The manner in which the EPIC information retrieval system is fully utilized in responding to these requests is depicted in Figure 8. Table IV shows that the volume of these requests has kept pace with the increase in total requests. The historical summary of all requests received by the Center since its inception, shown in Figure 1, further illustrates the magnitude of these increases.

The majority (69 percent) of the 670 Data and Information Analysis Requests received in 1968-69 each required less than two hours of technical staff effort to answer (Figure 2). This situation is extremely desirable; it indicates that the EPIC retrieval system and the EPIC technical staff are well prepared to meet the electronic and optical property data requirements of the Center's users.

When it is determined that a technical inquiry is of broad interest to users other than the original requestor, the Center often prepares a brief publication (Interim Report) containing pertinent data and bibliographic information in answer to the inquiry. These Interim Report publications were listed in Table III.

2. USERS

The number of individuals making use of the services of the Electronic Properties Information Center has increased dramatically during 1968-69. The most relevant measure of the number of current users of the Center is the size of the distribution list for the EPIC Bulletin, the Center's quarterly newsletter (see Section V - Publicity Program). Since individuals on this list have specifically requested receipt of the Bulletin, the Bulletin distribution represents only those users who have expressed a continued interest in the services and technical publications offered by the Center. Over 1000 engineers and scientists throughout the country now receive the Bulletin on this basis, an increase of 73 percent since January 1968 (Figure 3).

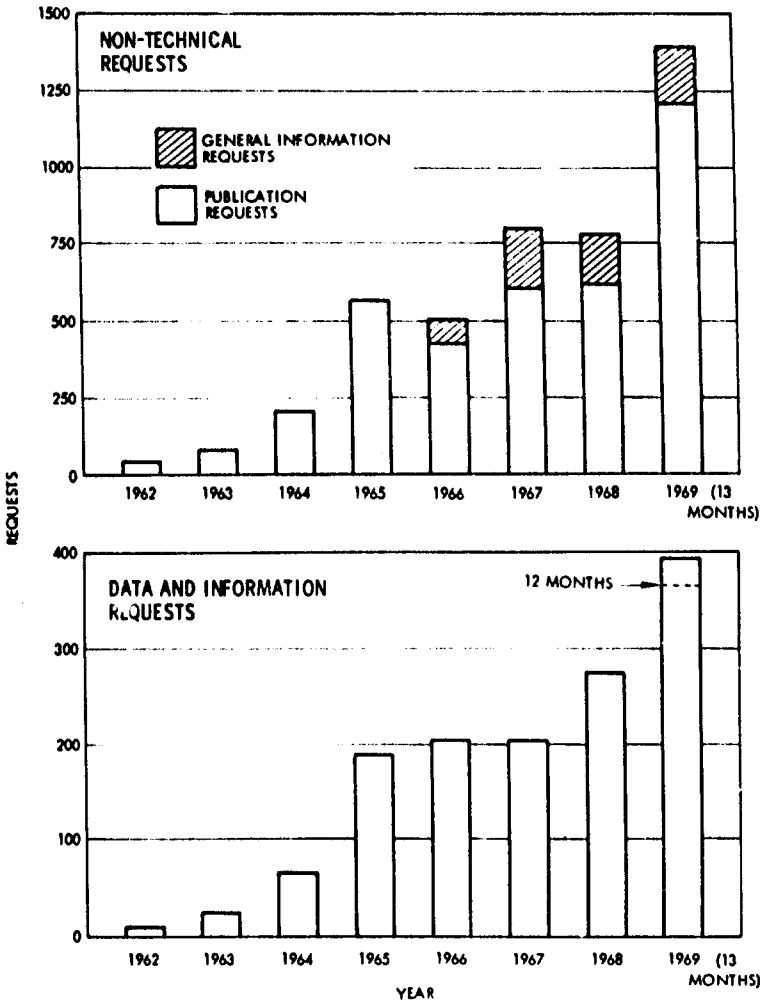


Figure 1. Requests received by EPIC since 1962.

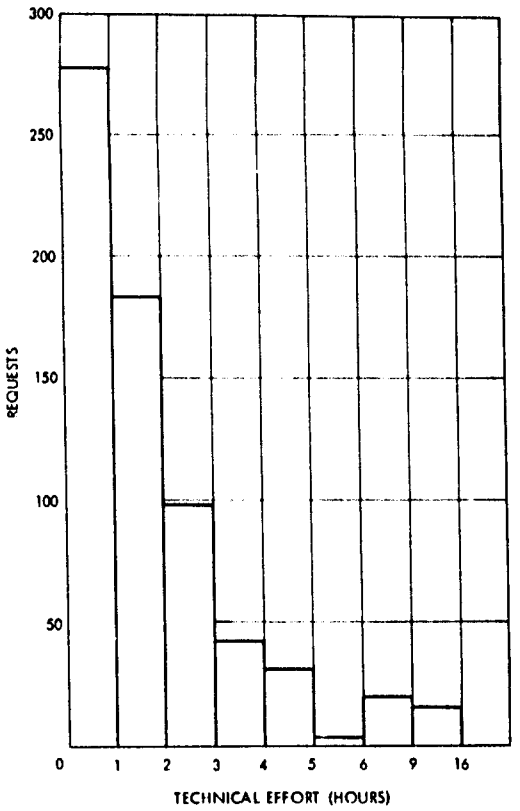


Figure 2. Technical effort distribution of 670 data and information analysis requests.

Table V indicates the distribution by user type of the 2861 requests received by the Center during 1968-69, as compared to the 1966-67 period. Of these 2861 requests, 2424 (or 85 percent) originate from 479 industrial organizations and 91 educational and research institutions. This total of 570 organizations represents a 20 percent increase over the 1966-67 period.

Figure 4 illustrates that 288 of these 570 user organizations (or 50 percent) submitted only one request during 1968-69 and thus accounted for 12 percent of the 2424 requests; 17 organizations (or 3 percent) submitted more than 20 requests and accounted for a total of 871 requests out of 2424 (or 36 percent). These 17 major

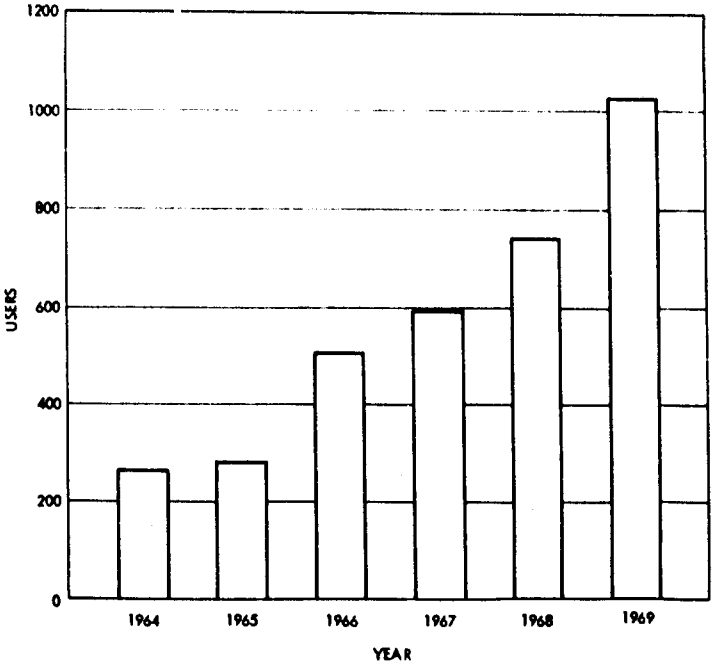


Figure 3. Number of individuals receiving each issue of the EPIC Bulletin.

users of the Center, along with three Government installations also submitting more than 20 requests, are listed in Table VI. All industrial organizations and educational and research institutions submitting three or more requests during 1968-69 are listed in Appendix I.

The geographic distribution of these 2424 requests and of the 570 organizations submitting them is detailed in Table VII and Figure 5. For convenience in compiling these statistics, when an organization had divisions from more than one state submitting requests, the location of the organization was determined by the location of the division submitting the most requests. One state, California, accounted for 36 percent of the requests and for 23 percent of the organizations, while the five highly-industrialized states, California, Massachusetts, New Jersey, New York and Pennsylvania, accounted for 68 percent of the requests and for 58 percent of the organizations.

Table V. Distribution of Requests by User Type

User Type	Requests			
	1966-67		1968-69	
	No.	%	No.	%
Industrial	1146	67.0	2000	69.9
University and Research Institution	244	14.3	424	14.8
Government	256	15.0	342	1.0
Air Force	120	7.0	107	3.8
Navy	28	1.6	58	2.0
Army	41	2.4	55	1.9
NASA	31	1.8	51	1.8
AEC	2	0.1	29	1.0
NBS	18	1.1	20	0.7
Other	16	1.0	22	0.8
Foreign	64	3.7	95	3.3
Totals	1710	100.0	2861	100.0

As shown in Table V, 12 percent of the inquiries submitted to the Center in 1968-69 originated from Government agencies. However, since all industrial and educational organizations submitting inquiries are Government contractors, subcontractors or suppliers, these non-Government requestors must be considered in order to fully evaluate EPIC support of Government agencies. During 1968, the Center collected statistics concerning particular Government agency support involved in requests from these organizations. The percentage distribution by Government agency of these inquiries is shown in

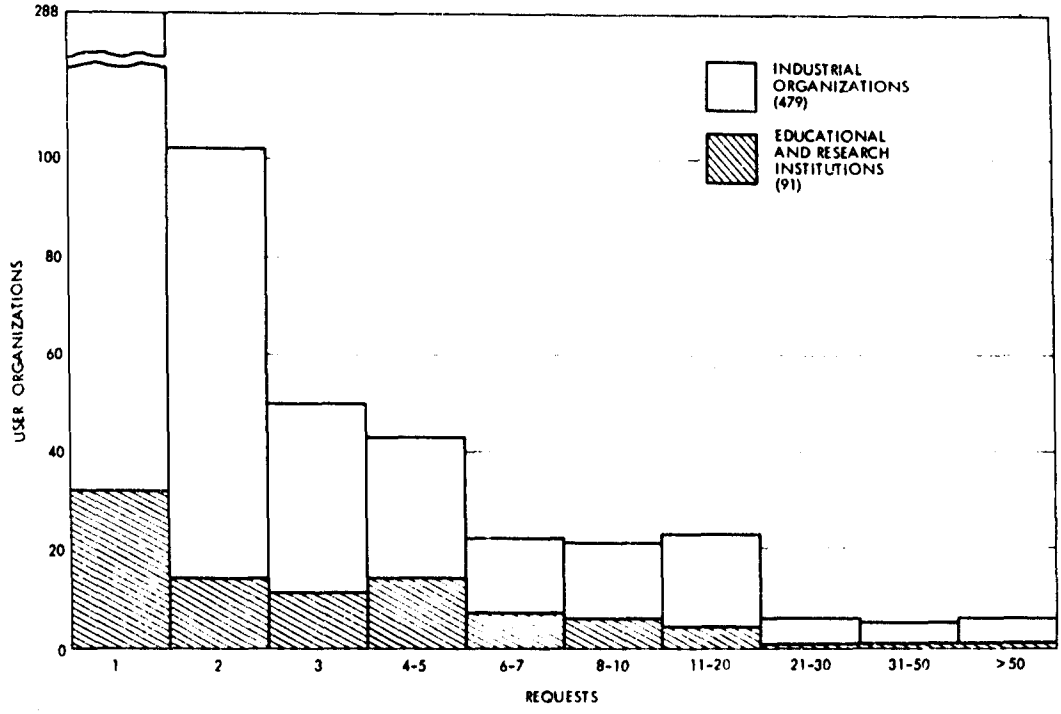


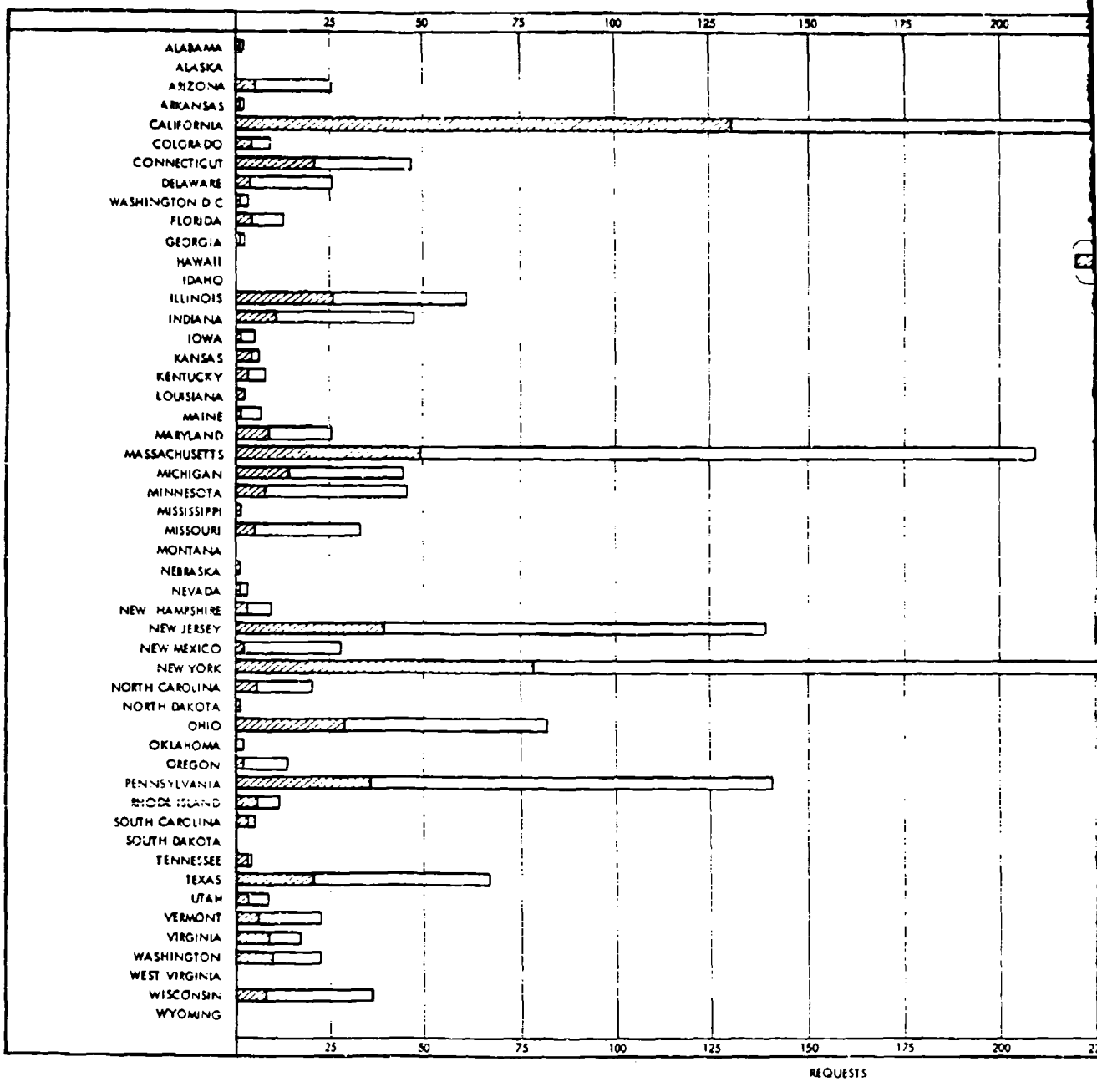
Figure 4. Distribution of 570 organizations by number of requests.

Table VI. Users Submitting More Than 20 Requests

Aerojet-General Corp.
Bell Telephone Laboratories, Inc.
E.I. DuPont de Nemours & Co., Inc.
General Electric Co.
Honeywell, Inc.
Hughes Aircraft Co.
International Business Machines Corp.
Massachusetts Institute of Technology
McDonnell Douglas Corp.
North American Rockwell Corp.
Northrop Corp.
Oak Ridge National Laboratory
Radio Corporation of America
Raytheon
Stanford University
TRW, Inc.
University of California
U.S. Air Force – Wright-Patterson Air Force Base
U.S. Army – Electronic Command, Ft. Monmouth
Westinghouse Electric Corp.

Table VII. Distribution by Geographic Region of Requests and User Organizations

Geographic Region (States)	Requests		Organizations	
	No.	%	No.	%
Pacific (AK, CA, HI, OR, WA)	920	38.0	142	24.9
Middle Atlantic (NJ, NY, PA)	571	23.6	152	26.7
New England (CT, MA, ME, NH, RI, VT)	306	12.6	85	14.9
East North Central (IL, IN, MI, OH, WI)	270	11.1	88	15.5
South Atlantic (DC, DE, FL, GA, MD, NC, SC, VA, WV)	109	4.5	37	6.5
West North Central (IA, KS, MM, MO, NB, ND, SD)	91	3.8	20	3.5
West South Central (AR, LA, OK, TX)	73	3.0	23	4.0
Mountain (AZ, CO, ID, MT, NM, NV, UT, WY)	69	2.8	15	2.6
East South Central (AL, KY, MS, TN)	15	0.6	8	1.4
Totals	2424	100.0	570	100.0


25
50
75
100
125
150
175
200
ALABAMA
ALASKA
ARIZONA
ARKANSAS
CALIFORNIA
COLORADO
CONNECTICUT
DELAWARE
WASHINGTON D C
FLORIDA
GEORGIA
HAWAII
IDAHO
ILLINOIS
INDIANA
IOWA
KANSAS
KENTUCKY
LOUISIANA
MAINE
MARYLAND
MASSACHUSETTS
MICHIGAN
MINNESOTA
MISSISSIPPI
MISSOURI
MONTANA
NEBRASKA
NEVADA
NEW HAMPSHIRE
NEW JERSEY
NEW MEXICO
NEW YORK
NORTH CAROLINA
NORTH DAKOTA
OHIO
OKLAHOMA
OREGON
PENNSYLVANIA
RHODE ISLAND
SOUTH CAROLINA
SOUTH DAKOTA
TENNESSEE
TEXAS
UTAH
VERMONT
VIRGINIA
WASHINGTON
WEST VIRGINIA
WISCONSIN
WYOMING
25
50
75
100
125
150
175
200
REQUESTS

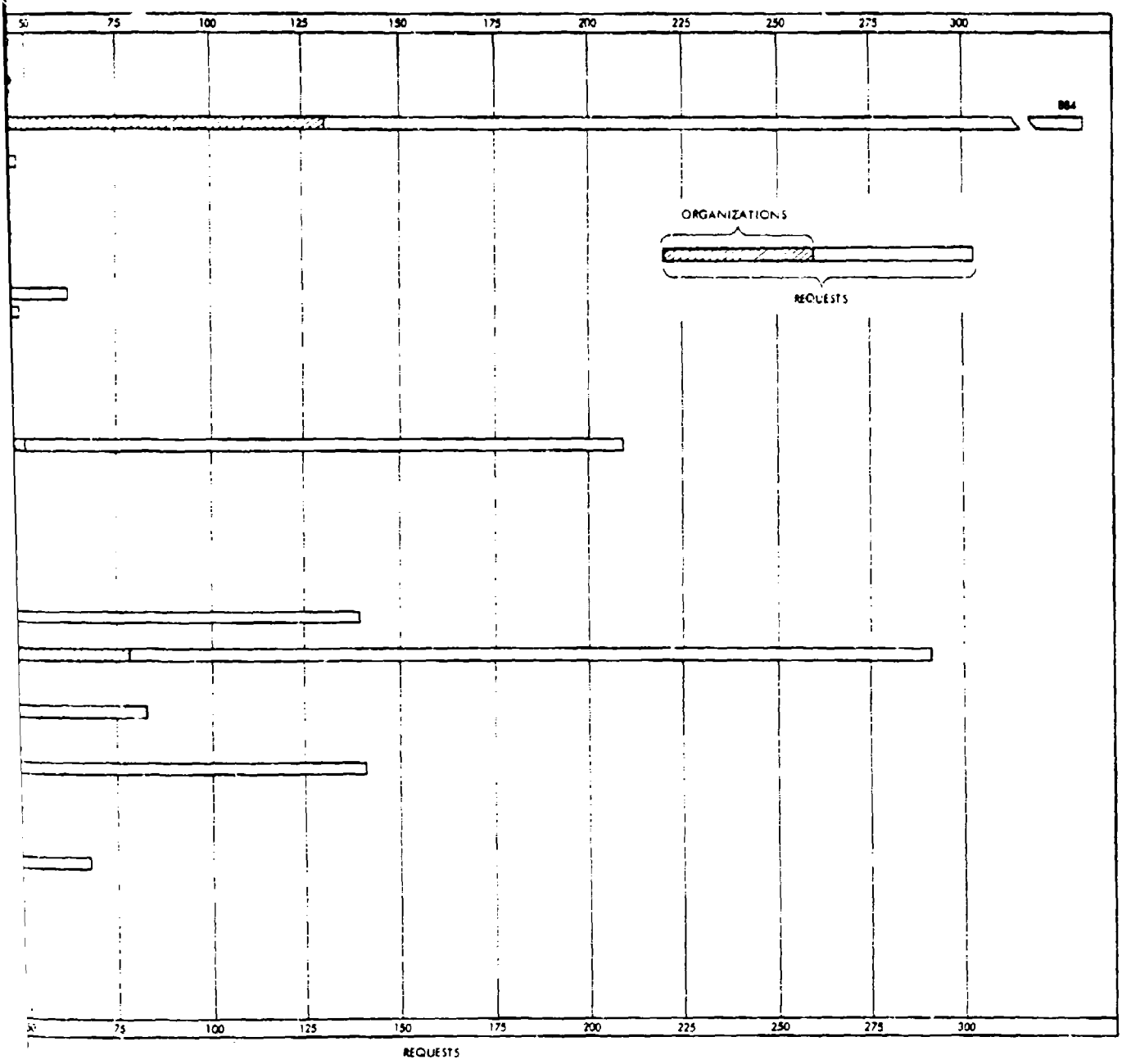


Figure 5. Distribution by state of requests and user organizations.

Table VIII, yielding the total (direct and indirect) Government agency support by the Center.

During 1968-69, 95 requests, all for EPIC publications, were received by the Center from foreign sources (Table V). Eleven of these requests were submitted during 1968 and 84 during 1969. The significant increase in foreign requests during the latter part of the contract period was due to the increased distribution of EPIC publications during 1969 (see Figure 6). In addition, all publications distributed were approved for public release, resulting in increased foreign access to the Center. A further and dramatic increase in foreign use of EPIC publications is expected once the Center begins to market its publications commercially (see Section VI – Sales Program).

Table VIII. Government Agencies Supported by Inquiries

	Air Force	NASA	Navy	Army	AEC	NBS	Other	Total
Direct Inquiries	107	51	58	55	29	20	22	342
Indirect Inquiries*	1042	558	242	242	218	49	73	2424
(Percent)	(43)	(23)	(10)	(10)	(9)	(2)	(3)	(100)
Total Government Agency Support Inquiries	1149	609	300	297	247	69	95	2766
Percent	42	22	11	11	9	2	3	100

*Inquiries from industrial, educational and research organizations identified with specific Government agency support.

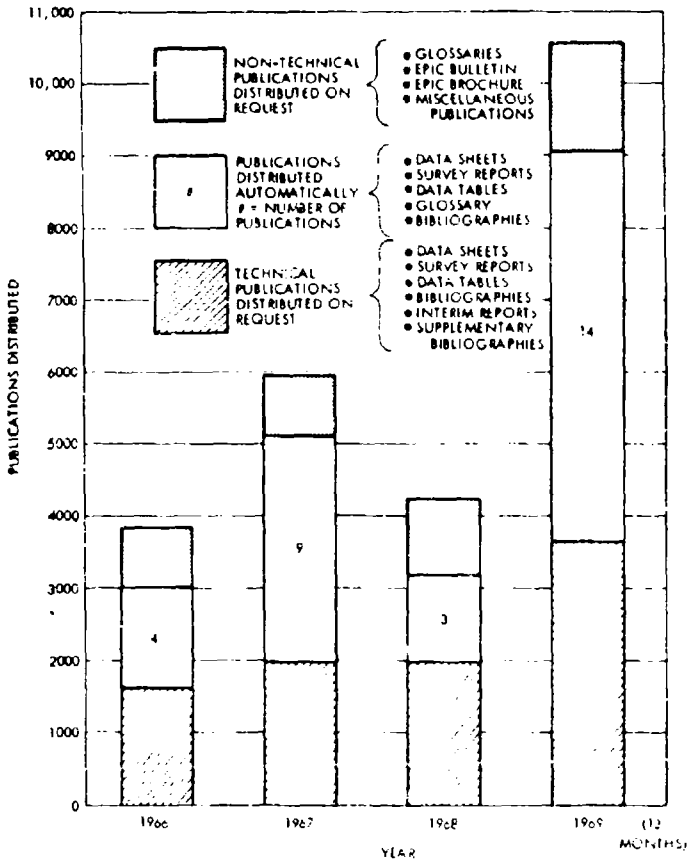


Figure 6. EPIC publications distributed.

3. PUBLICATIONS

During 1968-69, nearly 15,000 EPIC publications were distributed by the Center to the scientific community (Figure 6). This represents an increase of 50 percent over the 1966-67 period, and does not include publications distributed by the Defense Documentation Center (DDC). A large part of the EPIC distribution was issued automatically to approximately half of the users on the EPIC Bulletin distribution list (see Figure 3) who have requested receipt of all EPIC publications upon their release. The 17 Data Sheets, Survey Reports, Data Tables, Bibliographies and the Glossary listed in Table III received an initial distribution in this manner. Further distribution of these works was made upon request. Interim Reports and Supplementary Bibliographies are available only from EPIC upon request; the demand for Interim Reports, as illustrated in Figure 7, attests to their continued value to users of the Center.

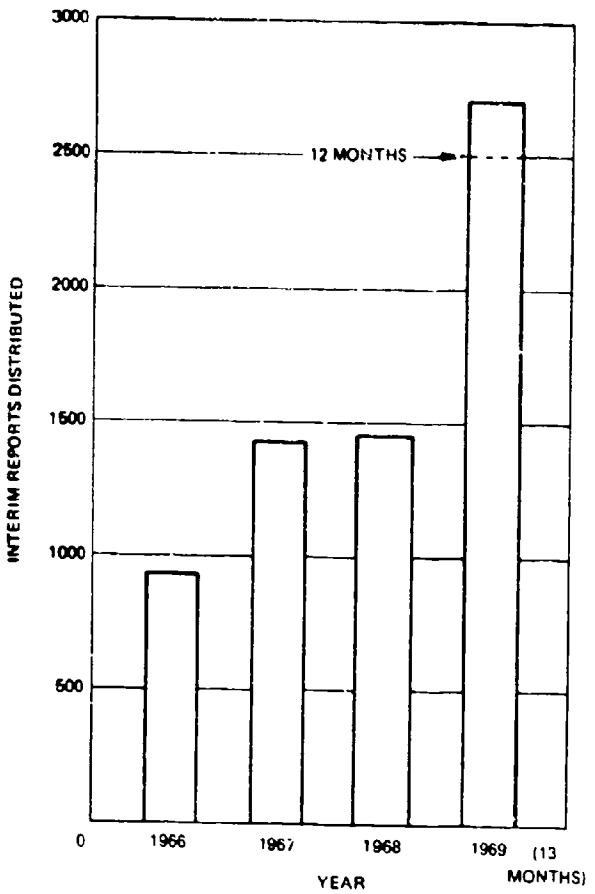


Figure 7. EPIC interim reports distributed.

SECTION IV
EPIC INFORMATION RETRIEVAL SYSTEM

The Electronic Properties Information Center operates a retrieval system based upon detailed indexing, using a controlled vocabulary, coupled with document retrieval by computer (GE-635) and by manual card files. A flow diagram summarizing this system is depicted in Figure 8. During this reporting period, the EPIC indexing system has been expanded and completely revised in accordance with the Center's expanded scope in the optical properties of materials area, and the format of the EPIC magnetic tape files has been revised and improved to accommodate these changes. The resulting retrieval system is more responsive than ever before to the data and information requirements of the Center's users.

1. LITERATURE SEARCH AND ACQUISITION

The Electronic Properties Information Center has continued its aggressive program of searching and acquiring world literature concerned with the electronic, optical and magnetic properties of materials. An overview of the sources of information utilized by the Center is presented in Figure 9.

During this reporting period, the Center has selectively acquired 10,000 documents, bringing EPIC holdings to 42,000. As in the past, these documents were obtained with a ratio of search to acquisition of 10 to 1; over 100,000 documents were reviewed for inclusion in the EPIC files in order to obtain 10,000 that contained pertinent electronic, optical or magnetic property data on materials of current interest to the DoD. These documents were obtained primarily from the technical journal literature, by searching over 100 journals on a month-to-month basis, and from the Government report literature, primarily by ensuring that the Center received contractor reports on all pertinent programs as they were issued.

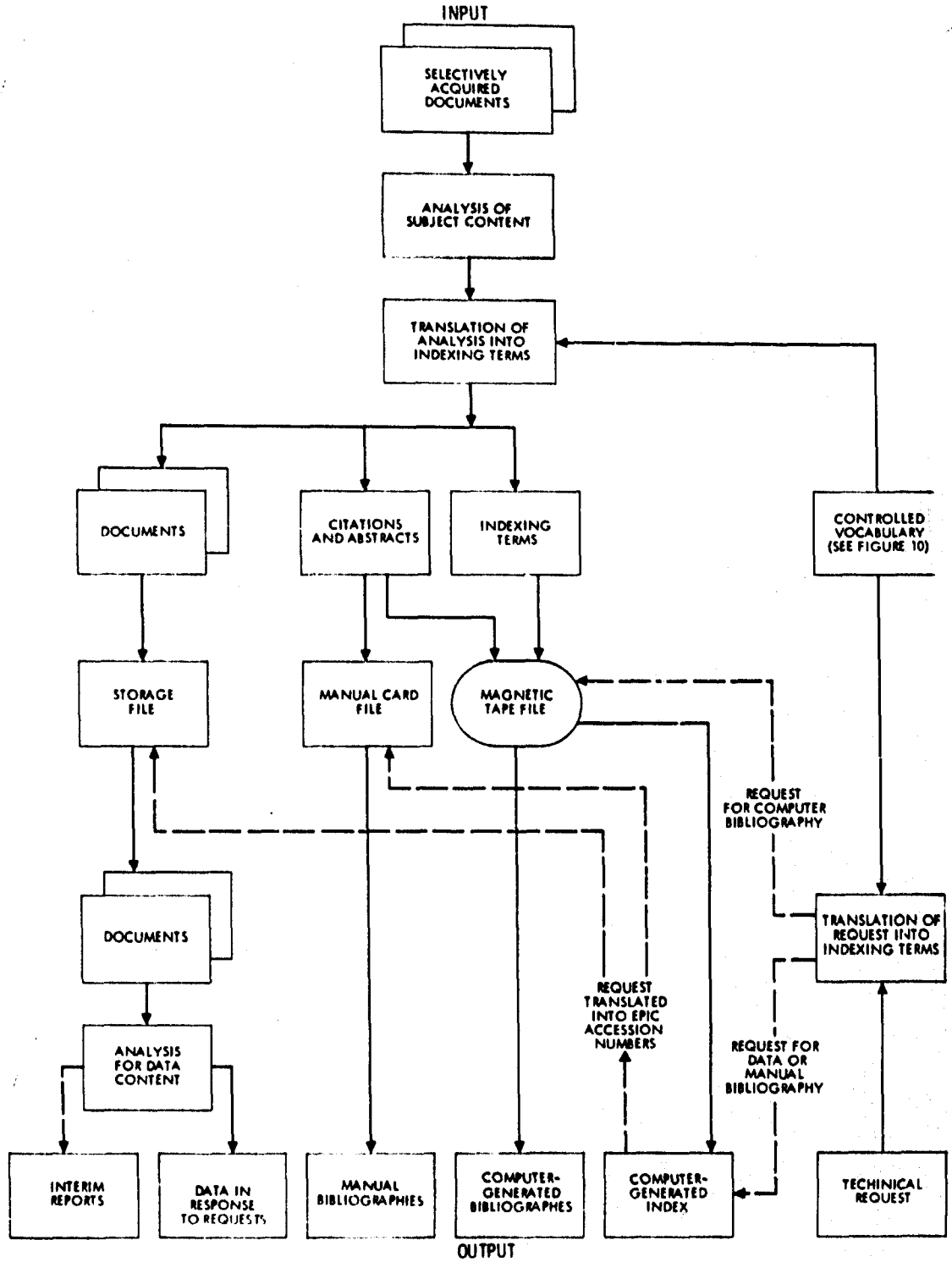


Figure 8. EPIC information retrieval system.

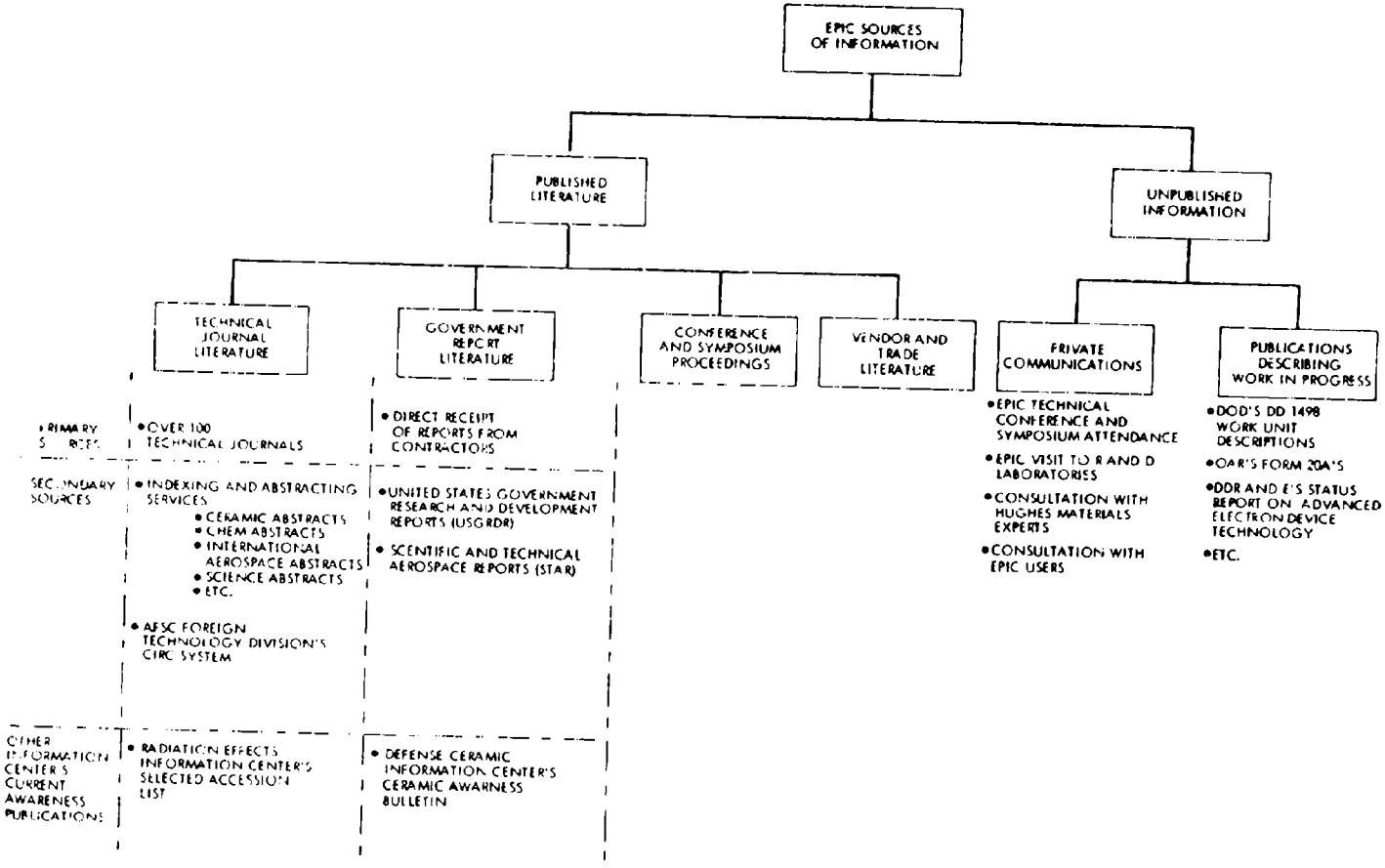


Figure 9. EPIC sources of information.

2. EXPANSION IN SCOPE AND INDEXING SYSTEM

During 1968-69, the Electronic Properties Information Center increased its coverage of optical materials which exhibit useful or practical optical properties in the wavelength range from the vacuum ultraviolet through the far infrared (0.01 to 100 microns). Of primary concern has been an emphasis on solid-state laser materials, including doped glass, doped crystals, and semiconductor lasers, infrared transmitting materials and practical electro-optic and magneto-optic materials used in optical display devices, optical modulators, optical memory units and tunable lasers.

To accommodate this increased emphasis on the optical properties of materials, it was necessary to expand and revise the EPIC materials-properties indexing system in order that optical information could be readily retrieved. The actual form presently used to index documents, shown in Figure 10, illustrates the current EPIC indexing structure. Approximately two thirds of the 10,000 documents entered into the EPIC files during this period were indexed under this new system.

As in the past, the materials indexing structure remained open-ended during 1968-69, allowing for the addition of as many descriptors as was necessary. In particular, the alkali halides have been added to the materials scope of the Center because of their use as infrared transmitting materials. Approximately 7000 materials descriptors currently make up this part of the indexing system. The original properties indexing structure consisted of 58 indexing terms including only three optical properties descriptors: ABSORPTION, REFLECTION COEFFICIENT and REFRACTIVE INDEX. Twenty two new optical property descriptors were added to this system during 1968-69. All property descriptors were carefully defined in the Glossary of Optical Properties (S-10, February 1969).

MATERIAL	Material Modifier	Material Form
MATERIAL CODE #	ACCESSION #	

T	E	H	P	W			T	E	H	P	W	
					010	GENERAL						
					015	CRYSTALLOGRAPHY						
					016	PHASE DIAGRAMS						
					017	COEFFICIENT OF EXPANSION						
					018	ELASTIC CONSTANTS						
					020	ABSORPTION						
						λ RANGE +__.___E+___|+__.___E+___						
					021	EXT. COEFF.						
						λ RANGE +__.___E+___|+__.___E+___						
					022	TRANSM.						
						λ RANGE +__.___E+___|+__.___E+___						
					030	ARC RESISTANCE						
					040	BRILLOUIN EFFECT						
					041	BRILLOUIN EFFECT, STIMULATED						
					050	CARRIER DIFFUSION						
					060	CORONA EFFECTS						
					080	CROSS SECTIONS						
					090	CURIE CONSTANT						
					100	CURIE TEMPERATURE						
					110	DEBYE TEMPERATURE						
					120	DIELECTRIC CONSTANT						
					130	DIELECTRIC STRENGTH						
					140	DISSIPATION FACTOR						
					150	DOMAIN STRUCTURE						
					160	EFFECTIVE MASS						
					170	ELECTRICAL HYSTERESIS						
					180	ELEC. RESIS.						
						T RANGE +__.___E+___|+__.___E+___						
					181	TEMP. COEFF. OF RESISTIVITY						
					185	I-V CHARACTERISTICS						
					186	SURFACE CONDUCTIVITY						
					190	ELECTROACOUSTIC PROPERTIES						
					195	ACOUSTIC ATTENUATION						
					196	PHONON SPECTRA						
					200	ELECTROMECHANICAL PROPERTIES						
					210	ELECTRON FIELD EMISSION						
					220	ELECTRON PHOTOEMISSION						
					230	ELECTRON SECONDARY EMISSION						
					240	ELECTRON THERMIONIC EMISSION						
					250	ELECTRONIC SPECIFIC HEAT						
					260	ELECTRO-OPTIC EFFECT						
					261	KERR EFFECT						
					262	POCKELS EFFECT						
					270	ENERGY BAND STRUCTURE						
					271	DEFORMATION POTENTIAL						
					272	DENSITY OF STATES						
					280	ENERGY GAP						
					290	ENERGY LEVELS						
					300	FLUX CHARACTERISTICS						
					310	GYROMAGNETIC PROPERTIES						
					311	g-factor						
					315	EPR						
					316	ESR						
					317	MAGNETIC RESONANCE						
					318	SPIN-LATTICE RELAXATION						
					320	HALL COEFFICIENT						
					340	INSULATION RESISTANCE						
					350	IRRADIATION PROPERTIES						
					351	NEUTRON						
					352	ELECTRON AND PROTON						
					353	GAMMA						
					354	UV						
					360	LASER PROPERTIES						
					361	LASER WAVELENGTH						
					370	LIFETIME, RECOMBINATION						
					380	LOSS FACTOR						
					390	MAGNETIC HYSTERESIS						
					395	MAGNETIC LOSS						
					396	MAGNETIC MOMENT						
					397	MAGNETIZATION						
					400	MAGNETIC SUSCEPTIBILITY						
					410	MAGNETOELECTRIC PROPERTIES						
					420	MAGNETOMECHANICAL PROPERTIES						
					421	MAGNETIC ANISOTROPY						
					422	MAGNETOSTRICTION						
					430	MAGNETO-OPTIC PROPERTIES						
					431	COTTON-MOUTON EFFECT						
					432	FARADAY EFFECT						
					433	KERR MAGNETO-OPTIC EFFECT						
					440	MICROWAVE EMISSION						
					450	MOBILITY						
					451	GUNN EFFECT						
					455	NONLINEAR OPTICAL EFFECTS						
					460	PENETRATION DEPTH						
					465	PHOTOELASTIC EFFECTS						
					470	PHOTOELECTRONIC PROPERTIES						
					480	PHOTON ELECTROLUMINESCENCE						
					490	PHOTON EMISSIVITY						
					500	PHOTON LUMINESCENCE						
					502	LIFETIME, LUMINESCENCE						
					503	QUANTUM EFFICIENCY						
					510	PHOTON MECH. LUMINESCENCE						
					520	PHOTON THERMOLUMINESCENCE						
					530	PIEZOELECTRIC PROPERTIES						
					540	POLARIZATION PROPERTIES						
					550	POWER FACTOR						
					560	RAMAN EFFECT						
					561	RAMAN EFFECT, STIMULATED						
					570	REFL. COEFF.						
						λ RANGE +__.___E+___|+__.___E+___						
					580	REFR. INDEX						
						λ RANGE +__.___E+___|+__.___E+___						
					581	BIREFRINGENCE						
					590	RICHARDSON'S CONSTANT						
					600	SCATTERING						
					610	SUPERCOND. TRANS. TEMP.						
					620	THERMAL CONDUCTIVITY						
					630	THERMOELECTRIC PROPERTIES						
					640	THERMOMAGNETIC PROPERTIES						
					650	THRESHOLD FIELD						
					655	TRANSPORT PROP. (CRITICAL CURRENT)						
					660	TUNNELING CHARACTERISTICS						
					670	WORK FUNCTION						

Figure 10. Indexing form.

In the process of simply expanding the number of property descriptors, the entire indexing structure was revised and expanded. The following changes were made beyond that necessary for the Center's expanded optical coverage:

- In addition to the 22 new property descriptors, 26 new descriptors were added as a result of the division of several original descriptors to obtain greater specificity (e.g., TEMPERATURE COEFFICIENT OF RESISTIVITY was added to ELECTRICAL RESISTIVITY).
- The experimental parameters, temperature (T), electric field (E), magnetic field (H), pressure (P) and wavelength (W), were added to each property descriptor, in particular, to allow for the indexing and retrieval of important electro- and magneto-optic phenomena (e.g., ABSORPTION + E = electro-absorption).
- The specific range of the wavelength parameter was added to five of the optical property descriptors and the range of the temperature parameter was added to the ELECTRICAL RESISTIVITY descriptor; this allows for the rapid retrieval of documents concerned with the optical properties of specified materials at a given wavelength and the electrical resistivity of specified materials at a given temperature.
- In order to retrieve information on doped glass and crystal laser materials, a modifier was added to the material descriptors to indicate the type and valence of the dopant.
- An additional material modifier was added to describe the material form (e.g., thin film, liquid, junction, composite, etc.).

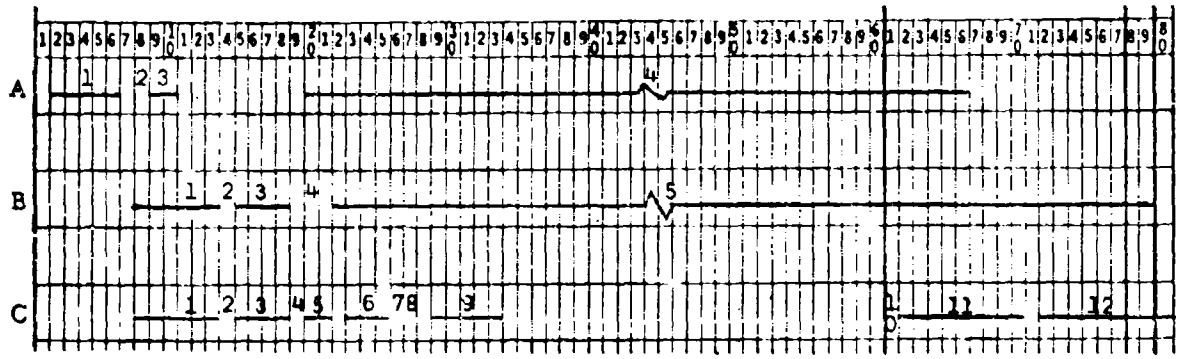
These additions to the indexing structure have given the Center a retrieval capability which is much improved over the simplified materials-58 properties system in existence at the beginning of this reporting period.

3. DATA PROCESSING

The present format for each of the three EPIC magnetic tape files is shown in Figure 11. During this reporting period, modifications were made in two EPIC data processing programs: the retrieval program and the program which produced the index file. The modification of the index file program has resulted in a more efficient and economical quarterly update of this file and has provided an opportunity for change in the retrieval program. This latter program change has given EPIC a linear file capability without an actual linear file structure. Both of these program modifications were completed and operational in July 1969. The bibliography file was not altered during this contract period and the name file was generated as part of the change in the index file.

The change in the index file was two-fold. First, the material descriptors which were once a part of the index file became a major part of the name file. In addition, the property descriptors which were once an internal dictionary in all programs associated with the index file are now an internal dictionary in the index file print program only. Whereas the material and property descriptors were once carried in all operations with the index file, the name file is now used only in the annual printing of the index file. This change in itself has resulted in a more efficient and a more economical quarterly update of the index file and has allowed the linear file capability in the retrieval program which will be discussed below.

The second of the changes in the index file was the addition of new property descriptors, material and property modifiers as well as property ranges discussed above in Section IV-2. Each of these additional descriptors is being used successfully by EPIC for both indexing and answering requests for information.



A. Bibliography File

1. Five digit accession number.
2. Alphabetic code to denote bibliography or abstract.
3. Two digit line number.
4. Text of bibliography or abstract. Two cards go together to form one line of the text; therefore a maximum of 94 characters is possible in each record.

B. Name File

1. Six digit material code.
2. Flag code if field three is occupied.
3. Four digit material modifier code.
4. Sequence code.
5. Material name. Two cards go together to form one material name; therefore a maximum of 94 characters is possible in each record.

C. Index File

1. Six digit material code.
2. Flag code if field three is occupied.
3. Four digit material modifier code.
4. Flag code if field five is occupied.
5. Two digit alphabetic code as a second material modifier.
6. Three digit property code.
7. Flag code if field eight is occupied
8. Single character alphabetic code as a property modifier.
9. Five digit accession number
10. Flag code if fields 11 and 12 are occupied.
11. Lower limit of a property modifier range of values.
12. Upper limit of a property modifier range of values.

Figure 11. EPIC file formats.

Aside from the increased capability afforded EPIC by the expanded indexing system and the changes in the index file program, the most important data processing modification in the EPIC System during this contract period was the change in the retrieval program. This change was also two-fold in nature. First the retrieval operation itself was changed from two, single-step operations to one, two-step operation. This particular change gave the Center a linear file capability without a linear file format. It had been the Center's original intent to physically combine the index and bibliography files into a single linear file to facilitate the retrieval process. However, many problems were inherent in this plan and it was found that the linear search capability, which was the desirable goal, could be obtained with the changes in the retrieval program. These changes were effected by July 1969 and have been used by the Center since then. In addition to the linear file capability, the retrieval program was modified to allow the use of GE-635 remote terminal processing. Both of these changes in the retrieval program have enabled EPIC to answer requests for information more efficiently and more economically than at any other period in the history of the Center.

4. EPIC INDEX

At the end of this contract period (February 1970), the Center delivered to the Air Force ten copies in microfiche form of the entire index and bibliography files representing all 42,000 documents in the EPIC files. The nature of the EPIC system with its separate index and bibliography files enabled the delivery of these complete indexes without any file manipulation beyond the regular quarterly update. The EPIC magnetic tape files maintain a linear search capability and need no sort routines whatsoever to provide the indexes for manual use of the system.

The entire EPIC files were delivered in hard copy to the Air Force in January 1967 and supplements in microfiche form were delivered in January 1968 and 1969. Had the 1970 indexes been delivered as an additional supplement, Air Force personnel would have had to perform

four searches using one hard copy and three sets of microfiche to obtain the information desired. For this reason, the complete index to accession number 42,000 in both the Material-Property Index and the Bibliography of Holdings was prepared and delivered in February 1970. Each copy of these indexes was delivered in "Viz-A-Fiche" pages in a one-inch loose leaf binder. The Center's experience in using microfiche for the 1968 and 1969 supplements showed that a suitable method of holding the fiche was needed. The "Viz-A-Fiche" pages have met this need better than any other product available at the time the indexes were delivered.

There are three new characteristics of the Material-Property Index. First, the accession numbers under each descriptor are now printed sequentially across the page instead of being ordered by terminal digit. This printing mode was first used in the 1969 supplement and was found to be satisfactory; therefore, it has been used for printing the entire index file. Secondly, the material modifier "F" is now found with some of the accession numbers. This is the first printing of the material modifier descriptors resulting from the expanded indexing and indicates that the document represented by the accession number contains data on the thin film form of the material. Since only two-thirds of the last 10,000 documents (or approximately 15 percent of the entire file) has been indexed under the expanded system (see Section IV-2), other material modifiers, the property modifiers and the property modifier range-of-values were not printed at this time. Finally, as an additional result of the expanded indexing system, some property descriptors are indented to denote that the property resulted from the division of the non-indented property descriptor which precedes it.

SECTION V
PUBLICITY PROGRAM

The Electronic Properties Information Center continued an aggressive publicity program throughout the 1968-69 period. The basic content of the program was to contact individual scientists and engineers within the electronics community, introduce them to the services and technical products of the Center, and, if they expressed a definite interest, place them on distribution for the EPIC Bulletin. The Bulletin was issued quarterly throughout 1968-69 and announced the current activities of the Center and the availability of the EPIC publications released during this period. In addition to the Bulletin, the EPIC Brochure, describing the Center and listing all available EPIC publications, was used to publicize the Center. The success of the publicity program is shown in Figure 3; a 73 percent increase was realized during this period in the number of individuals receiving the EPIC Bulletin on a regular basis.

Of course, the success of this program depended upon personal contact with individuals at the engineering level in a large number of organizations throughout the country engaged in electronics research and development. Several methods were employed to accomplish this:

- Technical Conferences. The EPIC staff attended nineteen technical meetings, conferences and symposia during 1968-69 (Appendix II). The location of the Center in the Los Angeles area is an ideal situation; the EPIC technical staff is able to attend a large number of local meetings pertaining to electronics with a minimum cost to the Air Force. In all cases, descriptive EPIC literature was distributed to as many attendees as possible and, in turn, pertinent information and data were collected for the EPIC files. In some cases, the Center was on the meeting agenda and an oral presentation describing the services of the Center was possible; in others, the Center took part in committee meetings pertinent to electronic materials and properties.

When such direct participation was not practical, EPIC technical publications pertinent to the subject of the meeting were distributed to attendees. Several meetings were attended primarily by library and information center personnel who are in a position to publicize EPIC to their clientele.

- Trade Journal Advertisements. Brief notices announcing the availability of EPIC Interim Reports were placed in the "new literature" section of two trade journals; IR-60 and 61, on thick film inks and pastes for microelectronics applications; and IR-67, a dielectric constant design guide, were announced, respectively, in the November 1968 issue of Research/Development magazine and in the October 1969 issue of Insulation magazine. Over 600 requests for these publications have been received through these magazines. The EPIC response to these requests has included a copy of the EPIC Brochure, copies of the latest EPIC Bulletins and a form letter describing the full services of the Center. Approximately 20 percent of these responses have been followed by further inquiries from these new users of the Center, proving the success of this publicity approach.
- Descriptive Literature Mailings. Periodic mailings of literature describing the Center were made to individual engineers and scientists most likely to have interests in electronic materials. Mailing lists were developed from rosters of pertinent technical conferences and university "short courses". Documents entered into the EPIC files were utilized as an additional and unique source of names and addresses of potential users of the Center; by definition, the professional interests of the authors fall within the scope of the Center.

- Technical Articles — As an additional publicity effort, the Center has prepared a technical paper describing the scope and operations of information analysis centers in general, and EPIC in particular, and explaining the role of EPIC in supplying design data necessary for materials selection: Milek, J. T. and Welles, S. J. The Role of the Specialized Information Analysis Center in Materials Selection. IEEE Transactions on Parts, Materials, and Packaging, PMP-4, 92-101 (December, 1968).

SECTION VI
SALES PROGRAM

The Electronic Properties Information Center has offered for sale through IFI/Plenum Data Corporation, New York, a comprehensive manual index representing all documents in the EPIC files.[2] At a sales price of $150 per volume, over 1200 volumes of the EPIC Index have been sold. Initially sales of the first volume of the Index were hampered because of concurrent sales at $15 per volume by the Clearinghouse for Federal Scientific and Technical Information.

Early in 1968 an extensive plan was developed by EPIC to publish all major technical products produced by the Center through IFI/Plenum Data Corporation. All EPIC Data sheets, and Survey Reports, selected EPIC Bibliographies, and Volume 3 of the EPIC Index were to be published by Plenum, both individually and in series form on a subscription basis. Ten of the 34 publications listed in Table III were to form the first volumes of this series. Adminstrative and legal problems prevented the accomplishment of this sales program effort.

The present sales plans for the Electronic Properties Information Center may be summarized as follows:

- Marketable EPIC publications will be sold individually and in series form through IFI/Plenum Data Corporation. Separate contracts - one for publication of Volume 3 of the index and a second for publication of other technical products are being negotiated with IFI/Plenum Data Corporation.
- The quality and magnitude of the EPIC technical answering service will be maintained on its present free of charge basis with the intent to market this service in the future through a qualified organization.
- The sales potential of the EPIC magnetic tapes will be investigated through a commercial marketing organization.

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2. Electronic Properties of Materials: A Guide to the Literature. Volume 1, Ed. by H. Thayne Johnson, 1965, 1681 pp. Volume 2, Ed. by D. L. Grigsby, 1967, 1799 pp.

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SECTION VII
FUTURE PLANS

The activities of the Electronic Properties Information Center in the near future will be dictated primarily by a reduction in funding; Air Force funding of the Center during 1970-71 will be decreased by more than 30 percent under the 1968-69 amount. Even though this reduction is substantial, the Center and the Air Force have agreed that the Center will not reduce its materials-properties coverage or its services. In particular, the Center will continue its coverage of the optical properties of materials, expanded only during the past two years, and will continue to answer all technical inquiries within the scope of the Center from the scientific community. On the other hand, the reduction in funding will necessitate a reduction in the number of technical publications prepared by the Center and a reduction in the number of documents acquired for the EPIC files. Thus, the Center will continue to cover the same technical areas but will be much more selective in adding data and information to the EPIC retrieval system and in compiling data and information into technical publications.

The subject and format of future EPIC publications will be dictated to a great extent by the saleability of the final product in accordance with an EPIC sales program. In particular, the Data Table format, found to be extremely popular during this contract period, will be continued with the preparation of Data Tables on the III-V semiconducting compounds and possibly on the Group IV semiconductors. Future EPIC Data Sheets will be expanded to cover broad categories of materials rather than individual materials; in particular, Data Sheets on the key properties of optical materials, including ceramics, semi-conductors and metals, will be published in 1970.

Other aspects of the sales program will be aggressively pursued. The Center will continue to explore the feasibility of marketing the EPIC magnetic tape files. The EPIC technical answering service, will be continued at full strength as described above. In the long range

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future, EPIC will study the possibilities of remote, on-line access to its files to provide increased use of the EPIC system by the entire scientific community on a pay-as-you-go basis.

An important addition to the activities of the Center in the near future will be the use of an Advisory Committee composed of experts in electronic and optical materials technology and information retrieval to assist the Center in planning its activities and formating its services and technical products to most efficiently meet the data and information needs of the electronics community. The formation and use of this Committee is particularly important at this time to advise EPIC as to how it may continue to be a center of excellence in electronic and optical materials technology under the reduced funding conditions described above. Twelve individuals representing the DoD, NASA, industry, technical societies and educational institutions have accepted an invitation to serve on this Advisory Committee. The first meeting of the Committee is tentatively scheduled for October 1970 at Wright-Patterson AFB. Appendix IV lists the members of the EPIC Advisory Committee.

APPENDIX I
ORGANIZATIONS SUBMITTING THREE OR MORE REQUESTS

Industrial Organizations

Aerojet-General Corp.
Aerospace Corp.
AiResearch Manufacturing Co.
Allen-Bradley Co.
Allied Chemical Corp.
Allis Chalmers Manufacturing, Inc.
Amperex Electronic Corp.
Automatic Electric Labs., Inc.
Avco Corp.

Beckman Instruments, Inc.
Belden Corp.
Bell & Howell Corp.
Bell Telephone Laboratories, Inc.
Bendix Corp.
Bertea Corp.
Boeing Co.
Borg-Warner Corp.
Bourns, Inc.
Burroughs Corp.

Cabot Corp.
Carborundum Co.
Centralab
Clarostat Mfg. Co., Inc.
Collins Radio Co.
Communications Satellite Corp.
Continental Device Corp.
Control Data Corp.
Corning Glass Works
Cutler-Hammer
Cyprus Mines Co.

Dickson Electronic Corp.
Dow Chemical Co.

E. I. DuPont de Nemours & Co., Inc.
Eastman Kodak Co.
EG & G Inc.
Electronic Resources Inc.
Electro Optical Systems, Inc.
Emerson Electric Co.
Engelhard Industries, Inc.
Erie Technological Products
Ethyl Corp.
Exotic Materials Inc.

Fairchild Semiconductor
Fenwal Electronics, Inc.
Field Emission Corp.
Filohm Corp.
FMC Corp.
Ford Motor Co.
Foxboro Co.

General Dynamics Corp.
General Electric Co.
General Laser Corp.

General Motors Corp.

General Telephone & Electronics, Inc.

G. & H. Technology Inc.

Goodyear Aerospace Corp.

W. L. Gore & Associates, Inc.

Gulf General Atomic, Inc.

Gulton Industries, Inc.

Hartman Systems Co.

Hazeltine Corp.

Hewlett-Packard Co.

Honeywell, Inc.

Hughes Aircraft Co.

ILC Laboratories, Inc.

International Business Machines Corp.

International Nickel Co., Inc.

International Telephone & Telegraph Corp.

Ion Physics Corp.

IRC, Inc.

Itek Corp.

Alex E. Javitz Co.

Kaiser Aluminum & Chemical

Kawecki Berylco Industries, Inc.

KDI Poly-Technic, Inc.

Lear Siegler, Inc.

Lenkurt Electric Co.

Ling-Temco-Vought, Inc.

Litton Industries

Lockheed Missiles & Space Co.

Magnavox Co.

P. R. Mallory & Company, Inc.

Martin-Marietta Corp.

Materials Reserach Corp.

Matthey Bishop, Inc.

McDonnell Douglas Corp.

McGraw-Edison Co.

Melpar, Inc.

Merrimac R & D, Inc.

Metrophysics, Inc.

Microwave Associates, Inc.

Microwave Electronics

Minnesota Mining & Manufacturing Co.

Monroe Electric Inc.

Monsanto Research Corp.

Motorola, Inc.

National Cash Register Co.

National Lead Co.

North American Rockwell Corp.

Northrop Corp.

Norton Research Corp.

Owens-Illinois, Inc.

Packard Bell Electronics

Phelps Dodge Corp.

Philco-Ford Corp.

Radio Corporation of America
Raychem Corp.
Raytheon Co.
Rogers Corp.
Rohr Corp.
Ryan Aeronautical Co.

Sanders Associates, Inc.
Sandia Corp.
G. T. Schjeldahl Co.
Signetics Corp.
Simmonds Precision Products, Inc.
Singer-General Precision Inc.
Speer Carbon Co.
Sperry Rand Corp.
Sprague Electric Co.
Stromberg Carlson Co.
Sylvania Electronics Products, Inc.

Tektronix, Inc.
Texas Instruments Inc.
TRW, Inc.
Tyco Laboratories

Union Carbide Corp.
United Aircraft Corp.

Varian Associates

Watkins-Johnson Co.
Western Electric Co., Inc.
Westinghouse Electric Corp.
Weston Instruments, Inc.
The Ralph White Co.

Xerox Corp.

Educational and Research Institutions

Arizona State University
Arizona, University of
Battelle Memorial Institute
Brandeis University
Brigham Young University
California Institute of Technology
California, University of
Carnegie-Mellon University
Colorado, University of
Connecticut, University of
Cornell University
Florida, University of
Illinois Institute of Technology
Illinois, University of
Indiana University
Iowa State University
Kentucky, University of
Maine, University of
Massachusetts Institute of Technology
Michigan, University of
Minnesota, University of
Missouri, University of
New York, State University of
New York University
North Carolina State University

Northeastern University
Ohio State University
Pennsylvania State University
Purdue University
Research Triangle Institute
Rutgers University
Southwest Research Institute
Stanford University
Temple University
Texas Technological College
Texas, University of
University of Dayton
University of Rochester
University of Southern California
University of Toledo
Utah, University of
Vermont, University of
Virginia, University of
Wisconsin, University of
Yale University

APPENDIX II

MEETINGS ATTENDED BY EPIC

Date	Meeting	Comments
February 27, 1968	Seminar on Beryllium Copper, Los Angeles	
March 11, 1968	WESTEC Exhibit, Los Angeles	
March 18-21, 1968	American Physical Society Meeting, Berkeley	
March 31 – April 4, 1968	Materials Conference, American Institute of Chemical Engineers, Philadelphia	Paper No. 23b on EPIC presented as part of DoD Information Centers for Materials Symposium, D. A. Shinn. Chairman
June 6, 1968	Special Libraries Association Meeting, Los Angeles	
June 26-28, 1968	71st Annual Meeting of the American Society of Testing and Materials (ASTM), San Francisco	EPIC took part in committee F-1 on Materials for Electron Devices and Microelectronics
August 23, 1968	WESCON Technical Program and Exhibits, Los Angeles	
October 21-23, 1968	International Conference on Silicon Carbide, Pennsylvania State University	Copies of Silicon Carbide Data Table and Supplementary Bibliography (IR-62) distributed to attendees; Data Table portion of this work appeared in conference proceedings

Date	Meeting	Comments
October 23-25, 1968	21st Pacific Coast Regional Meeting of the American Ceramic Society, Pasadena	
December 9-12, 1968	8th Electrical Insulation Conference and Exhibition, Los Angeles	
April 10, 1969	Orange County Chapter Meeting of the Society of Aerospace Material and Process Engineers (SAMPE)	Oral presentation of the EPIC program
April 28-29, 1969	Conference on Novel Investigations of Electronic Materials, California Institute of Technology	All registrants received EPIC literature
April 29, 1969	Annual Symposium on Materials Technology, Los Angeles	
May 7, 1969	Technical Information Advisory Committee (TIAC) meeting of the National Security Industrial Association (NSIA), Los Angeles	
May 22, 1969	National Association of Corrosion Engineers Meeting, Los Angeles	

Date	Meeting	Comments
June 24-25, 1969	National Engineering Information Conference, Washington, D. C.	
August 26-29, 1969	International Conference on the Science of Superconductivity, Stanford University	Copies of Niobium Titanium Data Table and Supplementary Bibliography (DS-148(S1)) distributed to attendees.
October 1-3, 1969	32nd Annual Meeting of the American Society for Information Science (ASIS), San Francisco	
October 9, 1969	San Fernando Valley Chapter Meeting of the Society of Aerospace Material and Process Engineers	Oral presentation of the EPIC program
February 10-12,1970	NEPCON West, Anaheim, Calif.	

APPENDIX III
EPIC PERSONNEL

Dr. Sheldon J. Welles*	Head, EPIC
Dr. Richard I. Akawie	Member of the Technical Staff
Donald L. Grigsby	Member of the Technical Staff
Irnee J. d'Haenens	Consultant, Hughes Research Laboratories
John T. Milek	Member of the Technical Staff
Alfred J. Moses	Member of the Technical Staff
Meta S. Neuberger	Member of the Technical Staff
John R. Chase	Data Processing Specialist

*On April 6, 1970 Walter H. Veazie replaced Dr. Welles as Head, EPIC.

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Electronic Properties Information Center						
Information Analysis Centers						
Information Retrieval						
Solid State Physics						
Semiconductors						
Metals						
Insulators						
Magnetic Properties						
Optical Properties						
Superconductors						
Dielectrics						
Ferrites						
Ferromagnetic Materials						
Ferroelectric Materials						