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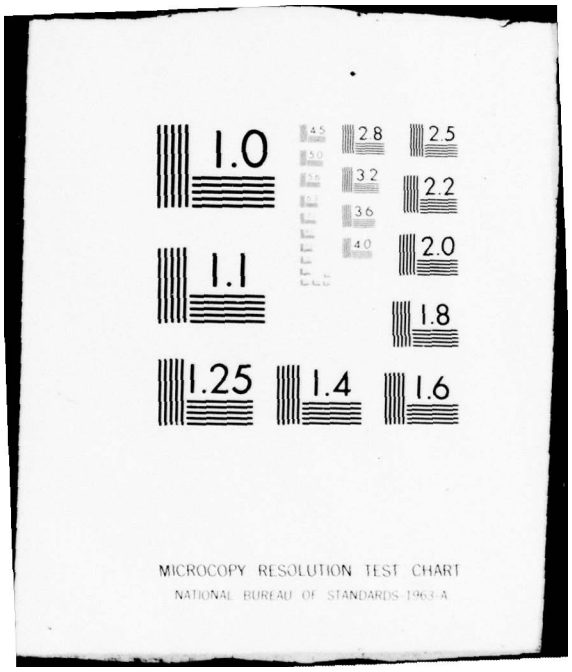
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THERMOPHYSICAL AND ELECTRONIC PROPERTIES INFORMATION ANALYSIS CENTER (TEPIAC)

A Continuing Systematic Program on Data Tables of Thermophysical and Electronic Properties of Materials

March 1979

Center for Information and Numerical Data Analysis and Synthesis
Purdue University
West Lafayette, Indiana 47906

Final Report - Contract DSA900-77-C-3758

Approved for public release; distribution unlimited.

Prepared for

ARMY MATERIALS AND MECHANICS RESEARCH CENTER
Watertown, Massachusetts 02172

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This Final Report on Contract No. DSA900-77-C-3758 covers the activities and accomplishments of the Thermophysical and Electronic Properties Information Analysis Center (TEPIAC) for the period 1 January 1977 to 31 December 1978. TEPIAC's activities reported herein include literature search, acquisition, and input of source information; documentation review and codification; material classification; information organization; operation of a computerized bibliographic information storage and retrieval system; data extraction

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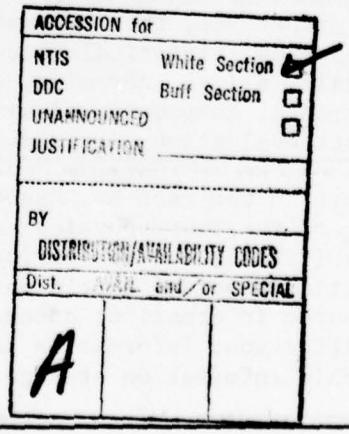
20. ABSTRACT (continued)

and compilation; data evaluation, correlation, analysis, synthesis, and generation of recommended values; preparation and publication of handbooks, data books, properties literature retrieval guides, state-of-the-art reports, critical reviews, and technology assessments; development of a computerized numerical data storage and retrieval system; technical and bibliographic inquiry services; and current awareness and promotion efforts. TEPIAC covers 14 thermophysical properties and 22 electronic, electrical, magnetic, and optical properties of nearly all materials at all temperatures and pressures and in all environments. TEPIAC represents one of the most efficient and cost-effective Full-Service Information Analysis Centers when evaluated on output and input volume per budgeted dollar. During this 24-month contractual period, the Center has screened 1,500,000 abstracts, scrutinized 92,000 potentially good entries, identified 24,800 pertinent references, acquired 20,784 research documents, reviewed, coded, and catalogued 11,336 documents, extracted and compiled 7,488 sets of property data from 2,988 data source documents by processing 7,313 research documents, and responded to 1041 inquiries from 46 states and the District of Columbia and 22 foreign countries. Furthermore, during this period the 1,786-page Volume 13 of the Thermophysical Properties of Matter - The TPRC Data Series was published and the 197-page Index Volume entitled "Master Index to Materials and Properties" of the 14-volume TPRC Data Series has been completed. Under multiple sponsorship, the manuscript of the first volume entitled "Thermal Accommodation and Adsorption Coefficients" of the new CINDAS Handbook Series of Material Properties has been completed and the manuscripts of the second and third volumes entitled "Selected Ferrous Alloying Elements" and "Nonmetallic Fluid Elements" are near completion, a 242-page technical report was published and four other technical reports with a total of 582 pages were completed and released, and the manuscripts of the 1,418-page "Thermophysical Properties Research Literature Retrieval Guide, Supplement II" and of the 1,553-page "Electronic Properties Research Literature Retrieval Guide, Basic CINDAS Edition" have been completed. During this period twelve issues of the "Thermophysics and Electronics Newsletter" with a total of 85,500 copies and two promotional brochures with a total of 20,000 copies have been distributed. TEPIAC sponsored two international conferences and TEPIAC staff conducted one short course, gave four seminars in other institutions, and participated in fifteen other major conferences and meetings. A promotional and documentary film entitled "The Anatomy of Data" was produced and has been shown to about 150 organizations during this period.



SUMMARY

The Thermophysical and Electronic Properties Information Analysis Center (TEPIAC) is a Full-Service Department of Defense Information Analysis Center operated by the Center for Information and Numerical Data Analysis and Synthesis (CINDAS) of Purdue University under contract with the Defense Logistics Agency (DLA) and under the technical direction of the Army Materials and Mechanics Research Center (AMMRC). The objective of TEPIAC operations is to increase the productivity of scientists, engineers, and technicians engaged in scientific and engineering programs for the Department of Defense by maintaining a comprehensive, authoritative, and up-to-date national data base on thermophysical and electronic (including also electrical, magnetic, and optical) properties of materials for use by the entire DOD community and by providing authoritative data and information analysis services. Its major functions are to search, collect, review, evaluate, appraise, analyze, synthesize, and summarize the available scientific and technical data and information from worldwide sources on the various thermophysical, electronic, electrical, magnetic, and optical properties of materials and to disseminate the results both by providing authoritative data and information directly to the individual users through technical and bibliographic inquiry services and by publishing major reference works on property data and information for the general users at large.

TEPIAC covers 14 thermophysical properties and 22 electronic, electrical, magnetic, and optical properties of nearly all materials at all temperatures and pressures and in all environments.

This Final Report on Contract No. DSA900-77-C-3758 covers the activities and accomplishments of TEPIAC in the period 1 January 1977 to 31 December 1978. TEPIAC's activities reported herein include literature search, acquisition, and input of source information; document review and codification; material classification; information organization; operation of a computerized bibliographic information storage and retrieval system; data extraction and compilation; data evaluation, correlation, analysis, synthesis, and generation of recommended values; preparation and publication of handbooks, data books, properties literature retrieval guides, state-of-the-art reports, critical reviews, and technology assessments; development of a computerized numerical data storage and retrieval system; technical and bibliographic inquiry services; and current awareness and promotion efforts.

TEPIAC represents one of the most efficient and cost-effective Full-Service Information Analysis Centers when evaluated on output and input volume per budgeted dollar. During this 24-month contractual period, the Center has screened 1,500,000 abstracts, scrutinized 92,000 potentially good entries, identified 24,800 pertinent references, acquired 20,784 research documents, reviewed, coded, and catalogued 11,336 documents, extracted and compiled 7,488 sets of property data from 2,988 data source documents by processing 7,313 research documents, and responded to 1041 inquiries from 46 states and the District of Columbia and 22 foreign countries. Furthermore, during this period the 1,786-page Volume 13 of the Thermophysical Properties of Matter - The TPRC Data Series was published and the 197-page Index Volume entitled "Master Index to Materials and Properties" of the 14-volume TPRC Data Series has been completed. Under multiple sponsorship, the manuscript of the first volume entitled "Thermal Accommodation and Adsorption Coefficients" of the new CINDAS Handbook Series of Material Properties has been completed and the manuscripts of the second and third volumes entitled "Selected Ferrous Alloying Elements" and "Nonmetallic Fluid Elements" are near completion, a 242-page technical report was published and four other technical reports with a total of 582 pages were completed and released, and the manuscripts of the 1,418-page "Thermophysical Properties Research Literature Retrieval Guide, Supplement II" and of the 1,553-page "Electronic Properties Research Literature Retrieval Guide, Basic CINDAS Edition" have been completed. During this period twelve issues of the "Thermophysics and Electronics Newsletter" with a total of 85,500 copies and two promotional brochures with a total of 20,000 copies have been distributed. TEPIAC sponsored two international conferences and TEPIAC staff conducted one short course, gave four seminars in other institutions, and participated in fifteen other major conferences and meetings. A promotional and documentary film entitled "The Anatomy of Data" was produced and has been shown to about 150 organizations during this period. A statistical summary of TEPIAC accomplishments is presented in Table 1.

TABLE 1. STATISTICAL SUMMARY OF TEPIAC ACCOMPLISHMENTS

(For the Period 1 January 1977 to 31 December 1978)

	This Period	Total as of 31 December 1978
Scope		
Properties covered	36	36
Materials covered	46,810	46,810
Scientific Documentation		
Abstracts screened	1,500,000	43,210,000
Relevant abstracts scrutinized	92,000	712,300
Pertinent documents identified	24,800	210,800
Documents acquired	20,784	165,697
Documents reviewed, coded, and catalogued	11,336	151,545
Entries of codification	32,281	536,723
Sources of documents	8,360	8,360
Data Table Generation		
Documents processed	7,313	42,707
Data source documents resulted	2,988	19,654
Data sets compiled	7,488	91,038
Data sets in the Evaluated Numerical Data Bank	4,268	4,268
Inquiry Services		
Inquiries from government laboratories and agencies	145	1,022[a]
Inquiries from defense contractors and other industrial organizations	674	3,650[a]
Inquiries from academic institutions	222	1,910[a]
Total inquiries	1,041	6,582[a]
Publications		
Research Literature Retrieval Guides and Supplements		
Number of volumes	10	19
Number of pages	2,971	8,132
Data Books and Handbooks		
Number of volumes	3	24
Number of pages	2,383	29,081
State-of-the-art reports and technical reports		
Number of reports	4	29
Number of pages	582	4,616
Masters Theses in the Pure and Applied Sciences		
Number of volumes	2	22
Number of pages	595	4,861
Current Awareness and Promotion Efforts		
Thermophysics and Electronics Newsletter		
Number of issues	12	42
Number of copies	85,500	194,100
Promotional brochures		
Number of brochures	2	16
Number of copies	20,000	42,650
Conferences and meetings		
Number of conferences and meetings sponsored	2	14
Number of conferences and meetings participated	20	131
Documentary film	1	1

[a] Since 1963.

PREFACE

This Final Report was prepared by the Thermophysical and Electronic Properties Information Analysis Center (TEPIAC), a Department of Defence Information Analysis Center (IAC). This Center is operated by the Center for Information and Numerical Data Analysis and Synthesis (CINDAS), Purdue University, West Lafayette, Indiana, under Contract No. DSA900-77-C-3758 with the Defense Logistics Agency (DLA), Alexandria, Virginia, with Mr. J. L. Blue being the IAC Program Manager, and under the technical direction of the Army Materials and Mechanics Research Center (AMMRC), Watertown, Massachusetts, with Mr. Samuel Valencia being the Contracting Officer's Technical Representative. The Contract was issued by the Defense Electronics Supply Center, Dayton, Ohio, with Mr. S. C. Rosta and Mrs. Frances Burke being the Contracting Officers.

This Final Report covers the contractual period from 1 January 1977 to 31 December 1978, and was submitted by the author in February 1979 to fulfill the contractual requirement (Item No. 0002, Sequence No. A002).

The work reported herein is credited to the collective efforts of the entire staff of the Thermophysical and Electronic Properties Information Analysis Center. Dr. Y. S. Touloukian, Director of CINDAS, has been the principal investigator.

This report has been reviewed and is approved.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SECTION I

INTRODUCTION

The Thermophysical and Electronic Properties Information Analysis Center (TEPIAC) is a Department of Defense Information Analysis Center operated by the Center for Information and Numerical Data Analysis and Synthesis (CINDAS) of Purdue University. Under CINDAS' operation, TEPIAC has long achieved the full operational status of a Full-Service DOD Information Analysis Center, and TEPIAC has been well oriented to the needs of its user community with its products and services well-known.

The objective of TEPIAC operations is to increase the productivity of scientists, engineers, and technicians engaged in scientific and engineering programs for the Department of Defense by maintaining a comprehensive, authoritative, and up-to-date national data base on thermophysical and electronic (including also electrical, magnetic, and optical) properties of materials for use by the entire DOD community and by providing authoritative data and information analysis services. Services are also rendered to other U.S. Government Agencies and their contractors and, to the extent practical without impairment of services to the foregoing users, to the private sector, consistent with security and other limitations on TEPIAC's information.

The major functions of TEPIAC are to search, collect, review, evaluate, appraise, analyze, synthesize, and summarize the available scientific and technical data and information from worldwide sources on the various thermophysical, electronic, electrical, magnetic, and optical properties of materials and furthermore to disseminate the results both by providing authoritative data and information directly to the individual TEPIAC users through technical and bibliographic inquiry services and by publishing major reference works on property data and information for the general TEPIAC users at large.

TEPIAC's major tasks and activities include literature search, acquisition, and input of source information for maintaining the data base; document review and codification; material classification; information organization; operation of a computerized bibliographic information storage and retrieval system; data extraction and compilation; data evaluation, correlation, analysis, synthesis, and generation of recommended values; preparation and publication of handbooks,

data books, properties literature retrieval guides, state-of-the-art reports, critical reviews, and technology assessments; technical and bibliographic inquiry services; and current awareness and promotion efforts.

While TEPIAC is a full-service IAC, it has traditionally stressed data evaluation and analysis and the generation of reference data more than any other single group anywhere. Furthermore, it has always felt that the maximum optimization of its efforts in serving the end users of data and information can best be realized through the publication of major reference works, whereby the data and information are readily available at arm's reach of the engineers, scientists, and technicians. Towards this end, TEPIAC has contributed greatly over the years by publishing a number of the most comprehensive and authoritative series of data books and handbooks published anywhere.

It is appropriate at this point to discuss briefly the importance of the knowledge of thermophysical, electronic, electrical, magnetic, and optical properties of materials covered by TEPIAC to the mission of the Department of Defense and the important role of Information Analysis Centers such as TEPIAC in national defense. There is no doubt that the knowledge of material properties is extremely important to the mission of the Department of Defense because the proper design of defense systems and military weapons, hardware, equipment, structures, etc. used in national defense requires a complete knowledge of the properties of materials. Consider first an example that concretely demonstrates the importance and usefulness of such knowledge to the Department of Defense and, as a consequence, that the mission of the Department of Defense is accomplished in a most competent manner with such knowledge. It is well known that a thorough knowledge of thermal conductive and radiative properties of refractory, insulation, and other aerospace materials is a fundamental requirement of the design of advanced weapons such as balistic missiles and spacecraft which require thermal protection systems for their operating at extremes in temperature and require lightweight high-efficiency thermal insulation systems for cryogenic fuel in booster applications. The thermal conductive and radiative properties of refractory and composite materials used in nose cones, nozzles, and leading edges are so important that these properties determine directly the temperature level of operation, and furthermore, together with thermal expansion they determine the thermal stress and thermal shock characteristics, which are most important design considerations for high temperature applications. In short,

without the knowledge of these properties, the design of spacecraft, balistic missiles, and all other similar warhead delivery systems would not have been possible, and this Nation's advanced defense systems and space programs could not be off the ground.

For the design of conventional military vehicles, tanks, airplanes, and warships or their power-plants and of various firearms ranging from small guns to heavy artilleries, the knowledge of thermal conductive, radiative, and other thermophysical properties is also very essential because their operations always involve rapid heat generation and high thermal stress and thus require efficient heat dissipation or cooling; all such processes are directly related to thermophysical properties of the materials used. Thermophysical properties of fluids are important in the design of engine cooling system, lubricating system, fuel system, combustion and exhaust system, etc. For the design of nuclear engine used in a submarine or warship, the knowledge of the thermophysical properties of nuclear fuel materials and fuel rod cladding materials is essential since these properties determine the maximum attainable heat flux from fuel rods and the temperature level of operation, which dictate almost the entire design.

In the current advanced technology, the knowledge of thermal radiative properties as well as optical properties is most essential both in the development of high-power laser weaponery for destroying enemy's aircrafts, missiles, satellites, etc. and in the development of laser-hardened materials for protecting our aircrafts, missiles, satellites, etc. against enemy's high-power laser attack. The knowledge of thermal radiative and optical properties is also extremely important in the development of target signature recognition systems for detecting and identifying enemy's oncoming aircrafts and missiles and for identifying terrestrial objects in guidance and reconnaissance applications.

The knowledge of electronic, electrical, and magnetic properties of materials is, of course, essential for the design of all electronic devices and equipment for military applications, including, for example, those electronic devices used in military electronic communication, electronic high-speed computation, electronic guidance, control, and tracking, electronic detection and sensing, electromagnetic memory and recording, electronic surveillance, reconnaissance, and intelligence, electronic jamming, deception, and countermeasure, and those military electronic devices for energy generation, storage, conversion, and

transmission. In fact, the rapid advance in electronic gadgetry in recent years is a direct result of increased knowledge of the electronic, electrical, and magnetic properties of materials, unusual or otherwise. In electronic devices, the availability of efficient heat sinks for micro-circuits is another essential requirement for their satisfactory performance, and the design of efficient heat sinks requires the knowledge of thermophysical properties. It is indeed an endless list of examples demonstrating the great importance and usefulness to the Department of Defense of the knowledge of thermophysical, electronic, electrical, magnetic, and optical properties, of which TEPIAC is responsible for coverage.

In the past, the data and information on the properties of materials, though so important, were buried in the world's enormous and ever-expanding volume of scientific and technical literature, and the scientists, engineers, and technicians engaged in scientific and engineering programs for the Department of Defense used no more than a small fraction of the data and information already existing. This disturbing situation has been gradually improved since the establishment of the scientific and technical Information Analysis Centers, such as TEPIAC, by the Department of Defense. TEPIAC has been conducting a continuing systematic program to dig the buried data and information and to screen and filter the current data and information out of the world's ever-increasing volume of literature and to critically evaluate, appraise, analyze, synthesize, summarize, and put the data and information in a form most useful to the users in the entire Defense community. There is no doubt that the more accurately the properties of materials are known, the more likely that a system can be designed properly and performed successfully, and that the more readily the property data and information are available, the more likely that a development program can be expedited.

The important role of TEPIAC, or of any other DOD Information Analysis Center, in national defense is to assure that the Department of Defense carries out its mission timely and most effectively by serving as a focal point for authoritative expertise and maintaining a national data base within the scope of its coverage to be tapped by the Department of Defense and its contractors for solutions to technological problems and for the planning of advanced defense systems, by providing instant response to meet urgent requirements of the Department of Defense when short reaction time is essential, by serving as a

vehicle for effective technology transfer within its scope, thus closing the time gap between R & D and application, by having complete cognizance of the topography of the state of knowledge within its scope, thus able to quickly identify areas where knowledge is lacking and research is required to meet existing needs and anticipated future demands, and by bringing about significant cost savings to the Department of Defense and others by preventing the use of erroneous input data in critical technical applications and avoiding duplication in present and future research efforts. In short, TEPIAC and other DOD Information Analysis Centers play a very significant role in our national defense.

CINDAS, who operates TEPIAC, is a part of Purdue University, which is one of the leading institutions of higher learning in the Nation. Purdue University has numerous research laboratories in all fields and disciplines and many of these are for the measurement and research on thermophysical and/or electronic properties. Furthermore, there are over 2500 highly-trained faculty members and research specialists at Purdue. When the need arises CINDAS/TEPIAC can draw on their scientific and engineering expertise with immediate access.

Due to the fact that CINDAS' own staff, with its 16 doctoral level professional personnel, possess a very high degree of expertise in thermophysical and electronic properties, material science, solid state physics, physical chemistry, and spectroscopy, the assistance from outside CINDAS is, therefore, seldom needed. CINDAS/TEPIAC' staff have an enviable performance record of scientific and professional accomplishments through original research contributions to the primary literature. Thus they possess a high level of professional recognition and credibility in their work, which is absolutely essential for acceptance by one's peers. Some of the staff have received honors and distinctions from National and International scientific and technical bodies. In the area of scientific documentation its staff comprise highly trained personnel (several staff having a degree of Master of Science) with an average of over 12 years experience in their speciality. On its premises CINDAS has an experimental research laboratory for the measurements of thermophysical and electronic properties which is recognized as a most outstanding laboratory with a wide range of "state-of-the-art" capabilities. The work of this laboratory contributes directly to the data evaluation and analysis process, which constitutes a unique and invaluable asset to TEPIAC.

TEPIAC's accomplishments in all its tasks and activities in the performance of this contract for the contractual period from 1 January 1977 to 31 December 1978 are detailed in the following sections.

SECTION II

SCIENTIFIC DOCUMENTATION ACTIVITIES

In order to maintain a comprehensive, authoritative, and up-to-date national data base on thermophysical, electronic, electrical, magnetic, and optical properties of materials and to provide authoritative information and data to the users with instant retrieval capability, TEPIAC has maintained a systematic program of literature search and acquisition, document review and codification, material classification, information organization, and of storing the resulting information in a computerized information storage and retrieval system. The various phases of activities in this program are discussed below.

1. LITERATURE SEARCH, ACQUISITION, AND INPUT OF SOURCE INFORMATION

The fourteen thermophysical properties under TEPIAC cognizance of information and data in all pertinent subject areas are as follows:

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

Originally two more properties (diffusion coefficient and surface tension) had been monitored, but these were dropped in mid-1970.

The fifteen specific electronic, electrical, magnetic, and optical properties and seven property groups under TEPIAC cognizance of information and data in all pertinent subject areas are as follows:

Properties

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

Property Groups

16. Electron emission properties
    a. Field emission
    b. Photoemission
    c. Secondary emission
    d. Thermionic emission
17. Luminescence properties
    a. Cathodoluminescence
    b. Electroluminescence
    c. Mechanical luminescence
    d. Photoluminescence
    e. Thermoluminescence
18. Magnetoelectric properties
    a. Ettingshausen effect
    b. Magnetoresistance
    c. Nernst effect
    d. Shubnikov-de Haas effect
19. Magnetomechanical properties
    a. Anisotropy energy
    b. Magnetostriction
20. Photoelectronic properties
    a. Dember effect
    b. Photoconductivity
    c. Photomagnetic effect
    d. Photopiezoelectric effect
    e. Photovoltaic effect
21. Piezoelectric properties
    a. Piezoelectric effect
    b. Pyroelectric effect
22. Thermoelectric properties
    a. Peltier effect
    b. Seebeck effect
    c. Thomson effect

As to material coverage in this documentation phase of the program, TEPIAC covers nearly all materials at all temperatures and pressures and in all environments, which are far more than what are required by the contract. The materials required by the contract to be covered for thermophysical properties include, as a minimum, metals and metal alloys, ceramics, cermets, intermetallics, polymers, and composites, and those for electronic (including also electrical, magnetic, and optical) properties to be given priority coverage include elements, inorganic compounds, alloys, intermetallics, glasses, ceramics, cermets, applied coatings, polymers, composites, and systems.

The strategy of literature search has been to use both the abstracting journals and the scientific and technical journals. A number of selected journals have been subscribed and furthermore the journals subscribed by Purdue Libraries have been fully utilized. The top ten high-yield scientific and technical journals for thermophysical properties are noted below:

1. Physical Review
2. Journal of Chemical Physics
3. Journal of Applied Physics
4. Russian Journal of Physical Chemistry
5. Soviet Physics - Solid State
6. Inorganic Materials (USSR)
7. Physica Status Solidi
8. Applied Optics
9. High Temperature (USSR)
10. Solid State Communications

The top ten high-yield scientific and technical journals for electronic properties are as follows:

1. Journal of Applied Physics
2. Soviet Physics - Semiconductors
3. Physica Status Solidi
4. Physical Review
5. Soviet Physics - Solid State
6. Solid State Communications
7. Physics Letters
8. Journal of Physical Society of Japan
9. AIP Conference Proceedings
10. Japanese Journal of Applied Physics

In addition to searching selected technical journals, four abstracting journals covering the open literature and four government abstracting journals covering the government report literature are monitored. These are:

1. Chemical Abstracts
2. Physics Abstracts
3. Electrical and Electronics Abstracts
4. Dissertation Abstracts International
5. Scientific and Technical Aerospace Reports (NASA)
6. Technical Abstracts Bulletin (DDC)
7. U. S. Government Reports Announcements (NTIS)
8. Technical Translations (NTIS)

In monitoring these abstracting journals, computer-screened inputs have been used. Close to 1.5 million abstracts were screened by computer using carefully designed search logics. These basic sources and other minor sources yielded 92,000 hits in this 24-month contractual period. These 92,000 potentially good entries were further scrutinized manually to yield 8,800 pertinent references on thermophysical properties and 16,000 pertinent references on electronic properties. This and other statistical data showing TEPIAC's overall scientific documentation accomplishments in this period are presented in Table 2. Table 2 shows that 94,400 research documents on thermophysical properties and 116,400 research documents on electronic, electrical, magnetic, and optical properties

TABLE 2. STATISTICAL SUMMARY OF SCIENTIFIC DOCUMENTATION ACCOMPLISHMENTS

Thermophysical Properties

	Total as of 31 Dec. 1976	This Period	Total as of 31 Dec. 1978
Potential abstracts further scrutinized	----	36,000	----
Documents identified (references in system)	85,600	8,800	94,400
Documents on hand (microfiches and hard copies)	77,870	9,513[a]	87,383
Documents reviewed, coded, and catalogued	73,400	2,790[a]	76,190
Codification entries on all properties	283,392	8,480	291,872

Electronic Properties

	Total as of 31 Dec. 1976	This Period	Total as of 31 Dec. 1978
Potential abstracts further scrutinized	----	56,000	----
Documents identified (references in system)	100,400	16,000	116,400
Documents on hand (microfilms, microfiches, and hard copies)	67,043	11,271	78,314
Documents reviewed, coded, and catalogued	66,809	8,546	75,355
Codification entries on all properties	221,050	23,801	244,851

[a] Work in this area was suspended for about 14 months in order that the staff could overhaul the bibliographic information system and magnetic tape search files.

have been identified and selected for the TEPIAC data base as of 31 December 1978. It is expected that on the average about 4,000 to 4,500 research documents on thermophysical properties and 6,000 to 8,000 research documents on electronic, electrical, magnetic, and optical properties will be added to the TEPIAC data base every year.

In addition to the basic sources, TEPIAC has searched certain specialized sources such as special bibliographies, compendia, conference proceedings, symposium volumes, and listings of doctoral dissertations and master theses. Of particular note is the Kobe Affiliate[a] of CINDAS at Kobe, Japan, who has served a very important input function for Far Eastern literature. Furthermore, TEPIAC has continued to develop its cooperative working arrangements on the exchange of research results and information with major national and international laboratories and institutions engaged in thermophysical and/or electronic properties research. Through these highly developed procedures and arrangements, TEPIAC has a high level of confidence in regard to completeness of its input of source information.

Recent statistics shows that research documents on thermophysical and electronic properties come from the following major sources:

	Percent
Journal articles from Purdue library subscriptions	47.5
Journal articles from TEPIAC subscriptions	9.7
Journal articles from authors	26.5
Journal articles from Library of Congress	4.3
Government reports from DDC	4.4
Government reports from NTIS	3.2
Ph.D. dissertations and M.S. theses	1.8
Other sources	2.6
Total	100%

The above listing indicates that scientific and technical journal articles and other open literature constitute about 92 percent of the total research documents and government reports constitute only about 8 percent.

TEPIAC's specialized holdings of research documents, which number 87,383 on thermophysical properties and 78,314 on electronic properties as of 31 December 1978 as shown in Table 2, constitute a unique national asset and are assuming increasing importance for rapid access to the world literature on thermophysical and electronic properties. Many of these research documents, though readily available from TEPIAC, are very difficult to obtain elsewhere especially in the

[a] This CINDAS' overseas affiliate is supported through other sources.

cases of foreign literature and special publications of limited distribution. It is our experience that literature retrieval programs which yield only bibliographies as their end product are becoming increasingly less useful because of the difficulty and time lapse involved in procuring the cited documents. To remedy this situation, TEPIAC has long been supplementing the practice of submitting bibliographic responses to literature search requests with copies of the actual documents in the form of standard microfiche or hard copy.

2. DOCUMENT REVIEW AND CODIFICATION, MATERIAL CLASSIFICATION, AND INFORMATION ORGANIZATION

As each pertinent research document was received, it was immediately microfiched and then thoroughly reviewed. Pertinent information was extracted from the document with respect to the particular property measured or treated and the temperature range, the material tested and its physical state, the subject coverage of the document, and the language used. All these except the material name were translated into mnemonic code letters, and the material was assigned a material number according to an established material classification scheme. The code letters, material number, and document number were recorded on a specially designed Coding Form (see Figure 1), and were processed subsequently by computer for storage and retrieval, and also for publication of the Research Literature Retrieval Guides. The code designations for codification of literature on thermophysical and electronic properties are given in Tables 3 and 4, respectively.

As shown in Table 2, in this 24-month contractual period 8,546 documents on electronic properties were reviewed, coded, and catalogued, and the coded information was processed by computer. Approximately 16 percent of the documents on electronic properties were coded from abstracts.

For thermophysical properties the review, coding, and cataloguing activities were suspended for about 14 months in order that the staff could completely overhaul the bibliographic information system, which involved, among other things, the generation of a unique computerized material index, the complete editing of the various segments of the bibliographic data base for complete internal consistency as well as compatibility with the new bibliographic data base on electronic properties. These improvements result in a more efficient codification and search operation and enable putting the entire bibliographic data base on

Figure 1.

CODED BY: _____

DATE: _____

TECHNICAL CODING FORM

38 40 41 42 43 44

PAGE No.

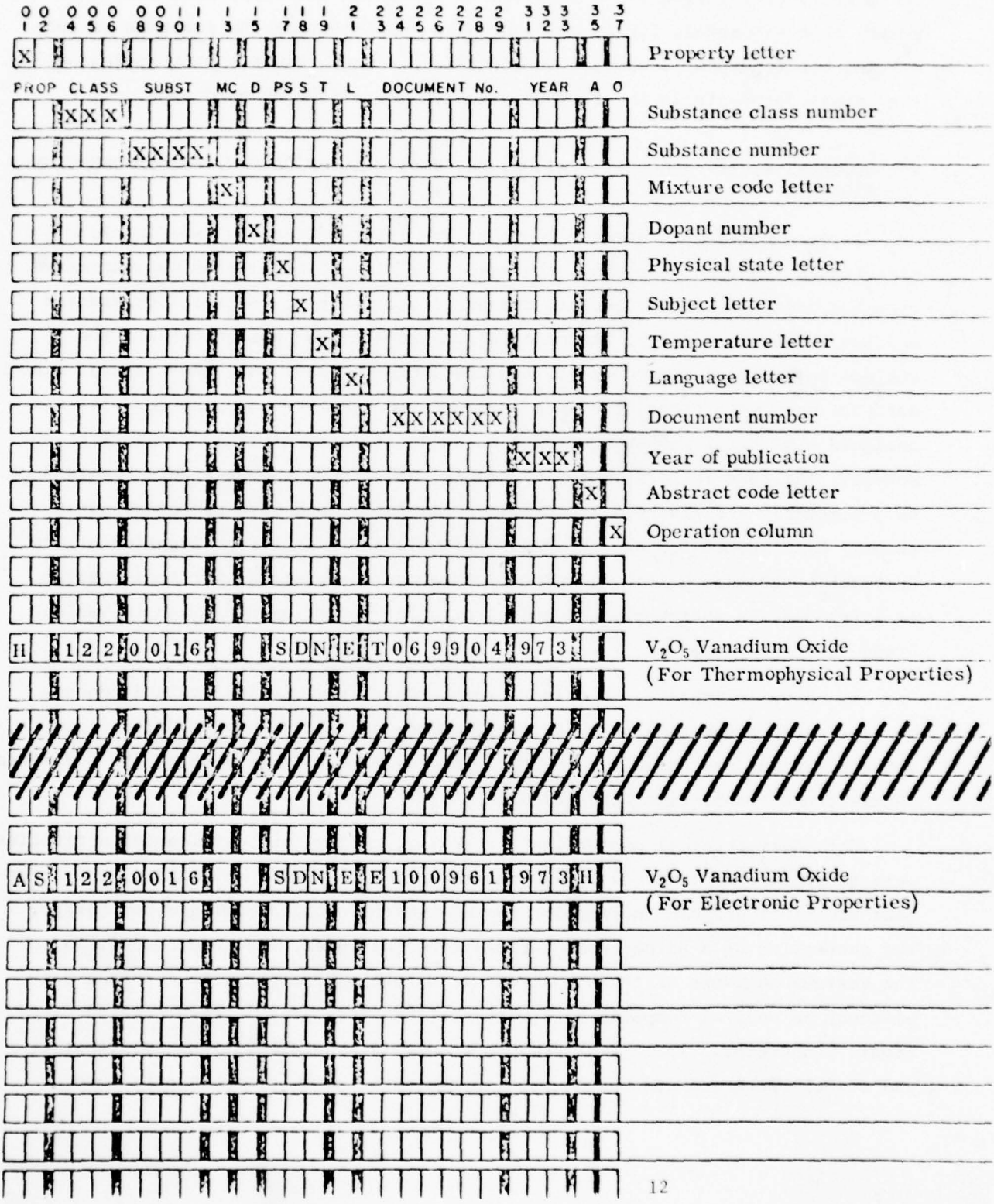


TABLE 3. CODE DESIGNATIONS FOR CODIFICATION OF LITERATURE ON THERMOPHYSICAL PROPERTIES

Property:	A - Thermal conductivity
	B - Accommodation coefficient
	C - Thermal contact resistance
	D - Thermal diffusivity
	E - Specific heat at constant pressure
	F - Viscosity
	G - Emittance
	H - Reflectance
	I - Absorptance
	J - Transmittance
	K - Absorptance to emittance ratio
	L - Prandtl number
	N - Thermal linear expansion coefficient
	O - Thermal volumetric expansion coefficient
Physical State:	D - Doped
	E - Expanded
	F - Fibrous or whisker
	G - Gas
	L - Liquid
	M - Multiphase
	P - Powder or fine particle
	S - Solid
Subject:	C - Theory + Data
	D - Data
	E - Experiment + Theory
	G - Experiment + Theory + Data
	M - Experiment + Data
	S - Survey, review, compendium, data collection, etc.
	T - Theory
Language:	C - Czechoslovakian
	D - Dutch
	E - English
	F - French
	G - German
	I - Italian
	J - Japanese
	O - Other
	P - Polish
	R - Russian
	S - Spanish
Temperature:	F - Full range (Low + Normal + High)
	L - Low (0 to 75 K)
	N - Normal (above 75 K to 1273 K)
	H - High (above 1273 K)
	U - Unspecified

TABLE 4. CODE DESIGNATIONS FOR CODIFICATION OF LITERATURE ON ELECTRONIC PROPERTIES

Property	Dopant	Physical State	Temperature
AS-Absorption coefficient	1-Group IA & IB	A-Amorphous	L-Low (0 to 75 K)
DC-Dielectric constant	2-Group IIA & IIB	C-Superconductive	N-Normal (above 75 K to 1273 K) or unspecified
DS-Dielectric strength	3-Group IIIA	D-Doped	
EB-Energy band	4-Group IVA	E-Expanded	
EF-Effective mass	5-Group VA	F-Fibrous or whisker	H-High (above 1273 K)
EG-Energy gap	6-Group VIA	G-Gas	
EH-Electric hysteresis	7-Group VIIA & VIIIA	I-Ionized (plasma)	
EL-Energy level	8-Group IVB, VB, VIB, VIIB, & VIII	L-Liquid	
ER-Electrical resistivity	9-Group IIIB, Lanthanide Series, Actinide Series	M-Multiphase	
HC-Hall coefficient	0-Other or unspecified	P-Powder or fine particle	
MH-Magnetic hysteresis		S-Solid	
MO-Mobility		T-Thin or thick film	
MS-Magnetic susceptibility			
RI-Refractive index			
WF-Work function			
EP-Electron emission properties	Form of Document	Subject	Language
GP-Magnetoelectric properties	A-Coded from abstract	D-Data	C-Czechoslovakian
LP-Luminescence properties	B-Coded from abstract, document available	E-Experiment	D-Dutch
MP-Magnetomechanical properties	H-Coded from hard copy	G-Experiment + Theory + Data	E-English
PP-Photoelectronic properties	M-Coded from microform (microfiche or microfilm)	S-Survey, review	F-French
TP-Thermoelectric properties	T-Coded from translation	T-Theory	G-German
ZP-Piezoelectric properties			I-Italian
			J-Japanese
			O-Other
			P-Polish
			R-Russian
			S-Spanish

magnetic tape. Due to the above diversion of efforts, only 2,790 documents on thermophysical properties were reviewed, coded, and catalogued, as indicated in Table 2.

For thermophysical properties, the technical coding of the 2,790 documents yielded 8,480 codification entries in the computerized document file on the 14 properties, making a total of 291,872 codification entries in the file as of 31 December 1978. One codification entry represents usually one property of one material. For electronic properties, the technical coding of 8,546 documents yielded 23,801 codification entries in the computerized documentation file on the 22 properties, making a total of 244,851 codification entries as of 31 December 1978. Tables 5 and 6 show the file composition for thermophysical and electronic properties, respectively, by indicating the percentages of codification entries of the various properties with respect to the total number of entries. It is noted that the percentages of codification entries for most of the properties remain fairly constant over the years.

The organization of the thermophysical and electronic properties information is by material, and thus a sound material classification scheme which can properly accommodate all materials and substances is very important. The established material classification scheme has been designed to accommodate materials and substances into similar groups, selected preferably by their chemical composition. However, because of their inherent nature, certain materials do not lend themselves to a purely chemical classification and a more logical method has been adopted to classify them, instead, by their physical form and/or use and application. The present classification scheme has been used successfully over the years for the classification of the more than 46,000 different materials and substances, for which information is available in the TEPIAC file.

3. COMPUTERIZED BIBLIOGRAPHIC INFORMATION STORAGE AND RETRIEVAL SYSTEM

A completely new bibliographic file maintenance and retrieval system has been completed. By using the CDC 6500 computer facility at Purdue University, to which TEPIAC is connected with three dedicated terminals, this new information storage and retrieval system is being used by TEPIAC to provide bibliographic searches for both thermophysical and electronic properties in response to specific inquiries. This new system is designed to reduce operating costs, eliminate certain manual procedures, assure integrity of the information, and provide a more flexible, powerful, and responsive search capability.

TABLE 5. THERMOPHYSICAL PROPERTIES FILE COMPOSITION

Property	% File
Thermal conductivity	21.5
Accommodation coefficient	0.3
Thermal contact resistance	0.5
Thermal diffusivity	1.9
Specific heat at constant pressure	18.4
Viscosity	22.5
Emittance	2.0
Reflectance	4.3
Absorptance	1.0
Transmittance	3.4
Absorptance to emittance ratio	0.1
Prandtl number	0.3
Thermal linear expansion coefficient	6.4
Thermal volumetric expansion coefficient	0.8
Thermal radiative properties	4.0
Diffusion coefficient	10.3
Surface tension	2.2
	100%

Subject	% File
Data	62.5
Experiment	3.0
Theory	4.5
Experiment + data	2.4
Theory + data	13.2
Experiment + theory + data	10.0
Survey, review, compendium, data compilation, etc.	4.4
	100%

Temperature Range	% File
Low (0 to 75 K)	6.9
Normal (above 75 K to 1273 K)	63.3
High (above 1273 K)	11.5
Full range (Low + Normal + High)	0.6
Unspecified	17.6
	100%

Physical State	% File
Solid	47.8
Liquid	32.3
Gas	13.0
Doped	0.9
Expanded	0.4
Fibrous or whisker	0.2
Powder or fine particle	2.0
Multiphase	3.3
	100%

Language	% File
English	68.5
Czechoslovakian	0.0
Dutch	0.2
French	3.1
German	8.8
Italian	0.5
Japanese	1.6
Polish	0.1
Russian	15.8
Spanish	0.3
Others	1.0
	100%

TABLE 6. ELECTRONIC PROPERTIES FILE COMPOSITION

Property	% File
Absorption coefficient	7.7
Dielectric constant	4.2
Dielectric strength	0.8
Energy bands	2.0
Effective mass	1.2
Energy gap	4.9
Electric hysteresis	0.3
Energy levels	5.4
Electron emission properties	2.3
Electrical resistivity	35.4
Magnetoelectric properties	2.0
Hall coefficient	2.5
Luminescence properties	3.1
Magnetic hysteresis	2.3
Mobility	2.8
Magnetomechanical Properties	0.8
Magnetic susceptibility	6.3
Photoelectronic properties	1.8
Refractive index	5.4
Thermoelectric properties	6.6
Work function	1.6
Piezoelectric properties	0.5
	100%

Subject	% File
Data	52.8
Experiment	5.1
Theory	16.5
Survey, review	25.5
	100%

Temperature Range	% File
Low (0 to 75 K)	18.0
Normal (above 75 K to 1273 K) or unspecified	76.9
High (above 1273 K)	5.1
	100%

Physical State	% File
Solid	63.9
Liquid	7.2
Gas	1.1
Doped	12.0
Expanded	0.0
Fibrous or whisker	0.2
Powder or fine particle	0.3
Amorphous	2.6
Thin or thick film	8.7
Ionized (plasma)	0.9
Superconducting	3.0
Multiphase	0.0
	100%

Language	% File
English	77.4
French	1.2
German	2.8
Russian	17.0
Others	1.6
	100%

The new system is build around an integrated file system which provides for direct access to the desired information; this is in contrast to our previous system which performed all operations in a batch sequential mode. As a result we can more easily cross-check information in the files as well as retrieve information at a lower cost. This new system supplants the original system established some 15 years ago.

4. RESEARCH LITERATURE RETRIEVAL GUIDES AND SUPPLEMENTS

The information resulting from scientific documentation efforts on thermophysical properties is disseminated partly through the formal publication entitled "Thermophysical Properties Research Literature Retrieval Guide" as its supplements.

The Basic Edition of the Retrieval Guide which covers the publication years up to 1964 was published in 1967 and contains the resulting information from the first 33,700 research documents. Its full reference citation is as follows:

> Thermophysical Properties Research Literature Retrieval Guide, Touloukian, Y.S. (Editor), Gerritsen, J.K. (Technical Editor), and Moore, N.Y. (Coordinating Editor), Basic Edition, Books 1 to 3, Plenum Press, New York, 2936 pp., 1967.

This basic edition provides a quick access to the world literature on thermophysical properties published from 1822 to June 1964. It contains 139,305 codification entries on thirteen thermophysical properties of 45,116 materials, citing 33,700 references representing 26,562 authors and 3,600 scientific and technical journals and governmental and industrial report sources.

The information on thermophysical properties resulting from the research documents with accession numbers from 33,701 up to 60,000 is contained in the Retrieval Guide Supplement I which was published in early October 1973. Its full reference citation is as follows:

> Thermophysical Properties Research Literature Retrieval Guide, Supplement I (1964-1970), Touloukian, Y.S. (Editor), Gerritsen, J.K. (Technical Editor), and Shafer, W.H. (Managing Editor), Volumes 1 to 6, IFI/Plenum Data Corp., New York, 2225 pp., 1973.

This six-volume Retrieval Guide Supplement I contains 87,050 codification entries on sixteen thermophysical properties of 16,745 materials, citing 26,300 references published from mid-1964 to December 1970. An additional 9,000 synonyms and trade names are cross-referenced to assist the user in identifying the

materials of interest. Supplement I follows essentially the same format of presentation as the Basic Edition. However, it has been restructured for improved user convenience in that the six volumes are actually six independent Retrieval Guides, each of which is for a specific group of materials. As a result, each user group can purchase, at a reasonable cost, selected volumes of specific interest, as well as the complete six-volume set.

Since the publication of the Retrieval Guide Supplement I in 1973, much additional information on thermophysical properties has been accumulated. Table 7 shows the statistical data on thermophysical properties information from the world literature covered by TEPIAC, listing the total number of materials in each material group, the total number of codification entries for each thermophysical property, and the grand totals in our computerized bibliographic information storage and retrieval system as of 31 December 1978.

The information on electronic properties resulting from scientific documentation efforts on research documents with accession numbers up to 49,400 has been published in the "Electronic Properties of Materials: A Guide to the Literature," Volumes 1 (1681 pp., 1965), Volume 2 (1799 pp., 1967), Volume 3 (1917 pp., 1971), and Update (2980 pp., 1972). Since 1973, information on electronic properties has been accumulated from 26,055 additional research documents coded for the new computerized bibliographic information storage and retrieval system. Table 8 shows similarly the statistical data on electronic properties information from the world literature covered by TEPIAC as of 31 December 1978. The number of codification entries given in Table 8 does not include those from the 49,300 research documents with accession numbers 101[a] to 49,400 processed before 1973.

In this contractual period, the preparation for publication of Supplement II to the "Thermophysical Properties Research Literature Retrieval Guide" and of the Basic CINDAS Edition of the "Electronic Properties Research Literature Retrieval Guide" has been completed. The printing pages of the manuscripts have been prepared by computer phototypesetting in the form of negative films. These films will soon be shipped to Plenum Publishing Corp. in New York City for printing. The full reference citation for the Supplement II is as follows:

Thermophysical Properties Research Literature Retrieval Guide, Supplement II (1971-1977), Gerritsen, J.K., Ramdas, V., and Putnam, T.M. (Editors), Volumes 1 to 6, IFI/Plenum Data Co., New York, 1418 pp., 1979.

[a] Accession numbers 1 to 100 have not been assigned to any documents.

TABLE 7. STATISTICAL DATA ON THERMOPHYSICAL PROPERTIES COVERAGE OF THE WORLD LITERATURE[a]

Material Group	No. of Materials as of 31 Dec. 1978
Elements and compounds	12,049
Ferrous and nonferrous alloys	12,784
Mixtures	7,037
Systems, composites, etc.	5,600
Polymers, rubbers, etc.	1,292
Refractories and slags	1,900
Glasses	1,720
Natural products	1,044
Minerals	1,043
Paints, aggregates, cermets, etc.	2,341
Grand Total	46,810

Property	No. of Codification Entries as of 31 Dec. 1978
Thermal conductivity (including accommodation coefficient and thermal contact resistance)	67,611
Specific heat	55,225
Viscosity	64,872
Thermal radiative properties	33,637
Diffusion coefficient (to 1972)	28,780
Thermal diffusivity	5,984
Prandtl number	1,117
Coefficient of thermal expansion	20,464
Others	14,182
Grand Total	291,872

Number of Documents Coded for Retrieval	76,190
Number of Document Sources	8,360

[a] Systematic coverage retrospective to the year 1920 with earlier publications as far back as to the year 1822.

TABLE 8. STATISTICAL DATA ON ELECTRONIC PROPERTIES COVERAGE OF THE WORLD LITERATURE[a]

Material Group	No. of Materials as of 31 Dec. 1978	Property	No. of Codification Entries as of 31 Dec. 1978[b]
Elements and compounds	4,778	Absorption coefficient	9,123
Ferrous and nonferrous alloys	3,143	Dielectric constant	4,909
Systems, composites, etc.	325	Dielectric strength	890
Polymers, rubbers, etc.	480	Energy bands	2,367
Refractories	580	Effective mass	1,411
Glasses	2,180	Energy gap	5,772
Minerals	160	Electric hysteresis	393
Cermets and metal mixtures	232	Energy levels	6,316
		Electron emission properties	2,752
		Electrical resistivity	41,760
		Magnetoelectric properties	2,384
		Hall coefficient	2,949
		Luminescence properties	3,663
		Magnetic hysteresis	2,725
		Mobility	3,267
		Magnetomechanical properties	993
		Magnetic susceptibility	7,399
		Photoelectronic properties	2,147
		Refractive index	6,411
		Thermoelectric properties	7,789
		Work function	1,843
		Piezoelectric properties	588
Grand Total	11,878	Grand Total	117,851

Number of Documents Coded for the New Retrieval System	26,055[b]
Number of Document Sources	8,000

[a] Systematic coverage retrospective to the year 1950 with earlier publications as far back as to the year 1853.

[b] Does not include 49,300 documents processed before 1973.

This six-volume Retrieval Guide Supplement II contains 57,108 codification entries on 14 thermophysical properties of 11,789 materials, citing 18,557 references with accession numbers up to 94,260 and with publication years to 1977. Table 9 gives the title, number of pages, and number of reference citations for each of the six volumes of Supplement II.

The full reference citation for the Basic CINDAS Edition of the "Electronic Properties Research Literature Retrieval Guide" is as follows:

> Electronic Properties Research Literature Retrieval Guide, Basic CINDAS Edition (1972-1976), Chaney, J.F. and Putnam, T.M. (Editors), Volumes 1 to 4, IFI/Plenum Data Co., New York, 1533 pp., 1979.

This four-volume Retrieval Guide Basic CINDAS Edition contains 110,582 codification entries on 22 electronic, electrical, magnetic, and optical properties of 9,634 materials, citing 21,808 references with accession numbers up to 103,608 and with publication years to 1976. Table 10 gives the title, number of pages, and number of reference citations for each of the four volumes of the Basic CINDAS Edition.

TABLE 9. THERMOPHYSICAL PROPERTIES RESEARCH LITERATURE RETRIEVAL GUIDE, SUPPLEMENT II

(Covering the publication years 1971-1977)

		No. of Pages	No. of Reference Citations
Volume 1.	Elements and Inorganic Compounds	496	8345
Volume 2.	Organic Compounds and Polymeric Materials	176	1917
Volume 3.	Alloys, Intermetallic Compounds, and Cermets	271	2703
Volume 4.	Oxide Mixtures and Minerals	150	1651
Volume 5.	Mixtures and Solutions	147	1571
Volume 6.	Coatings, Systems, and Composites	178	2370
		1418	18557

TABLE 10. ELECTRONIC PROPERTIES RESEARCH LITERATURE RETRIEVAL GUIDE, BASIC CINDAS EDITION

(Covering the publication years 1972-1976)

		No. of Pages	No. of Reference Citations
Volume 1.	Elements	490	8021
Volume 2.	Inorganic and Intermetallic Compounds	609	8750
Volume 3.	Alloys and Cermets	247	2839
Volume 4.	Mixtures, Rocks and Minerals, Composites and Systems, Polymers	207	2198
		1553	21808

SECTION III

DATA TABLES ACTIVITIES

1. DATA EXTRACTION AND COMPILATION

As a result of the systematic and comprehensive search of literature in the scientific documentation phase of this program described earlier, the original research documents of interest to TEPIAC are uncovered. These documents are procured and studied, from which the data are extracted, scrutinized, organized, converted to be in uniform units, and homogeneously plotted and tabulated in the form of "Tables of Original Data" which present all the available experimental data and information, as the first stage toward the preparation of internally consistent tables of critically evaluated "best data" referred to as "Tables of Recommended Reference Values." Subsequently, this information is reviewed and the organized data are given a final critical evaluation. At this second stage, the experimental data are analyzed, correlated, and synthesized, and the recommended values are generated. This two-stage data processing is found by TEPIAC to be the most logical approach lending itself to greater effectiveness in bringing to the user the results of this type of painstaking research in the shortest possible time.

The detailed procedures which TEPIAC follows in data compilation as well as in data analysis and synthesis are not necessarily a matter of established routines and do vary from property to property and from one group of materials to another. There are certain principles which must be followed, however, irrespective of the type of data or materials involved. For example: (a) the data should be extracted directly from their original sources to ensure freedom from errors of transcription; (b) the characterization and physical and chemical conditions of the test specimen should be specified as clearly as possible so as to fully identify the materials tested; (c) especially for solids, the source of the material, method of fabrication, thermal history, heat, mechanical, irradiative, and other treatments of the specimen and the measuring method and conditions should be noted; (d) if a comparative measurement method is used, the material used as comparative standard and its property values should be cited; (e) the accuracy and precision of the data reported should be separately denoted; (f) the complete reference to the original work should always be cited with the data; etc. Whenever some of the above criteria cannot be satisfied

because of absence of necessary information in the original work, an attempt is made to contact the author, if possible. In the cases where data cannot be adequately evaluated by TEPIAC due to lack of required information, such data are appropriately "flagged".

In connection with its activities in data processing, TEPIAC has established, through experience, appropriate procedures of operational practice which lend to good organization of work, uniform recording and filing, and other procedures of "good housekeeping," thus assuring ready tractability of original records of processed data, which are permanent working records for reference at any time in the future. Every effort has been made and all necessary steps have been taken to ensure that the data tables production rate is the maximum possible consistent with TEPIAC's high professional standards.

Within each data tables project there are four major tasks: (a) data extraction and compilation, (b) data evaluation, analysis, synthesis, and generation of recommended reference values, (c) text preparation, and (d) preparation of a manuscript for publication.

The statistical summary of accomplishments of the task on data extraction and compilation for all material properties are presented in Table 11, which shows that in this 24-month contractual period 7,313 research documents have been processed for data extraction, yielding 2,988 data source references, and 7,488 data sets have been compiled. These make a grand total of 42,707 research documents processed for data extraction, yielding 19,654 data source references, and TEPIAC has compiled a total of 91,038 data sets in its data file. It is important to note that data extraction and compilation is only one of the tasks and a small part of the total efforts.

TABLE 11. STATISTICAL SUMMARY OF ACCOMPLISHMENTS OF DATA EXTRACTION AND COMPILATION

	Total as of 31 Dec. 1976	This Period	Total as of 31 Dec. 1978
No. of documents processed	35,394	7,313	42,707
No. of documents accepted as data sources	16,666	2,988	19,654
No. of materials compiled	10,226	373	10,599
No. of data sets compiled	83,550	7,488	91,038

In many of the research documents data are presented in graphs only. More than ten years in the past a Gerber Electronic Digitizer had been used at TEPIAC to read data points off graphs. Recently the Gerber Digitizer has been replaced by a higher speed and more versatile Talos Electronic Digitizer/DEC Minicomputer-Data Processor for performing digitizing and more advanced data processing. The new equipment, which was purchased by funds provided by Purdue University, is in full operation. Whenever the graph is too small to give accurate readings, an attempt is made to contact the author for original data in tabular form.

2. DATA EVALUATION, CORRELATION, ANALYSIS, SYNTHESIS, AND GENERATION OF RECOMMENDED VALUES

Owing to the difficulties encountered in the accurate measurement of the properties of materials and in the adequate characterization of test specimens, especially solids, the property data recorded in the scientific and technical literature are often conflicting, widely diverging, and subject to large uncertainty. Indiscriminate use of literature data for engineering and design calculations without knowing their reliability is dangerous and may cause inefficiency or product failure, which at times can be disastrous. Consequently, only critically evaluated data should ever be used. Another important TEPIAC task is, therefore, to critically evaluate and analyze the available data and information, to give judgment on the reliability and accuracy of the data, and to generate recommended values.

The procedure involves critical evaluation of the validity of the data and related information, resolution and reconciliation of disagreements in conflicting data, correlation of data in terms of various controlling parameters, curve fitting with theoretical or empirical equations, comparison of results with theoretical predictions or with results derived from theoretical relationships or from generalized empirical correlations, etc. Besides critical evaluation and analysis of existing data, theoretical methods and semiempirical techniques are employed to fill data gaps and to synthesize fragmentary data so that the resulting recommended values are internally consistent and cover as wide a range of each of the controlling parameters as possible.

Considering the thermal conductivity data for example, in the critical evaluation of the validity and reliability of a particular set of experimental data, the temperature dependence of the data is examined and any unusual dependence

or anomaly is carefully investigated. The experimental technique is reviewed to see whether the actual boundary conditions in the measurement agreed with those assumed in the theoretical model used to define the property. It is ascertained whether all the stray heat flows and losses were prevented or minimized and accounted for. Furthermore, the reduction of data is examined to see whether all the necessary corrections were appropriately applied, and the estimation of uncertainties is checked to ensure that all the possible sources of errors, particularly systematic errors, were considered by the authors. Since the primary factor contributing to unreliable and erroneous experimental results is the systematic error in the measurement, experimental data can be judged to be reliable only if all sources of systematic error have been eliminated or minimized and accounted for. Major sources of systematic error may include unsuitable experimental method, poor experimental technique, poor instrumentation and poor sensitivity of measuring devices, sensors, or circuits, specimen and/or thermocouple contamination, unaccounted for stray heat flows, incorrect form factor, and, perhaps most important, the mismatch between actual experimental boundary conditions and those assumed in the theoretical model used to derive the value of thermal conductivity. These and other possible sources of errors are carefully considered in critical evaluation of experimental data. The uncertainty of a set of data depends, however, not only on the estimated error of the data but also on the adequacy of characterization of the material for which the data are reported.

Besides evaluating and analyzing individual data sets, correlation of data in terms of various controlling parameters is a valuable technique that is frequently used in data analysis. These parameters may include purity, composition, residual electrical resistivity or electrical resistivity ratio (if a metal), density or porosity, hardness, crystal axis orientation, degree of cold working, degree of heat treatment, etc. Applying the principle of corresponding states, reduced property values may be correlated with reduced temperature, pressure, and other reduced parameters.

Several properties of the same material can also be cross-correlated. For instance, thermal conductivity, specific heat, and density can be correlated with thermal diffusivity, and viscosity and specific heat of a gas can be correlated with thermal conductivity through the Chapman-Enskog theory or through the experimental data on the Prandtl number. For a fluid, the property of the saturated liquid can also be correlated with that of the saturated vapor.

It is important to note that irrespective of how much experimental data are available, reliable information exists only after the experimental data had been critically evaluated and recommended values generated. Figures 2 to 9 serve to illustrate this point. Figure 2 presents the experimental data and the recommended values on the thermal conductivity of titanium carbide and shows that the lower two sets of experimental data are utterly erroneous, being about five times too low at 800 K and ten times too low at 1350 K. Yet the lower two sets of data were published by an internationally well-known scientist and were obtained by using two completely different experimental methods for measurement. Titanium carbide has been extensively used to make machine tools. If machine tool designers blindly use the lower data for design without knowing that the data are erroneous, one can imagine the serious consequence.

Figure 3 presents the experimental data and the recommended values on the thermal conductivity of platinum (60%) + rhodium (40%) alloy. This figure shows that the higher experimental data are utterly erroneous, being about 140% too high at 550 K.

Figure 4 presents the experimental data and the recommended values on the thermal conductivity of tungsten and shows that most of the experimental data are erroneous, conflicting, and widely diverging. It has been estimated that the cost of experimental research (around 1968) was about $30,000 per published research paper. Since the number of published papers reporting experimental results on the thermal conductivity of tungsten is larger than 100, a total of over $3,000,000 research funds had been spent to produce the confusion of experimental data shown in Figure 4. It can apparently be seen from Figure 4 that it was not until TEPIAC critically evaluated the discordant experimental data and generated the recommended reference values that the true values of the thermal conductivity of tungsten were known.

Figure 5 presents the experimental data and the recommended values on the thermal diffusivity of tungsten. It shows that the lower three sets of data are utterly erroneous, being about five times too low. The recommended curve shown in the figure generated by TEPIAC not only indicates where the true thermal diffusivity values of tungsten are but also gives the values covering the full range of temperature, going far beyond the limited range covered by the experimental data.

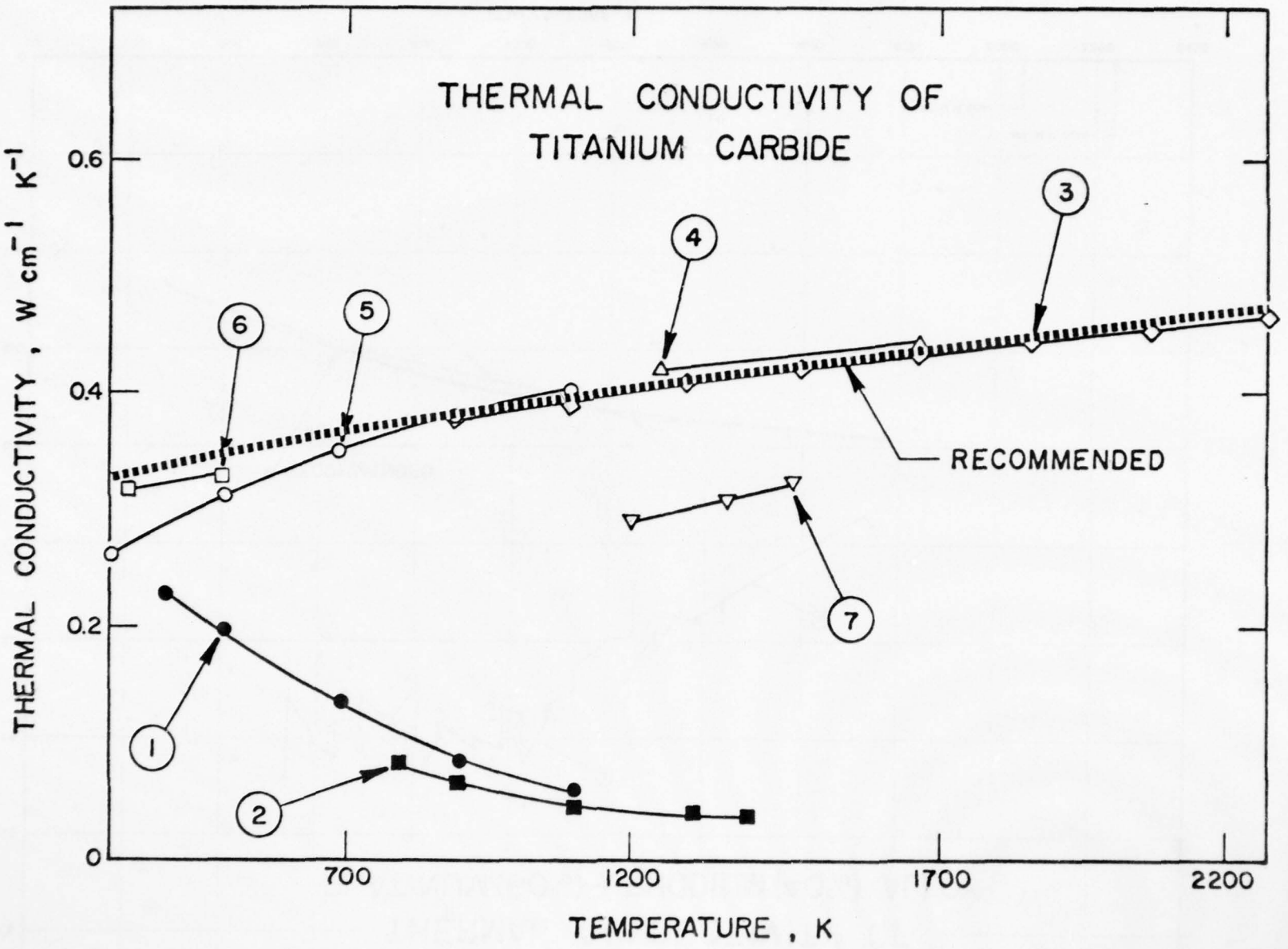


Figure 2. Experimental data and recommended values on the thermal conductivity of titanium carbide. This shows that the lower experimental data are utterly erroneous, being about five times too low at 800 K and ten times too low at 1350 K.

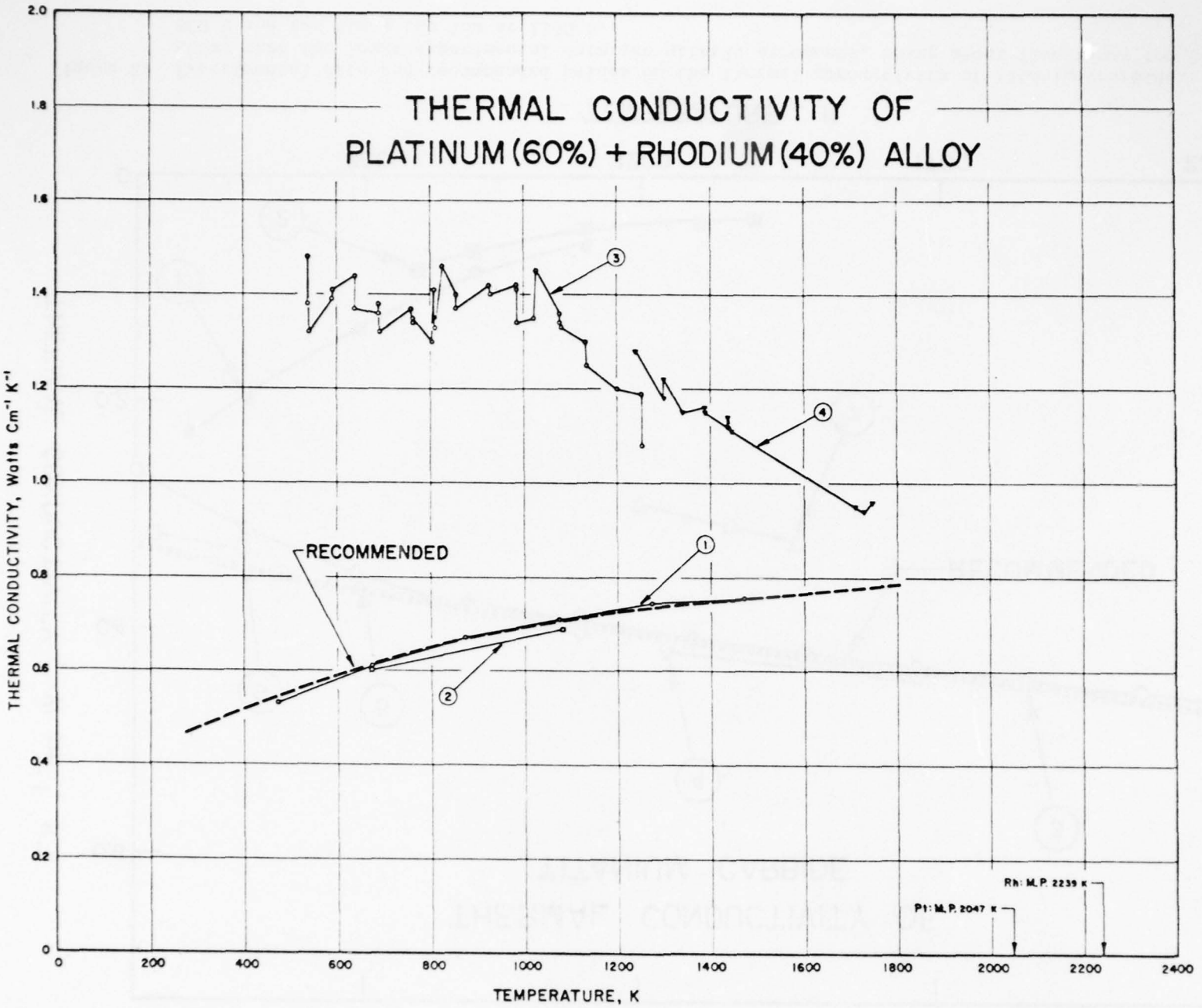


Figure 3. Experimental data and recommended values on the thermal conductivity of platinum (60%) + rhodium (40%) alloy. This shows that the higher experimental data are utterly erroneous, being about 140% too high at 550 K.

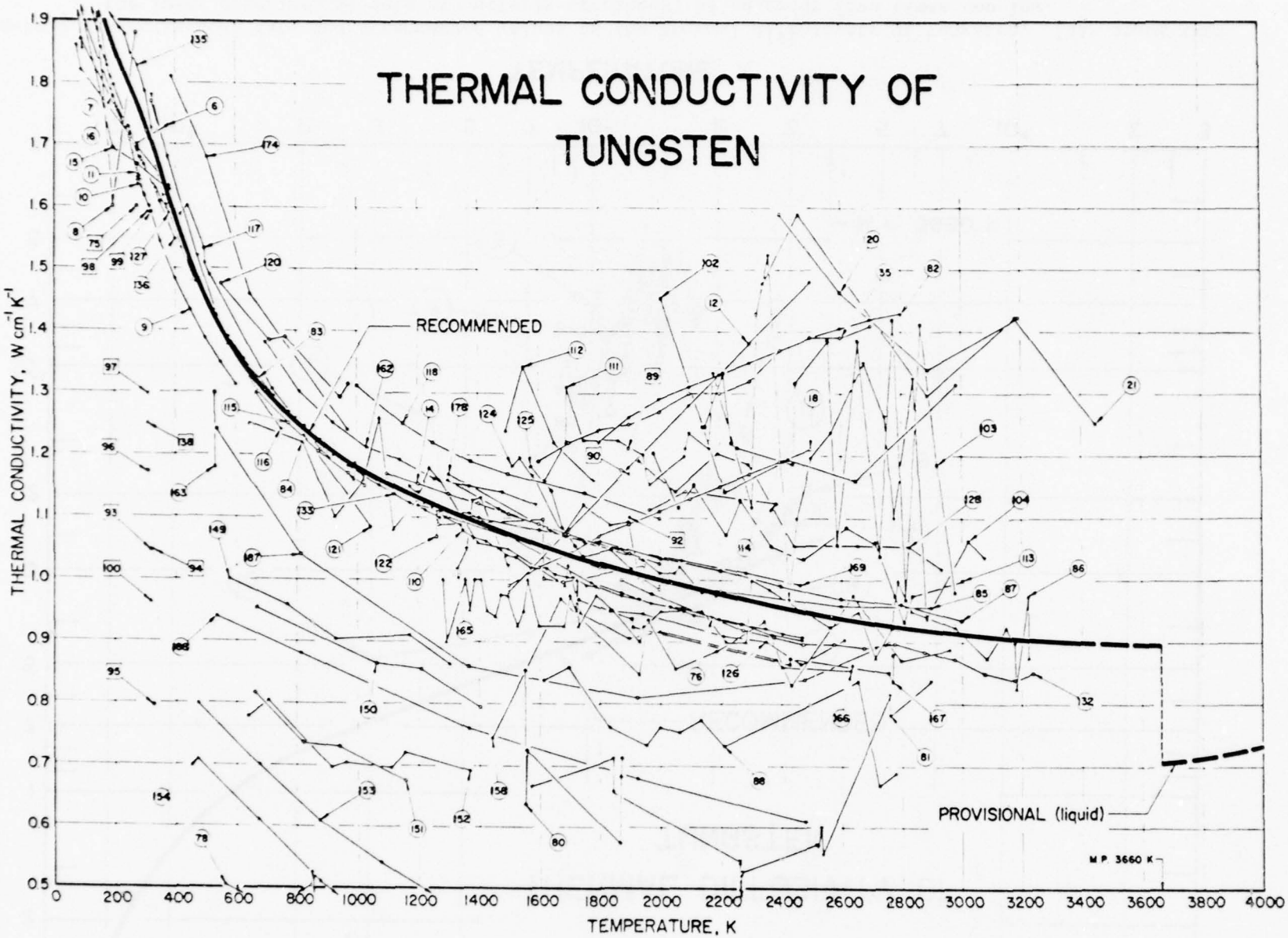


Figure 4. Experimental data and recommended values on the thermal conductivity of tungsten. This shows that most of the experimental data are erroneous, conflicting, and widely diverging.

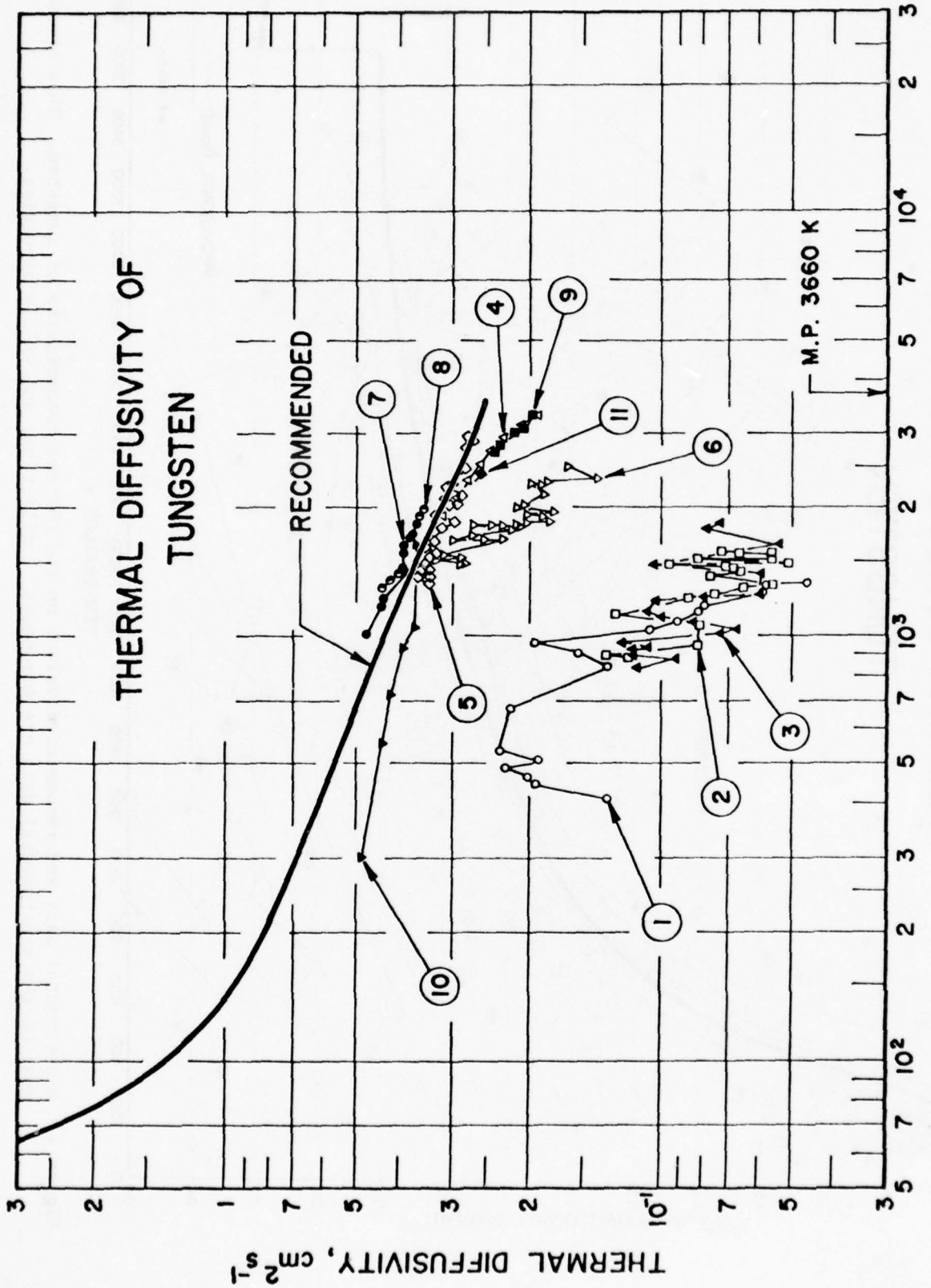


Figure 5. Experimental data and recommended values on the thermal diffusivity of tungsten. This shows that the lower experimental data are utterly erroneous, being about five times too low.

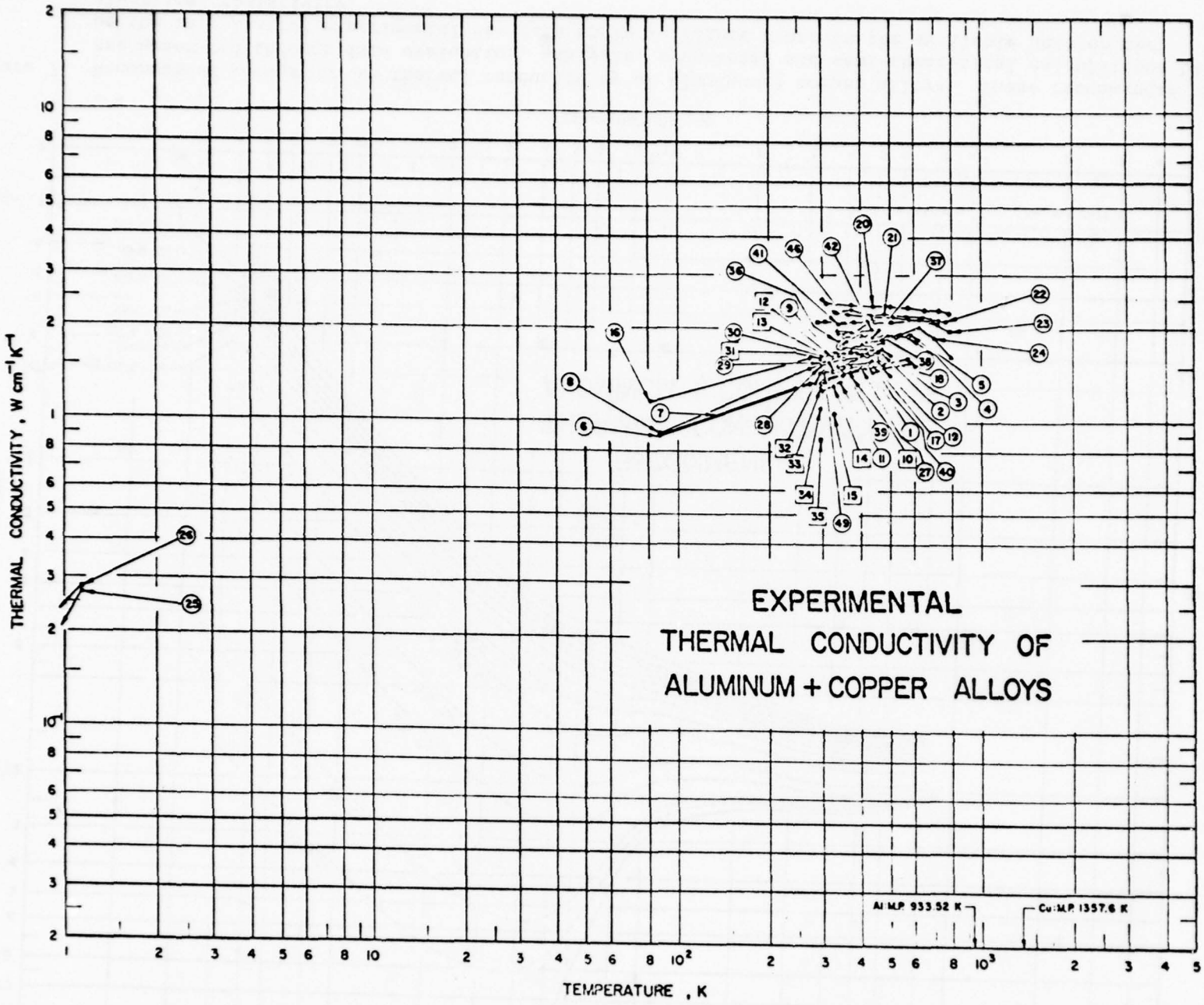


Figure 6. Experimental data on the thermal conductivity of aluminum + copper alloys. These experimental raw data are very limited, fragmentary, and conflicting.

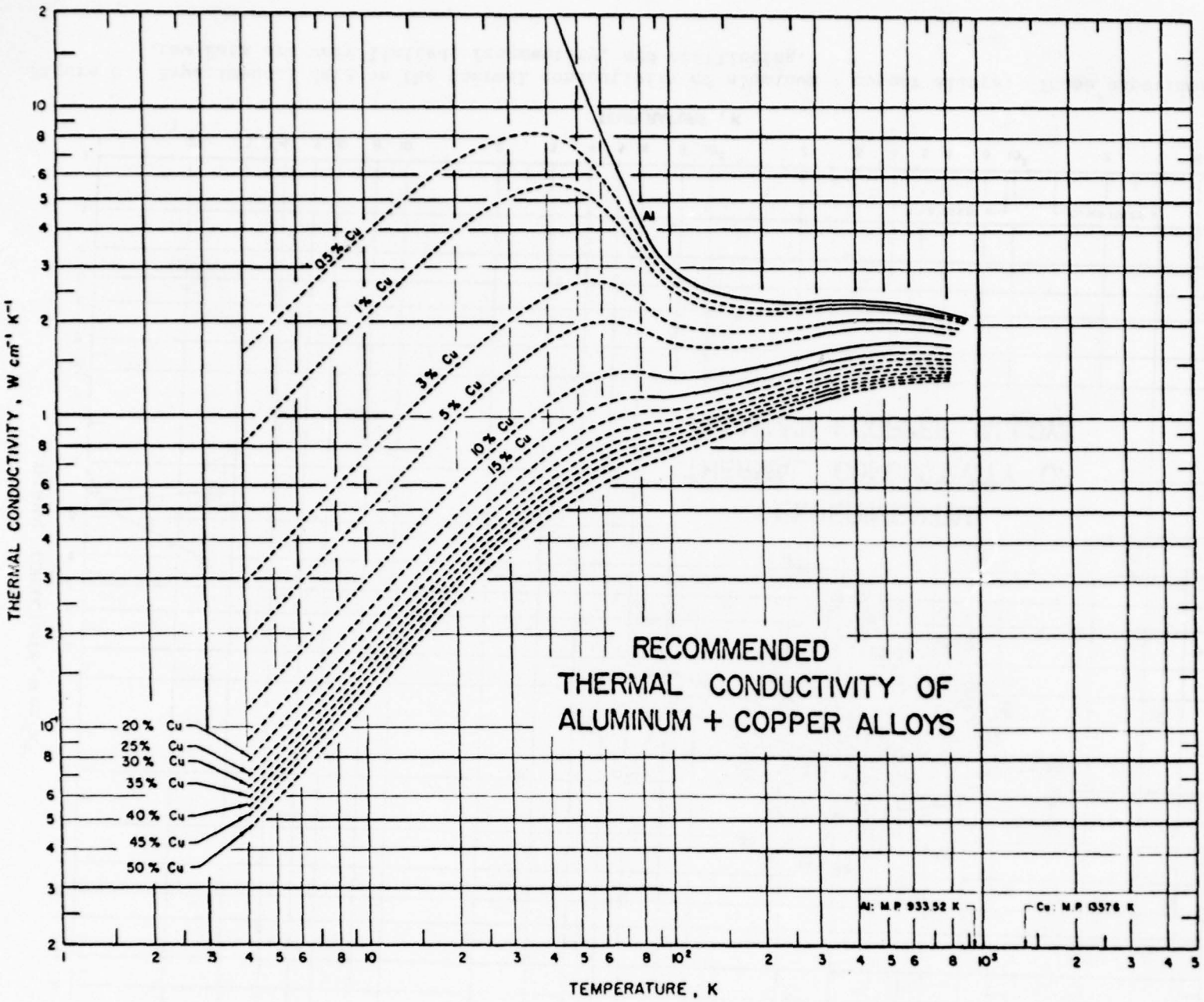


Figure 7. Recommended values for the thermal conductivity of aluminum + copper alloys. These recommended values are generated through data evaluation, analysis, synthesis, and semi-theoretical calculations based on the very limited experimental raw data shown in Figure 6 and on the available data on the electrical resistivity.

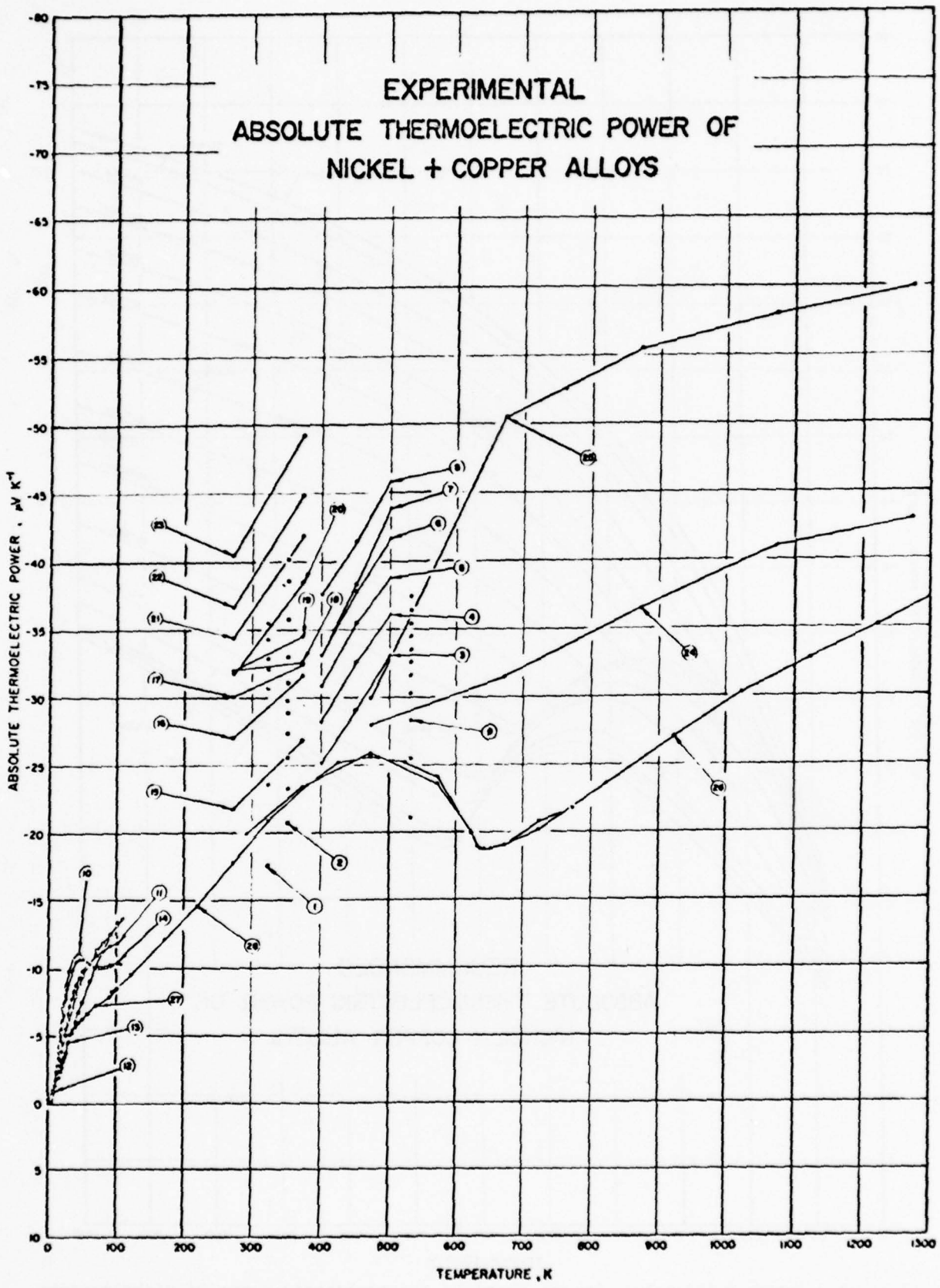


Figure 8. Experimental data on the absolute thermoelectric power of nickel+copper alloys. These experimental raw data are very limited, fragmentary, and conflicting.

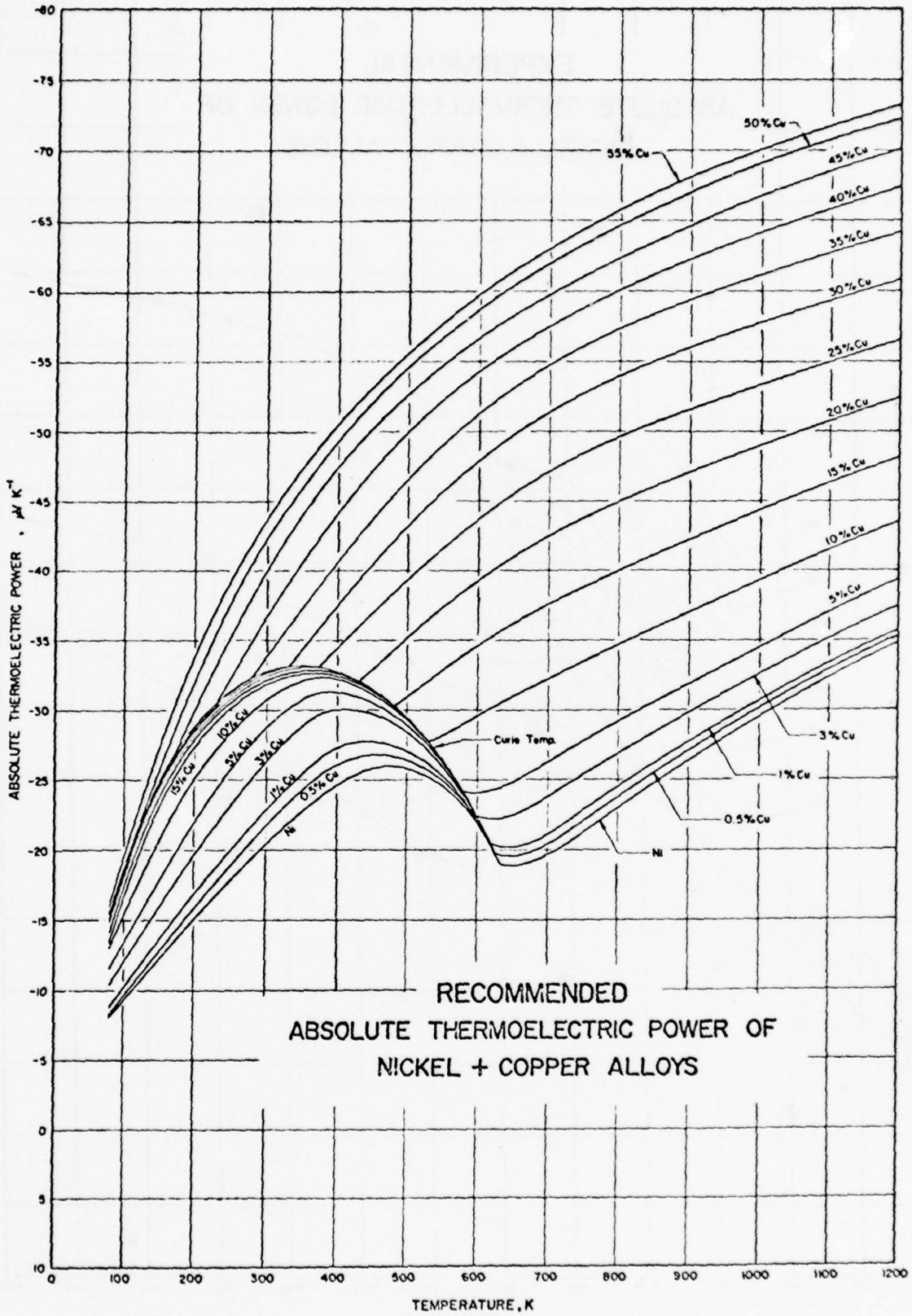


Figure 9. Recommended values for the absolute thermoelectric power of nickel+copper alloys. These recommended values are generated through data evaluation, correlation, analysis, and synthesis from the very limited experimental raw data shown in Figure 8.

Figure 6 presents all the available experimental data on the thermal conductivity of aluminum + copper alloys, which are very limited, fragmentary, and conflicting. Through data evaluation, analysis, synthesis, and semi-theoretical calculations based on some of the data selected from those shown in Figure 6 and on the available data on the electrical resistivity, recommended values were generated which cover the full range of temperature and alloy composition as presented in Figure 7. It should be apparent from this and other illustrations that data evaluation, analysis, and synthesis is a very powerful tool which not only can clean up a body of conflicting and confusing data, but also can create new knowledge heretofore non-existent.

Figure 8 shows all the available experimental data on the absolute thermoelectric power of nickel + copper alloys, which are likewise very limited, fragmentary, and conflicting. Figure 9 presents the recommended values for the absolute thermoelectric power of nickel + copper alloys covering the full range of temperature and alloy composition, which were generated through critical evaluation, correlation, analysis, and synthesis of the limited experimental data shown in Figure 8.

3. HANDBOOKS AND DATA BOOKS[a]

The phenomenal growth of science and technology in recent decades has brought about a universal appreciation of the fact that the availability of adequate reference data for various properties of materials is essential to national progress, economy, and defense. To this end, TEPIAC has been contributing greatly through the generation of reference data tables and the design, preparation, publication, and maintenance of data books and handbooks, which is the principal means of satisfying user requirements for comprehensive and authoritative data and information on material properties.

The monumental 14-volume Thermophysical Properties of Matter - The TPRC Data Series has been completed (see Table 12 for a summary of statistical data) and the 1,786-page Volume 13 was published in December 1977. For the user convenience and for promoting the sale of the Data Series, a Master Index to Materials and Properties for the entire Series has been prepared for publication. This Master Index contains 197 pages and lists alphabetically all the materials contained in the 13 volumes and give the volume number and page

[a] The work on handbooks and data books has been jointly sponsored by DLA and other agencies and organizations.

TABLE 12. SUMMARY OF STATISTICAL DATA ON "THERMOPHYSICAL PROPERTIES OF MATTER - THE TPRC DATA SERIES"

	No. of Pages	No. of Data Sets	No. of Materials	No. of References To Text	No. of References To Data Sources	No. of References Total
Volume 1. Thermal Conductivity - Metallic Elements and Alloys	1595	5539	892	433	1013	1446
Volume 2. Thermal Conductivity - Nonmetallic Solids	1302	4627	812	439	598	1037
Volume 3. Thermal Conductivity - Nonmetallic Liquids and Gases	707	1505	170	681	725	1406
Volume 4. Specific Heat - Metallic Elements and Alloys	830	1186	322	61	428	789
Volume 5. Specific Heat - Nonmetallic Solids	1737	1009	550	61	457	518
Volume 6. Specific Heat - Nonmetallic Liquids and Gases	383	863	56	70	595	665
Volume 6 Supplement	169	726	307	0	878	878
Volume 7. Thermal Radiative Properties - Metallic Elements and Alloys	1644	5130	242	149	371	520
Volume 8. Thermal Radiative Properties - Nonmetallic Solids	1890	4971	782	121	455	576
Volume 9. Thermal Radiative Properties - Coatings	1569	5269	1161	180	295	475
Volume 10. Thermal Diffusivity	760	1733	445	253	315	568
Volume 11. Viscosity	801	1803	188	1218	377	1595
Volume 12. Thermal Expansion - Metallic Elements and Alloys	1440	4253	672	91	781	872
Volume 13. Thermal Expansion - Nonmetallic Solids	1786	4990	815	101	1112	1213
Index Volume. Master Index to Materials and Properties	197	----	6362	---	----	----
Total	16810	43604	----	3858	8400	12258

number for each property of each of the materials listed. This index volume is now in press and should become available from Plenum Data Co. in early 1979.

As the TPRC Data Series is completed, a new plan for the continuing data tables generation and publication with an even greater scope has been developed and is being implemented. In this new plan a 40-volume CINDAS Handbook Series of Material Properties will be prepared and published. Volumes in the new CINDAS Handbook Series will primarily be application (material) oriented, in contrast to the discipline (property) oriented structure of the TPRC Data Series. In other words, each volume in the new CINDAS Handbook Series will contain data on all the important physical properties of a group of materials, rather than containing data on only one property of many materials such as the volume in the old TPRC Data Series. In presenting the property data in each volume, all possible steps will be taken to reduce the buck of the presentation by limiting the content to essential elements of information without sacrificing the information essential for scientific and technical usage of the data presented. In other words, the volumes will comprise mainly the recommended reference values or selected data.

The structure of the new CINDAS Handbook Series of Material Properties has been revised twice since the initial conceptual presentation in 1977. At this time a realistic structure has been attained and it is contemplated that CINDAS Handbook Series will consist of some 41 volumes comprising approximately 14,000 pages. The revised tentative structure and scope of the new Handbook Series is presented in Table 13. The revision of the structuring of the Handbook Series has been mainly the combination of volumes previously conceived. For example, the previously conceived two volumes: one on "Nonstainless Alloy Steels" and the other on "Carbon Steels and Cast Irons" will be combined to become a larger volume entitled "Nonstainless Alloy Steels, Carbon Steels, and Cast Irons"; the completion of this new volume will therefore actually be the completion of previously conceived two volumes on alloys. The previously conceived volume on "Alloys of Hafnium, Molybdenum, Niobium, Tantalum, Titanium, Tungsten, and Zirconium" will combine with three other volumes on alloys to become a much larger volume entitled "Selected Transition-Metal Alloys," the completion of which will actually be the completion of four volumes on alloys.

Table 14 shows the properties to be covered by the volumes of the new Handbook Series. The properties include eleven thermophysical and seven electrical,

TABLE 13. TENTATIVE STRUCTURE AND SCOPE OF "CINDAS HANDBOOK SERIES OF MATERIAL PROPERTIES"

SERIES I. THEORY, ESTIMATION, AND MEASUREMENT OF PROPERTIES

Vol. 1. *Transport Properties of Fluids*
- Thermal Conductivity
- Viscosity
- Diffusion Coefficient

Vol. 2. *Transport Properties of Solids*
- Thermal Conductivity
- Electrical Resistivity and Dielectric Constant
- Thermoelectric Properties

Vol. 3. *Thermodynamic Properties of Solids*
- Specific Heat
- Thermal Expansion

Vol. 4. *Thermal Radiative Properties of Solids*
- Metallic Solids
- Nonmetallic Solids
- Coatings and Thin Films

SERIES II. SPECIAL TOPICS

Vol. 1. *Thermal Accommodation and Adsorption Coefficients*
Vol. 2. *Physical Properties of Rocks and Minerals*
Vol. 3. *Optical Properties*
Vol. 4. *Thermal Radiative Properties of Coatings*
- Pigmented, Contact, and Conversion Coatings

SERIES III. PROPERTIES OF ELEMENTS

Vol. 1. *Selected Ferrous Alloying Elements*
(Cr, Co, Fe, Mn, Ni, and V)

Vol. 2. *Nonmetallic Fluid Elements*
(Ar, Br, Cl, F, He, H_2, I, Kr, Ne, N_2, O_2, Rn, and Xe)

Vol. 3. *Selected Refractory Elements*
(Hf, Mo, Nb, Ta, Ti, W, and Zr)

Vol. 4. *Liquid Metal Elements*
(Li, Na, K, Rb, Cs, Fr, Hg, Ga, and In)

Vol. 5. *Selected Nonferrous Alloying Elements and Precious Metals*
(Al, Be, Cd, Cu, Pb, Mg, Sn, Zn, Au, Ir, Pd, Pt, Re, Rh, and Ag)

Vol. 6. *Rare-Earth and Radioactive Elements*
(Sc, Y, La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Tc, Po, At, Rn, Fr, Ra, Ac, Th, Pa, U, Np, Pu, Am, Cm, Bk, Cf, Es, Fm, Md, No, and Lw)

Vol. 7. *Selected Semiconducting, Semimetallic, Nonmetallic Solid, and Other Elements*
(Ge, Po, Se, Si, Te, Sb, As, Bi, At, B, C, P, S, Ba, Ca, Os, Ru, Sr, and Tl)

SERIES IV. PROPERTIES OF ALLOYS AND CERMETS

Vol. 1. *Stainless Steels*
Vol. 2. *Nonstainless Alloy Steels, Carbon Steels, and Cast Irons*
Vol. 3. *Selected Transition-Metal Alloys*
(Alloys of Cr, Co, Hf, Mn, Mo, Ni, Nb, Pd, Pt, Rh, Ta, Ti, W, U, V, and Zr)

Vol. 4. *Selected Nontransition-Metal Alloys*
(Alloys of Al, Sb, Be, Bi, Cd, In, Pb, Mg, Sn, and Zn)
Vol. 5. *Copper, Gold, and Silver Alloys*
Vol. 6. *Cermets*

SERIES V. PROPERTIES OF FLUIDS AND FLUID MIXTURES

Vol. 1. *Inorganic and Organic Fluids*
Vol. 2. *Commercial Refrigerants and Fluid Mixtures*

SERIES VI. PROPERTIES OF OXIDES AND OXIDE MIXTURES

Vol. 1. *Rare-Earth Oxides and Actinide Oxides*
(Oxides of Sc, Y, La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Ac, Th, Pa, U, Np, Pu, and Am)
Vol. 2. *Electronic Oxides*
(Oxides of Cr, Co, Cu, Fe, Mn, Ni, Ti, V, and Zn)
Vol. 3. *Selected Nontransition-Metal Oxides*
(Oxides of Al, Sb, Ba, Be, Bi, Cd, Ca, Cs, Fr, Ga, Ge, Au, In, Pb, Li, Mg, Hg, Po, K, Ra, Rb, Ag, Na, Sr, Tl, and Sn)
Vol. 4. *Selected Transition-Metal Oxides and Oxides of Selected Nonmetallic Solid Elements*
(Oxides of Hf, Ir, Mo, Nb, Os, Pd, Pt, Re, Rh, Ru, Ta, Tc, W, Zr, As, B, P, Se, Si, and Te)
Vol. 5. *Complex Oxides*
Vol. 6. *Oxide Mixtures*
Vol. 7. *Ceramics and Glasses*

SERIES VII. PROPERTIES OF COMMERCIAL GRAPHITES, COMPOSITES, AND SYSTEMS

Vol. 1. *Commercial Graphites and Carbon-Carbon Composites*
Vol. 2. *Composites (Other Than Carbon-Carbon)*
Vol. 3. *Systems*

SERIES VIII. PROPERTIES OF NON-OXIDE INORGANIC COMPOUNDS AND INTERMETALLIC COMPOUNDS

Vol. 1. *Halides (Bromides, Chlorides, Fluorides, Iodides)*
Vol. 2. *Borides, Carbides, Hydrides, Nitrides, and Silicides*
Vol. 3. *Arsenides, Phosphides, Selenides, Sulfides, and Tellurides*
Vol. 4. *Carbonates, Nitrates, Phosphates, Silicates, and Sulfates*
Vol. 5. *Intermetallic Compounds*

SERIES IX. PROPERTIES OF ORGANIC COMPOUNDS, POLYMERS, BUILDING MATERIALS, FOODS, AND BIOLOGICAL MATERIALS

Vol. 1. *Organic Compounds, Foods, and Biological Materials*
Vol. 2. *Polymers*
Vol. 3. *Building Materials*

TABLE 14. PROPERTIES COVERED BY "CINDAS HANDBOOK SERIES OF MATERIAL PROPERTIES"[a]

I. PROPERTIES PRESENTED AS A FUNCTION OF ONE OR MORE VARIABLES

A. Thermophysical Properties

1. Thermal Conductivity
2. Specific heat
3. Thermal linear expansion
4. Thermal diffusivity
5. Thermal emittance
6. Thermal reflectance
7. Thermal absorptance
8. Thermal transmittance
9. Solar absorptance to emittance ratio
10. Viscosity
11. Prandtl number[b]

B. Electrical, Electronic, Optical, and Magnetic Properties

12. Electrical resistivity
13. Thermoelectric power
14. Dielectric constant[c]
15. Hall coefficient
16. Optical constants (absorption index and refractive index)
17. Magnetic susceptibility

II. PROPERTIES PRESENTED AS A SINGLE VALUE OR FOR ROOM TEMPERATURE

A. Thermophysical Properties

18. Density (at NTP)
19. Normal melting point
20. Normal boiling point
21. Triple point
22. Critical temperature and pressure
23. Phase transition temperature
24. Magnetic transition temperature
25. Superconducting transition temperature
26. Debye temperature (at T)
27. Heat of fusion (at NMP)
28. Heat of vaporization (at NBP)
29. Vapor pressure (at T)

B. Electrical and Electronic Properties

30. Dielectric strength
31. Mobility
32. Energy gap
33. Work function

C. Mechanical Properties

34. Elastic constants (c_{ij})
35. Tensile strength
36. Yield strength
37. Compressive strength
38. Shear strength
39. Impact strength
40. Young's modulus
41. Compressive modulus
42. Shear modulus
43. Bulk modulus
44. Poisson's ratio
45. Hardness
46. Toughness
47. Creep rate
48. Velocity of sound (longitudinal and transverse)

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[a] Data on some of the properties are presented only for selected materials.
[b] Presented only for materials which are fluid at NTP.
[c] Presented only for long wavelengths ($\lambda > 100$ μm).

electronic, optical, and magnetic properties which are to be presented as a function of one or more variables such as temperature, pressure, wavelength, etc. and further include twelve additional thermophysical properties, four additional electrical and electronic properties, and fifteen mechanical properties which are to be given for room temperature or as single values. It is important to note that the properties covered include not only all the important thermophysical, electronic, electrical, magnetic, and optical properties but also all the important room-temperature mechanical properties. Although mechanical properties are outside the scope of TEPIAC, it is believed that it would not be too difficult to obtain their room-temperature values alone and that the inclusion of a large number of mechanical properties (even with values given for room temperature only) would increase the usefulness of the volumes in the new Handbook Series significantly.

In the work on the new Handbook Series, efforts have been concentrated in the preparation of the following four volumes:

(1) Series II-Volume 1. Thermal Accommodation and Adsorption Coefficients

(2) Series III-Volume 1. Selected Ferrous Alloying Elements [Cr, Co, Fe, Mn, Ni, V]

(3) Series III-Volume 2. Nonmetallic Fluid Elements [Ar, Br, Cl, F, He, H, I, Kr, Ne, N, O, Rn, Xe]

(4) Series IV-Volume 1. Stainless Steels

The manuscript of the first volume listed above has been completed and the manuscripts of the second and third volumes are near completion. When the typing, graphing, and composing work on these manuscripts are finished, the camera-ready manuscripts will be shipped to the publisher in New York City for printing. The preparation of the fourth volume is in full progress.

In the meantime the following four volumes are also being worked on:

(5) Series I-Volume 1. Transport Properties of Fluids
- Thermal Conductivity
- Viscosity
- Diffusion Coefficient

(6) Series I-Volume 3. Thermodynamic Properties of Solids
- Specific Heat
- Thermal Expansion

(7) Series I-Volume 4. Thermal Radiative Properties of Solids
- Metallic Solids
- Nonmetallic Solids
- Coatings and Thin Films

(8) Series II-Volume 2. Physical Properties of Rocks and Minerals

4. STATE-OF-THE-ART REPORTS, CRITICAL REVIEWS, AND TECHNOLOGY ASSESSMENTS

In order to keep abreast of the user needs in relation to high-interest technology and information, TEPIAC has prepared and issued state-of-the-art reports, critical reviews, and technology assessments, which are all special technical reports resulted, respectively, from comprehensive studies, extensive critical reviews, and short comparative assessments of current high-interest technology and information.

In this contractual period one major technical report was published and four major technical reports were completed and released as described below.

(1) "Thermophysical Properties of Selected Aerospace Materials. Part II: Thermophysical Properties of Seven Materials," Purdue University, TEPIAC/CINDAS, 242 pp., 1977.

This report contains the most comprehensively compiled experimental data and information on five thermophysical properties of seven selected aerospace materials and presents the recommended values resulting from critical evaluation, analysis, and synthesis of the available data and information. The five thermophysical properties are thermal conductivity, specific heat, heat of fusion, thermal linear expansion, and thermal diffusivity. The seven selected materials are aluminum alloy 2024, AISI 304 stainless steel, Pyroceram (Corning 9606), silicon nitride (Si_3N_4), boron fiber epoxy composite, glass fiber epoxy composite, and graphite fiber epoxy composite. This report was published in a hard-bound book form and copies were available for distribution in July 1977.

(2) "Coder's Manual (A Guide to TEPIAC Documentation)," Purdue University, CINDAS Report 43, 161 pp., 1977.

This special report was the result of a comprehensive study for finding the most efficient way for the operation of the TEPIAC scientific documentation and the result of extensive revision of the rules and procedures used in the past for the codification of research documents. It describes the new operating rules and procedures for TEPIAC's scientific documentation and codification and serves as a working guide for standardizing the work of all staff in order to assure the uniformity and increase the efficiency of output. It also serves as a training tool for new personnel.

(3) "Electrical Resistivity of Copper, Gold, Palladium, and Silver," Purdue University, CINDAS Report 46, 189 pp., 1977.

This technical report contains the most comprehensively compiled experimental data and information on the electrical resistivity of copper, gold, palladium, and silver and presents the recommended reference values resulted from critical evaluation, analysis, and synthesis of the available data and information and also from the knowledge on the theory of electrical resistivity. The recommended values for the total electrical resistivity

cover the full range of temperature from 1 K to well beyond the melting point for both solid and molten states. In addition, recommended values for the intrinsic electrical resistivity are presented for the solid from cryogenic temperature to the melting point.

(4) "Thermophysical, Electrical, and Optical Properties of Selected Metal-Nonmetal Transition Materials: Comprehensive Bibliography with Typical Data," Purdue University, CINDAS Report 50, 154 pp., 1978.

This technical report presents a comprehensive bibliography on twelve thermophysical, electrical, and optical properties of twelve selected metal-nonmetal transition materials. Typical data on each property of each of the twelve materials are provided, if available. The twelve properties covered are thermal conductivity, specific heat, thermal linear expansion, thermal diffusivity, thermal emittance, thermal reflectance, thermal absorptance, thermal transmittance, electrical resistivity, dielectric constant, absorption coefficient, and refractive index. The twelve selected metal-nonmetal transition materials are vanadium dioxide (VO_2), vanadium sesquioxide (V_2O_3), vanadium sesquioxide doped with chromium, vanadium sesquioxide doped with titanium, trivanadium pentoxide (V_3O_5), titanium sesquioxide (Ti_2O_3), niobium dioxide (NbO_2), europium monoxide (EuO), sodium tungsten bronze (Na_xWO_3), nickel monosulfide (NiS), nickel disulfide (NiS_2), and samarium monosulfide (SmS). The information on the characteristics of the selected materials, the nature of the metal-nonmetal transitions in the selected materials, and the transition temperatures and pressures is also given in the report.

(5) "Selected Electrical and Thermal Properties of Undoped Nickel Oxide," Purdue University, CINDAS Report 52, 78 pp., 1978.

This technical report contains the most comprehensively compiled experimental data and information on the electrical resistivity, thermoelectric power, specific heat, thermal conductivity, elastic constants, Young's modulus, and thermal expansion of both single crystal and polycrystalline undoped nickel oxide (NiO) and presents the recommended values for these properties which were generated from critical evaluation, analysis, and synthesis of the available data and information and also from the knowledge on the theory of the properties.

5. COMPUTERIZED NUMERICAL DATA STORAGE AND RETRIEVAL SYSTEM

Although TEPIAC has long possessed a fully Computerized Bibliographic Information Storage and Retrieval System capable of instant retrieval of all kinds of bibliographic information, the Computerized Numerical Data Storage and Retrieval System is still under development.

The development of this numerical data system was supported mainly through other sources. This Computerized Numerical Data Storage and Retrieval System

will comprise two data files (data banks): one for evaluated numerical data (recommended values) and the other for unevaluated numerical data (raw experimental data).

For the evaluated numerical data bank, the overall design of the data bank and of the data capturing scheme has long been completed and the computer programming for storing the data has been finished. However, much remains to be done, especially in the computer programming phase of data retrieval and manipulation. Evaluated data extracted from seventeen data source references have been stored on magnetic tapes in this bank, which currently contains 4,268 evaluated data sets (comprising 69,439 data points) on 15 properties of 1,764 materials. Detailed statistical data on the evaluated data available are given in Table 15.

For the unevaluated data file no work has yet been done.

This development work was halted at the end of 1977 pending the continuation of funding.

This computerized numerical data system, when completed, should eventually be able to perform at least the following functions:

(1) Store and retrieve recommended reference data together with information on material identification and characterization and on data uncertainty.

(2) Store and retrieve experimental data together with information on specimen specification and characterization and on measurement method and condition.

(3) Manipulate data for data analysis, correlation, derivation, curve fitting, etc.

(4) Prepare tables, graphs, and list of references by computer for publication and for answering technical inquiries.

(5) Search for materials with given ranges of values of various properties.

(6) Be used for on-line computer search.

TABLE 15. STATISTICAL DATA ON EVALUATED NUMERICAL DATA BANK

OVERALL STATISTICAL DATA	
Total number of materials	1,764†
Total number of data sets	4,268
Total number of data points	69,439
Total number of properties	15

DISTRIBUTION OF MATERIALS BY SUB-GROUPS	
Material Group	Number of Materials†
Alloys/Intermetallics	960
Compounds(solid at N.T.P.)	565
Fluids(liquid or gas at N.T.P)	161
Elements(including their isotopes)	126

NUMBER OF MATERIALS HAVING ONE OR MORE PROPERTIES	
Number of Materials	Number of Properties for Given Material
1009	1
462	2
144	3
50	4
57	5
19	6
6	7
1	8
8	9
8	10

FREQUENCY OF MATERIAL SUB-GROUPS FOR EACH PROPERTY

Property	Elements	Alloys/ Inter-Metal.	Compounds (solids at N.T.P.)	Fluids (liq./gas at N.T.P.)	Total†
Specific Heat	119	530	404	140	1193
Thermal Linear Expansion	99	294	208		601
Thermal Linear Expansion Coefficient	90	283	169		542
Thermal Conductivity/ Diffusivity	199	162	56	63	417
Electrical Conductivity/ Resistivity	12		152		164
Viscosity	13		124	137	137
Density			123		123
Surface Tension			105		105
Refractive Index and Derivatives			60		60

† The totals of these columns are not equal due to overlap in certain sub-groups of materials.

SECTION IV

INQUIRY SERVICES

TEPIAC's day-by-day contributions in inquiry services to individual users have been primarily in the nature of specialized advisory and technical consulting, data recommendation and prediction, and special bibliographic and data searches. During this 24-month contractual period 1041 inquiries have been responded, of which 889 came from 46 states and the District of Columbia and 152 from 22 foreign countries. It is noted also that 145 of the 1041 inquiries came from government agencies, 222 from academic institutions, and 674 from industrial organizations. Detailed statistical summaries of inquiry responses for 1977 and 1978 are presented separately in Tables 16 and 17. Tables 18 and 19 give breakdowns on the geographical distribution of inquiry responses separately for 1977 and 1978. A summary of inquiry responses for the last 16 years since 1963 is presented in Figure 10.

Over the years TEPIAC has developed a most efficient way for responding to technical and bibliographic inquiries. This is the result of our efficient "User Service Control System," which is based on the concept of having one staff member to be responsible for centralized control and coordination of requests and responses and using the contributions from various staff members whose expertises are in the areas of the requests. Furthermore, in order to expediting the service, TEPIAC accepts authorization for requests for normal technical and bibliographic inquiries by telephone as well as by letter or purchase order. All technical inquiry responses are recorded by the serial number, date, analyst (persons contributing to answering query), total hours, subject code, fee charged or service code, user codes, and mailing address. These recorded data are very useful for user service control and are also reported to the sponsor in the Quarterly R & D Contract Status Reports.

In order to assess the usefulness of TEPIAC's inquiry service and the degree of user satisfaction, a short questionnaire is sent to each inquirer together with the inquiry response (see Appendix 1 for a copy of TEPIAC Technical Inquiry Questionnaire). It should be noted that this simple questionnaire can be easily and quickly filled out by simple checks or short answers to questions. The information from the returned questionnaire is used as a feedback to our User Service Control System for constantly improving the quality of TEPIAC's inquiry service.

TABLE 16. STATISTICAL SUMMARY OF INQUIRY RESPONSES FOR 1977

	Information Request	Publication Request	Technical Question[a]	Bibliographic Search	TOTAL
DOMESTIC					
Government	16	5	37	3	61
Industry	97	31	114	35	277
University	36	12	39	13	100
Subtotal	149	48	190	51	438
FOREIGN					
Government	3	7	3	0	13
Industry	8	7	6	3	24
University	12	5	7	0	24
Subtotal	23	19	16	3	61
TOTAL	172	67	206	54	499

[a] Including data analysis and technical review.

TABLE 17. STATISTICAL SUMMARY OF INQUIRY RESPONSES FOR 1978

	Information Request	Publication Request	Technical Question[a]	Bibliographic Search	TOTAL
DOMESTIC					
Government	21	4	10	7	42
Industry	142	41	111	39	333
University	30	10	21	15	76
Subtotal	193	55	142	61	451
FOREIGN					
Government	10	8	4	7	29
Industry	22	6	9	3	40
University	4	8	9	1	22
Subtotal	36	22	22	11	91
TOTAL	229	77	164	72	542

[a] Including data analysis and technical review.

TABLE 18. GEOGRAPHICAL DISTRIBUTION OF INQUIRY RESPONSES FOR 1977

	No. of Inquiries
Alabama	3
Arizona	4
Arkansas	1
California	80
Colorado	4
Connecticut	10
Delaware	3
District of Columbia	15
Florida	3
Georgia	4
Idaho	3
Illinois	26
Indiana	26
Kentucky	1
Louisiana	2
Maine	1
Maryland	17
Massachusetts	37
Michigan	13
Minnesota	3
Mississippi	4
Missouri	4
Nebraska	1
Nevada	1
New Jersey	12
New Hampshire	2
New Mexico	5
New York	52
North Carolina	3
Ohio	34
Oklahoma	3
Oregon	2
Pennsylvania	28
South Dakota	1
Tennessee	6
Texas	4
Utah	1
Virginia	6
Washington	12
Wisconsin	1
	438
Foreign Countries	61
TOTAL	499

TABLE 19. GEOGRAPHICAL DISTRIBUTION OF INQUIRY RESPONSES FOR 1978

	No. of Inquiries
Alabama	2
Arizona	6
California	70
Colorado	13
Connecticut	19
Delaware	4
District of Columbia	10
Florida	10
Georgia	2
Idaho	3
Illinois	21
Indiana	25
Iowa	3
Kansas	2
Kentucky	1
Louisiana	2
Maryland	12
Massachusetts	28
Michigan	11
Minnesota	9
Missouri	6
Montana	2
Nebraska	1
Nevada	1
New Jersey	20
New Hampshire	1
New Mexico	5
New York	47
North Carolina	1
North Dakota	1
Ohio	30
Oklahoma	3
Oregon	4
Pennsylvania	25
Rhode Island	1
South Dakota	1
Tennessee	4
Texas	13
Utah	2
Vermont	1
Virginia	19
Washington	3
West Virginia	3
Wisconsin	4
	451
Foreign Countries	91
TOTAL	542

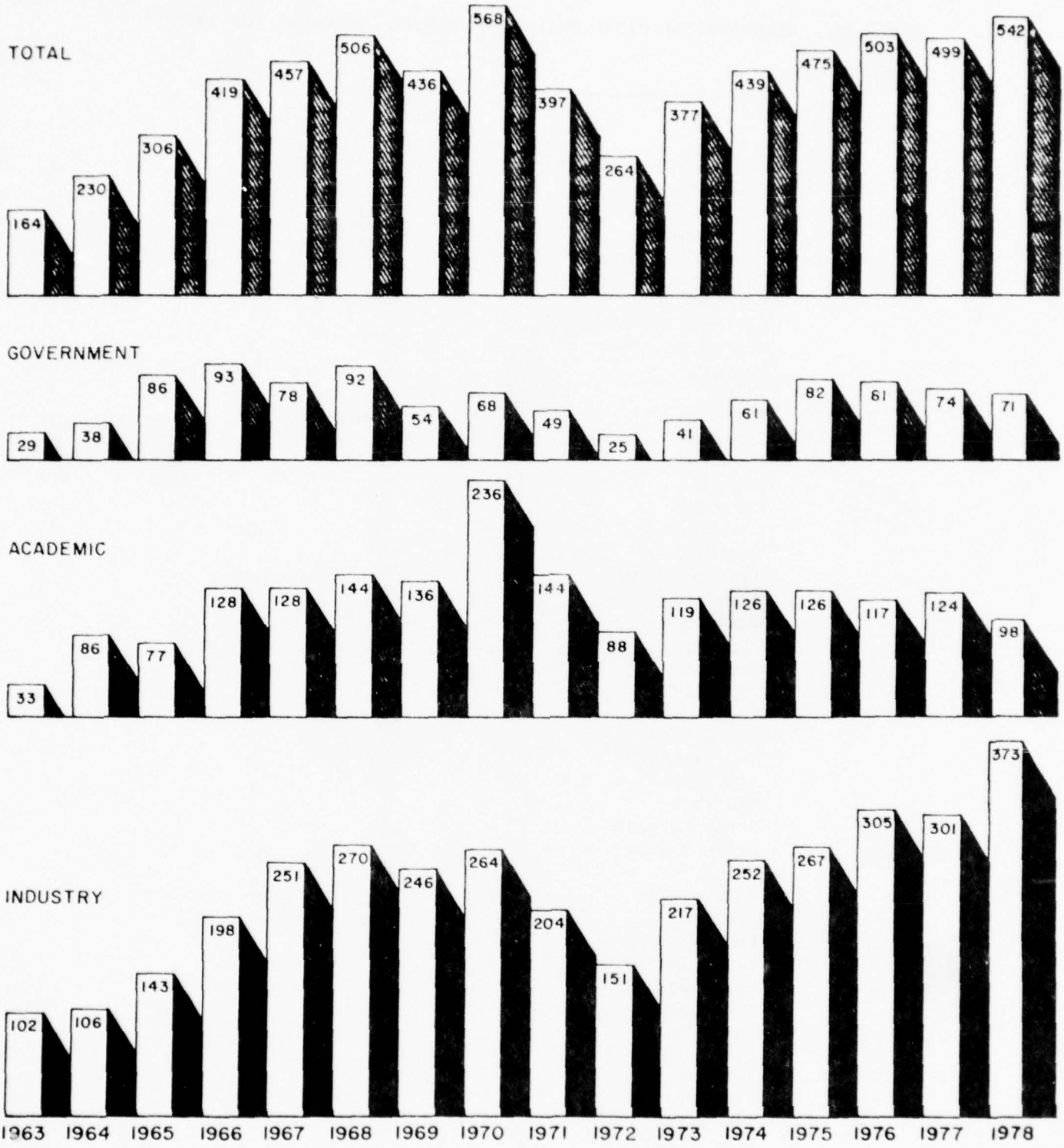

Figure 10. Summary of Inquiry Responses Since 1963.

Between 1 July 1977 and 31 December 1978, 819 questionnaires were sent to inquirers with our responses to their inquiries. A total of 198 completed questionnaires were returned to TEPIAC. The rate of return was an outstanding 24 percent; most survey researchers would consider a 10 percent return to be excellent. The survey results from the returned questionnaires are presented in Appendix 2. It is very encouraging to note from the survey results that more than 20 percent of the users of TEPIAC technical inquiry services were "repeat customers". Note also that another 23 percent users were aware of TEPIAC through their co-workers, who must have given to them good recommendations about TEPIAC. Most users were pleased with TEPIAC responses to their inquiries, as more than 45% users rated the TEPIAC responses to be "very good" while only 14 percent users considered the responses to be of marginal value. About 91 percent of the replies rated the TEPIAC inquiry service as prompt and the charges reasonable, and only 7 percent considered the charges to be too high and 2 percent considered the charges too low. Perhaps the most important information obtained from these questionnaires was the value of the TEPIAC responses to the users. The survey results indicate that 34 percent of the responses saved the users 5 hours or less (these include the responses informing the users that no data/information are uncovered from our exhaustive search for the properties of materials requested), 26 percent of the responses saved the users 40 hours or more, 11 percent of the responses saved the users 20 to 10 hours, another 11 percent saved the users 10 to 5 hours, and 8 percent of the responses saved the users 30 to 20 hours. Those larger savings (far exceeding 40 hours) were from inquiry responses that provided the users with numerical property data rather than bibliographic information. Typical comments of users on TEPIAC inquiry services are also listed in Appendix 2.

It is important to note that even though TEPIAC has provided excellent inquiry services to the users, these services import only a relatively small part of the total information and data that TEPIAC has provided to the users. The major part of the information and data are provided to the users through TEPIAC's major publications. For example, two users commented "we are regularly using Volumes 1-13 of the Thermophysical Properties of Matter - The TPRC Data Series; these volumes are extremely useful in our research". Of course, there are numerous other unreported cases where users use the data and information contained in this and other major publications of TEPIAC. Consider this

13-volume 16,810-page TPRC Data Series alone, of which more than 1,000 sets have been sold. If it is assumed that each volume is used once a month by only one of the engineers or scientists in an organization who would save 40 hours (at $25 per hour) each time by obtaining and using the data and information from the TPRC Data Series, the total savings would be $156,000,000 per year. Even if each volume is used only once a year by only one person, the total savings would be $13,000,000 per year. If each volume is used by several persons, much larger savings to engineers and scientists would be achieved. Adding all the savings from all the major publications of TEPIAC over the years, one would realize how great a contribution TEPIAC has made.

TEPIAC has been maintaining a sound "Service Charge System" including an auditable detailed file of charges and users, and has been seeking its continual improvement. The nominal charges for TEPIAC products and services are as follows:

1. Bibliographic search. The nominal charge for a single bibliographic search is $35. A single bibliographic search is defined as a search for a maximum of five properties of one material for any temperature range and subject area. The number of references retrieved are restricted to 50 citations. In the cases of extensive searches (over 50 citations per search or a large number of materials) or for special search requirements, price quotations are given.

2. Technical consultation, data recommendation, data synthesis and prediction. Minor technical assistance are provided at the rate of $25 per hour. Price quotations are given for extended technical services.

3. Publications. Brochures containing information on the content, availability, price, etc. are sent to requesters for information on major book and report publications. Copies of reprints of journal articles written by TEPIAC staff, if available, are sent to requesters free of charge.

4. Reproductions. The charge for microfiche reporduction is $2.00 per fiche if they are requested with a bibliographic search order and $2.50 per fiche without a search order. Hard copy reproduction is charged at $0.35 per page. A $3.00 special handling charge will be added to the total charge for an order under $10.00.

5. Promotional and current awareness products and general information on TEPIAC. These are provided at no cost.

Most routine users of scientific and technical information generally order and pay for TEPIAC's products and services through their local technical library or through their scientific and technical information office. TEPIAC has the following flexible payment options available:

1. Pre-paid account. This payment option allows an organization to deposit funds with TEPIAC/Purdue University. When TEPIAC delivers products or services in response to orders placed by organization's authorized employees, it will deduct the costs from the deposit account. The requester will be informed of the remaining dollar balance each time technical service is provided.

2. Telephone/letter authorization, pay later. A user may grant approval by telephone or letter for the performance of services for a specified nominal dollar value. TEPIAC provides the technical services to the requester, and Purdue University issues an invoice soon after, making reference to the purchase order number, if available, or to the authorization call or letter and the name of authorizing individual.

3. Account with the National Technical Information Services (NTIS). TEPIAC has an agreement with NTIS which allows user organizations to charge their NTIS account for TEPIAC products and services if they so choose. The requester is reminded, however, that NTIS will add a surcharge to the TEPIAC service fee in billing the customer's account. This surcharge is currently about five percent.

4. Standing order. This plan authorizes an organization to expend a specified amount of funds by anyone from the organization or by specified personnel only over a specified period. As products and services are rendered, TEPIAC invoices the organization through Purdue University against this established standing order.

5. Blanket purchase agreement (BPA) or military deposit account. DOD agencies use this arrangement with a DD Form 1155 (order for supplies and services). A BPA according to the Armed Services Procurement Regulations (ASPR) is a "simplified method of filling anticipated repetitive needs for small quantities of supplies or services by establishing 'charge accounts' with qualified sources of supply. Blanket purchase agreements are designed to reduce administrative costs in accomplishing small purchases by eliminating the need for issuing individual purchase documents." In addition, BPA's allow for timely fulfillment of order.

It is interesting and informative to note those properties and materials on which information is most frequently requested by inquirers. Therefore, a study of the interest profile of all the technical inquiries in this two-year period is made and the findings are presented in Table 20. It can be observed from Table 20 that over 65% of the inquiries were on the top five of the 36 properties and top four of the material groups listed.

Since most users contacted TEPIAC for data and information via the telephone, TEPIAC has installed a national WATS line (No. 1-800-428-7675) to make it easier for all users to call TEPIAC toll free. TEPIAC has attempted a number of innovations in getting the word out and the WATS line is one of the contributions to establish a better and easier communication.

A list of organizations in the United States using TEPIAC inquiry services in the period 1 October 1975 to 31 December 1978 is given in Appendix 3.

TABLE 20. INTEREST PROFILE OF TECHNICAL INQUIRIES

(In the Period 1 January 1977 to 31 December 1978)

A. Properties (listed in the order of interest)

1.	Thermal Conductivity 24.0%	14.	Magnetic Susceptibility . . . 0.7%
2.	Specific Heat 16.0%	15.	Absorption Coefficient . . . 0.6%
3.	Thermal Linear Expansion. .13.0%	16.	Thermoelectric Properties . . 0.6%
4.	Electrical Resistivity . . 9.1%	17.	Magnetic Hysteresis 0.3%
5.	Thermal Diffusivity 6.7%	18.	Mobility 0.3%
6.	Viscosity 5.5%	19.	Thermal Volumetric Expansion. 0.3%
7.	Emittance 4.5%	20.	Energy Levels 0.2%
8.	Refractive Index 3.7%	21.	Thermal Contact Resistance . 0.2%
9.	Reflectance 3.4%	22.	Energy Bands 0.1%
10.	Absorptance 3.1%	23.	Energy Gap 0.1%
11.	Transmittance 2.1%	24.	Work Function 0.1%
12.	Dielectric Constant 1.7%	25.	Misc.(9 Electrical + 3 Thermo.) 2.9%
13.	Dielectric Strength 0.8%		

B. Materials (listed in the order of interest)

1.	Inorganic Compounds 27.6%	9.	Minerals 4.8%
2.	Elements 16.5%	10.	Organic Compounds[a] 2.7%
3.	Non Ferrous Alloys 12.6%	11.	Hydrocarbons. 1.2%
4.	Ferrous Alloys 8.5%	12.	Solutions and Mixtures. . . . 1.0%
5.	Intermetallics 5.8%	13.	Foods 0.7%
6.	Composites and Systems . . 5.6%	14.	Cermets 0.5%
7.	Polymers 5.4%	15.	Coatings 0.3%
8.	Glasses, Refractories, etc. 5.1%	16.	Miscellaneous 1.7%

[a] Excluding hydrocarbons.

SECTION V

CURRENT AWARENESS AND PROMOTION EFFORTS

The "Thermophysics and Electronics Newsletter" has been issued bimonthly since January 1972 to a circulation list of TEPIAC users and potential users as a means of keeping them abreast of significant developments and coming events, the availability of new information and publications, the initiation of new R & D programs, and of the availability of products and services from TEPIAC. The number of names in the mailing list has been increasing slowly and reached 11,000 recently. In this contractual period 12 issues of the Newsletter have been released with a total of 85,500 copies distributed.

The development of an enlarged and computerized mailing list for TEPIAC users and potential users has continued to be in progress. A simple profile code is given to each name on the mailing list so that the computer can generate selective mailing lists from a master file. The new mailing list therefore not only covers a greater percentage of TEPIAC's total audience, but also allows the isolation of selected portions of that audience for specialized mailings, which increases the effectiveness of the mailing and saves much money in dissemination costs.

In order to ensure that TEPIAC users and potential users are aware of the Center, the products and services it offers, and the benefits to be realized through use of the Center, promotional brochures and users guide are periodically issued and distributed, in addition to the distribution of the bimonthly Newsletter. Two new promotional brochures, one 18 pages and the other 5 pages, were produced in this contractual period and thousands of copies have been distributed to make the users and potential users better acquainted with TEPIAC' functions, capabilities, technical assistance, products, and services.

In this 24-month period TEPIAC sponsored the Fifteenth International Thermal Conductivity Conference and the Sixth International Symposium on Thermal Expansion. Furthermore, TEPIAC staff conducted a short course on thermophysical properties, gave four seminars on the methodology of data evaluation, analysis, and synthesis, and participated in fifteen other conferences and meetings. A list of these 22 conferences and meetings is given in Table 21.

TABLE 21. CONFERENCES AND MEETINGS PARTICIPATED BY TEPIAC STAFF MEMBERS IN THE PERIOD 1 JANUARY 1977 TO 31 DECEMBER 1978

Name	Location	Date
DOD Information Managers' Conference	Chicago, IL	Feb. 28-March 1, 1977
Science Information Conference on "Incentives for the Generation, Dissemination and Use of Scientific and Technical Information"	Philadelphia, PA	March 10-11, 1977
CODATA Task Group on Transport Properties Meeting	New York, NY	March 21-22, 1977
Seventh ASME Symposium on Thermophysical Properties	Gaithersburg, MD	May 10-12, 1977
Meeting of Numerical Data Advisory Board and U.S. National Committee for CODATA	Washington, DC	July 13-14, 1977
Fifteenth International Thermal Conductivity Conference	Ottawa, Canada	Aug. 24-26, 1977
Sixth International Symposium on Thermal Expansion	Hecla Island, Manitoba, Canada	Aug. 29-31, 1977
Twelfth Intersociety Energy Conversion Engineering Conference	Washington, DC	Aug. 28-Sept. 2, 1977
Conference on Electrical Transport and Optical Properties of Inhomogeneous Media	Columbus, OH	Sept. 7-9, 1977
Fortieth ASIS Annual Meeting on "Information Management in the 1980's"	Chicago, IL	Sept. 26-Oct. 1, 1977
ASM Materials Show and Materials Conference	Chicago, IL	Oct. 25-27, 1977
Short Course on Thermophysical Properties	West Lafayette, IN	Nov. 7-10, 1977
Materials Technology Conference	Washington, DC	Feb. 21-23, 1978
Physics Seminar on "The Anatomy of Physical Data and the Data Evaluation, Analysis, and Synthesis"	Storrs, CT	March 24, 1978
Seminar on "Methodology of Data Evaluation, Analysis, and Synthesis, and Reference Data Generation Program of TEPIAC"	Argonne, IL	April 13, 1978

Name	Location	Date
Seminar on "Anatomy of Physical Data and Methodology of Data Evaluation, Analysis, and Synthesis"	College Park, MD	April 26, 1978
Seminar on "Reference Data Generation Program of TEPIAC and Methodology of Data Evaluation, Analysis, and Synthesis"	Gaithersburg, MD	April 27, 1978
Sixth International CODATA Conference	Santa Flavia, Sicily, Italy	May 22-25, 1978
Eleventh General Assembly of CODATA	Santa Flavia, Sicily, Italy	May 26-27, 1978
Materials Science Conference on Materials in Solar Energy Collection, Conversion, and Storage	Argonne, IL	June 1-2, 1978
Sixth European Thermophysical Properties Conference	Dubrovnic, Yugoslavia	June 26-30, 1978
Tenth Annual Electro-Optics and Laser 78 Conference	Boston, MA	Sept. 19-21, 1978

TEPIAC has maintained periodic contacts with a number of national and international experts in the field of thermophysics and thermophysical and electronic properties and has developed cooperative working arrangements with a number of national and international laboratories and institutions engaged in thermophysical and/or electronic properties research for the exchange of ideas, technical information, and research results.

As part of the continuing effort to bring about improved awareness of the need and value of using evaluated reference data versus data directly taken from the open literature and of the benefits to be realized through the use of Information Analysis Centers such as TEPIAC, a documentary film entitled "The Anatomy of Data" was produced. "The Anatomy of Data" points out and stresses the serious discord that exists among the numerical data of science and technology as reported in the open research literature. Through on-location interviews with prominent scientists highly knowledgeable in this field, and using examples drawn from our files, the film illustrates the serious pitfalls an engineer or scientist may fall into unless he uses critically evaluated data prepared by such National Information Analysis Centers as TEPIAC. The role and usefulness of data synthesis is also stressed and demonstrated. This movie has been shown to about 150 organizations in this contry and abroad.

SECTION VI

OTHER PUBLICATIONS NOT UNDER THIS CONTRACT BUT IN DIRECT SUPPORT OF THIS PROGRAM

In the following are listed some selected technical products produced in this same period which are not under this contract but are in direct support of this program. Thus, CINDAS' other activities have benefited this program greatly.

1. "Refractive Index of Alkaline Earth Halides and Its Wavelength and Temperature Derivatives," Purdue University, CINDAS Report 44, 206 pp., 1977.
2. "Electrical Resistivity and Thermal Conductivity of Nine Selected AISI Stainless Steels," Purdue University, CINDAS Report 45, 51 pp., 1977.
3. "Establishment and Operation of the Underground Excavation and Rock Properties Information Center (UERPIC)," Purdue University, CINDAS Report 47, 40 pp., 1977.
4. "Methodology in the Generation of Critically Evaluated, Analyzed and Synthesized Thermal, Electrical, and Optical Properties Data for Solid Materials," in The Proceedings of the Fifth Biennial International CODATA Conference, Pergamon Press, Oxford, England, 615-27, 1977.
5. "Thermal Conductivity of Selected Fluids," Purdue University, CINDAS Interim Report, 66 pp., 1977.
6. "Study of Nationwide On-Line Access to Evaluated Engineering Design Data," Purdue University, CINDAS Final Report, 48 pp., 1977.
7. "The Impact of Physical Properties Research on Technological Advancement," in Proceedings of the Seventh Symposium on Thermophysical Properties, ASME, New York, N.Y., 1-6, 1977.
8. "Thermophysical Properties of Polystyrene and Poly(Vinyl Chloride)," in Proceedings of the Seventh Symposium on Thermophysical Properties, ASME, New York, N.Y., 198-218, 1977.
9. "Correlations for the Prandtl Number of Saturated Liquids, Saturated Vapors and Dilute Gases," in Proceedings of the Seventh Symposium in Thermophysical Properties, ASME, New York, N.Y., 739-43,1977.
10. "Thermal Linear Expansion of Nine Selected AISI Stainless Steels," Purdue University, CINDAS Report 51, 46 pp., 1978.
11. "Specific Heat at Constant Pressure of Selected Fluids," Purdue University, CINDAS Interim Report, 102 pp., 1978.
12. "Viscosity of Selected Fluids," Purdue University, CINDAS Interim Report, 104 pp., 1978.
13. "Mechanical, Thermophysical, Optical, Electrical, and Magnetic Properties of Salt," Purdue University, CINDAS Special Report, 1978.
14. "Thermal Conductivity of Ten Selected Binary Alloy Systems," J. Phys. Chem. Ref. Data, 7(3), 959-1177, 1978.

15. "Thermal Conductivity and Electrical Resistivity of Eight Selected AISI Stainless Steels," in Thermal Conductivity 15, Plenum Press, New York, N.Y., 79-104, 1978.

16. "Thermal Diffusivity of Layered Composites," in Thermal Conductivity 15, Plenum Press, New York, N.Y., 135-48, 1978.

17. "Masters Theses in the Pure and Applied Sciences," Plenum Press, New York, N.Y., Volume 21, 290 pp., 1977; Volume 22, 305 pp., 1978. This has been an annual publication of CINDAS with its first volume published in 1957. A brief statistical summary of coverage of this publication is given in Table 20. Table 21 shows a complete list of academic disciplines covered by the publication.

TABLE 22. STATISTICAL SUMMARY OF COVERAGE OF "MASTERS THESES IN THE PURE AND APPLIED SCIENCES"

Volume No.	Publication Date	Thesis Year	No. of Pages	No. of Contributing Institutions	No. of Thesis Titles Reported
1	Oct. 1957	1955	108	93	1,002
		1956		93	1,027
2	Aug. 1958	1957	104	154	1,727
3[a]	Oct. 1959	1958	500	139	3,736
4	Dec. 1960	1959	443	162	4.984
5	Dec. 1961	1960	443	183	5,708
6	Aug. 1966	1961	127	186	5,911
7	Aug. 1966	1962	133	186	6,321
8	Aug. 1966	1963	143	175	6,505
9	Jan. 1968	1964	146	174	6,940
10	Jan. 1968	1965	156	170	7,310
11	Jan. 1968	1966	150	173	7,099
12	July 1968	1967	148	167	6,909
13	July 1969	1968	166	174	7,802
14	Jan. 1971	1969	151	175	7,160
15	July 1971	1970	153	183	7,413
16	July 1972	1971	152	182	7,170
17	July 1973	1972	179	250	8,513
18[b]	Dec. 1974	1973	286	251	10,381
19	Dec. 1975	1974	285	229	10,045
20	Dec. 1976	1975	293	267	10,374
21	Nov. 1977	1976	290	244	10,586
22	Oct. 1978	1977	305	255	10,658

[a] Volume 3 includes also doctoral dissertations for 1956-57 academic year, citing 2846 titles from 103 universities.

[b] Effective with Volume 18, the coverage has been extended to include Canadian universities.

TABLE 23. ACADEMIC DISCIPLINES COVERED BY THE "MASTERS THESES IN THE PURE AND APPLIED SCIENCES"[a]

1. Aerospace Engineering
2. Agricultural Economics, Sciences and Engineering
3. Architectural Engineering and Urban Planning
4. Astronomy
5. Astrophysics
6. Ceramic Engineering
7. Chemical Engineering
8. Chemistry and Biochemistry
9. Civil Engineering
10. Communications Engineering and Computer Science
11. Cryogenic Engineering
12. Electrical Engineering
13. Engineering Mechanics
14. Engineering Physics
15. Engineering Science
16. Fuels, Combustion and Air Pollution
17. General and Environmental Engineering
18. Geochemistry and Soil Science
19. Geological Sciences and Geophysical Engineering
20. Geology
21. Geophysics
22. Industrial Engineering and Operations Research
23. Irrigation Engineering
24. Marine and Ocean Engineering
25. Materials Science and Engineering
26. Mechanical Engineering and Bioengineering
27. Metallurgy
28. Meteorology and Atmospheric Sciences
29. Mineralogy and Petrology
30. Mining and Metallurgical Engineering
31. Missile and Space Systems Engineering
32. Nuclear Engineering
33. Nuclear Physics
34. Nuclear Science
35. Oceanography and Marine Science
36. Petroleum and Natural Gas Engineering
37. Photogrammetric and Geodetic Engineering
38. Physics and Biophysics
39. Plastics Engineering
40. Wood Technology, Forestry and Forest Science
41. Reactor Science
42. Sanitary Engineering and Water Pollution
43. Textile Technology
44. Transportation Engineering

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[a] Mathematical and most life sciences have been excluded on a purely arbitrary basis simply to limit the scope of the work.

SECTION VII

CONCLUSIONS AND FUTURE PLANNING

This Final Report has covered all the tasks and activities of the Thermophysical and Electronic Properties Information Analysis Center in the contractual period 1 January 1977 to 31 December 1978 and has contained details of all technical work accomplished and information gained in the performance of the contract.

TEPIAC has maintained a comprehensive authoritative, and up-to-date national data base on thermophysical, electronic, electrical, magnetic, and optical properties of all important materials, and has disseminated the resulting data and information to the general users at large through publishing major reference works and other technical products and at the same time has provided the data and information directly to individual users through technical and bibliographic inquiry services. As the objective of TEPIAC operations is to increase the productivity of scientists, engineers, and technicians engaged in scientific and engineering programs for the Department of Defense by maintaining a comprehensive and up-to-date national base for use by the entire DOD community and by providing authoritative information and data analysis services, it is obvious that the objective has been achieved very successfully. In fact, the accomplishments of TEPIAC have far exceeded the requirements of the contract.

To the extent that TEPIAC's activities constitute a continuing program, the planning of its activities has been geared to both short range as well as long range goals, thus leading to effective utilization of both intellectual and fiscal resources. As CINDAS operates through the multiple sponsorship of organizations having a common interest, the results obtained from the support provided by one group benefits all others. Thus the supports from all other sources have benefited this contract greatly. Since the support from other sources has been approximately equal to that from DLA, TEPIAC/CINDAS returns to DLA the results of two dollars of research for every dollar invested by the DLA.

In future years TEPIAC will continue to be operated as a full-service DOD information analysis center using the methods and procedures developed and fully established at CINDAS over the years since 1960 for the most efficient and effective service to the Department of Defense and its scientific and technical

community. The past successful performance of TEPIAC assures continued future success in achieving its objective and accomplishing all its tasks.

Among the tasks of TEPIAC, the preparation and publication of volumes in the new Handbook Series is one that should gain much greater momentum, as TEPIAC/CINDAS has always felt that the maximum optimization of its efforts in serving the end users of data and information can best be realized through the publication of major reference works. Due to the low funding level of this program in recent years, the level of effort that can be devoted to this important task is believed far too low. It is earnestly hoped that the level of effort for the Handbook preparation can be increased so that more volumes of the new Handbook Series can be produced in a timely manner.

APPENDICES

APPENDIX 1

TEPIAC TECHNICAL INQUIRY QUESTIONNAIRE

_____19__

QUESTIONNAIRE

(REQUIRED BY CINDAS SPONSORS - PLEASE RETURN)

FROM:

1. How did you find out about us? ___from previous contact, ___a co-worker, ___TEPIAC Newsletters, ___Annual Report, ___referral from another center, ___recent publication, ___other (Explain item 8 below)
2. Did the information/data enclosed satisfy your needs? ___Very good, ___Adequate, ___Marginal.
3. Was the information/data timely to be useful? ___Yes, ___No, because: _____
4. Approximately how much time did the enclosed information/data save your research group? ___more than 40, ___40-30 hours, ___30-20 hours, ___20-10 hours, ___10-5 hours, ___5-0 hours
5. The enclosed information/data will be used in: ___university research program, ___military programs, ___space programs, ___civilian equipment and design programs, ___materials selection, ___input to larger research studies, ___support in-house research, ___material for publication, ___proposal preperation, ___other (Explain item 8 below)
6. Are you on our Newsletter Mailing List? ___Yes, continue sending it to me, ___No, add my name to your list. Fill out the following:
   a. Other communications of interest: ___Annual Report, ___Special announcements on publications/data tapes, ___Other (Explain item 8 below)
   b. Your professional field: _____
   c. Type industry: _____
   d. Organizational function: _____ (Examples: Corp Officer, Project Management, etc)
7. Was our charge reasonable for the service (product) provided? ___Too high, ___Reasonable, ___Too low.
8. Additional Comments: _____

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2595 Yeager Road
West Lafayette, IN 47906

APPENDIX 2

SURVEY RESULTS FROM TEPIAC TECHNICAL INQUIRY QUESTIONNAIRE

Between 1 July 1977 and 31 December 1978 (18 months), 819 TEPIAC Technical Inquiry Questionnaires were mailed out with inquiry responses to inquirers. A total of 198 questionnaires were returned; this is a 24.2 percent return. There are eight questions listed in the questionnaire (see Appendix 1). The responses to each of the eight questions are detailed below.

1. How did you find out about us?

From a co-worker	45	(22.7%)
From a previous contact	41	(20.7%)
From TEPIAC Newsletters	33	(16.7%)
From TEPIAC recent publications	24	(12.1%)
Referral from another center	22	(11.1%)
From CINDAS Annual Reports	5	(2.5%)
From other sources	28	(14.2%)
Total	198	

Typical "other sources" given in the responses are:

"Our information group"
"Reference librarian"
"Frequent use of your publications"
"Brochures mailed to me"
"CINDAS brochures"
"NTIS brochure"
"Critical survey of data sources, NBS (Dec. 75)"
"June issue of R/D magazine"
"CRC handbook"
"A US lecturer on medical physics"
"ASHRAE fundamentals book"
"Kruzas Encyclopedia of Information Systems and Services"
"At ASM Chicago Meeting 1977"
"Via North American Thermal Analysts Society (NATAS)"
"User Guide - DOD Information Analysis Center"

2. Did the information/data enclosed satisfy your needs?

Very good	81	(45.3%)
Adequate	73	(40.8%)
Marginal	25	(13.9%)
Total	179[a]	

3. Was the information/data timely to be useful?

Yes	156	(91.2%)
No (because no data are available)	15	(8.8%)
Total	171[a]	

4. Approximately how much time did the enclosed information/data save your research group?

5-0 hours	34	(37.8%)
More than 40 hours	26	(28.9%)
20-10 hours	11	(12.2%)
10-5 hours	11	(12.2%)
30-20 hours	8	(8.9%)
Total	90[a]	

5. The enclosed information/data will be used in:

Support in-house research	49	(24.7%)
Civilian equipment and design programs	34	(17.2%)
Input to larger research studies	29	(14.6%)
Materials selection	21	(10.6%)
Military programs	20	(10.1%)
Space programs	15	(7.6%)
University research program	13	(6.6%)
Material for publication	10	(5.1%)
Proposal preparation	7	(3.5%)
Total	198	

6. Are you on our Newsletter Mailing List?

No, add my name to your list	126	(71.2%)
Yes, continue sending it to me	51	(28.8%)
Total	177[a]	

7. Was our charge reasonable for the service (product) provided?

Reasonable	105	(91.3%)
Too high	8[b]	(7.0%)
Too low	2	(1.7%)
Total	115[a]	

8. Additional Comments:

Typical "additional comments" given in the responses are:

"I was surprised that the information was found at all - let alone quickly"

"I received a very quick answer to my request for data on thermal expansion of steel"

"Very comprehensive work in your area"

"A tremendous amount of savings in time can be realized with the proper use of this valuable resource"

"Our own group unable to locate any references"

"We could not have done the job"

"We had exhausted all other possible sources"

"Estimate reduction of search time by 90 percent"

"We are regularly using Volumes 1-13 of the Thermophysical Properties of Matter - The TPRC Data Series; these volumes are extremely useful in our research"

"Very pleased with speed and accuracy of your reply"

"I appreciate the friendly and helpful manner you have when dealing with clients"
"Thank you for the assistance that you gave during our telephone conversation"
"You are fulfilling a very worthwhile service and we will continue to turn our service requirements your way"
"Brochures appear to have useful information to be utilized in materials selection for off shore petroleum production platforms"
"In the future I expect your service will be very helpful"
"We hope to use TEPIAC in the future"
"Our tendency is to turn to CINDAS only when all other information sources are inadequate, but it is reassuring to industries such as ours to have this back-up"
"The response from Mr. Shafer was rapid and to the point. I appreciate this type of response"
"You people write nice letters"
"This critical evaluation of research data is extremely valuable to the scientific and engineering communities"
"Appreciated the cordiality and helpfulness of Mr. Shafer"
"Your center has repeatedly been referenced as a prime source of information in my area of research"
"I foresee a need for this type of service in the future - next time I will start with TEPIAC search"
"You offer a valuable service which is much appreciated"
"Very honest and reasonable data source"
"Estimate man-hour savings at 400 hours per year"
"Saved our lab testing time more than 40 hours"
"Very pleased with searches"
"Your objectives are very important and of great help to science and engineering fields"
"Very quick response"

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[a] "No responses" are not included in the statistics - a total of 198 questionnaires were returned.

[b] Six of the eight responses saying the charge being too high were from university students/faculty members and small company employees.

APPENDIX 3

ORGANIZATIONS USING TEPIAC INQUIRY SERVICES[a]

(In the Period 1 October 1975 to 31 December 1978)

A. B. Chance Co.
Centralia, MO

ACRES American
Buffalo, NY

Action Research
Acton, MA

Actron, Inc.
Monrovia, CA

Acurex Corp.
Mountain View, CA

Aerojet Electrosystems
Azusa, CA

Aerojet Nuclear Co.
Idaho Fall, ID

Aerospace Corp.
Los Angeles, CA

Air Force Materials Laboratory
Wright-Patterson Air Force Base, OH

Air Force Office of Scientific Research
Bolling Air Force Base, DC

Air Force Rocket Propulsion Laboratory
Edwards Air Force Base, CA

Air Force Weapons Laboratory
Kirkland Air Force Base, NM

Air Products and Chemical Co.
Allensburg, PA

AIRCO, Inc.
Murray Hill, NJ

Alhegheny Ludlum Steel Corp.
Pittsburgh, PA

Aluminum Company of America
Alcoa Center, PA

American Home Foods, Inc.
LaPorte, IN

American Iron and Steel Institute
Washington, DC

Amoco Chemical Co.
Naperville, IL

Anaconda Brass Co.
Waterbury, CT

Anaconda Co.
Marion, IN

Anamet Lab., Inc.
San Carlos, CA

Argonne National Laboratories
Argonne, IL

Army Materials and Mechanics Research Center
Watertown, MA

Arthur D. Little, Inc.
Cambridge, MA

Ashland Chemical Co.
Columbus, OH

Atlantic Research Center
Alexandria, VA

Atlantic Richfield Hartford Co.
Richland, WA

Atomic Energy Documentation Service, Inc.
Larchmont, NY

Atomic International
Canoga Park, CA

Autonetics, Inc.
Anaheim, CA

[a] Only organizations within the United States are listed.

Babcox and Wilcox Co.
Lynchburg, VA

Baker and Taylor Co.
Somerville, NJ

Ball Corp.
Muncie, IN

Barber Colman Co.
Loves Park, IL

Battelle Columbus Laboratories
Columbus, OH

Battelle-Northwest
Richland, WA

Bechtal Power Co.
San Francisco, CA

Bell Aerospace/Textron
Buffalo, NY

Bell Telephone Laboratories, Inc.
Murray Hill, NJ

Bendix Corp.
Dayton, OH

Bendix Corp.
Davenport, IA

Bendix Corp.
Kansas City, MO

Bettis Atomic Power Laboratories
W. Mifflin, PA

Boeing Co.
Seattle, WA

Boeing Computer Services
Richland, WA

Borg Warner Corp.
Des Plaines, IL

Bresler and Assoc.
New York, NY

Brigham Young University
Provo, UT

Brockway Glass Co.
Brockway PA

Brookhaven National Laboratories
Upton, NY

BRL/Aberdeen Proving Ground
Aberdeen, MD

Brunswick Corp.
Skokie, IL

Bunker Ramo Corp.
Chatsworth, CA

Burns and Roe Co.
Hempstead, NY

Burroughs Corp.
San Diego, CA

California State University
Fullerton, CA

Calspan Corp.
Buffalo, NY

Carson Alexion Corp.
Costa Mesa, CA

Case Western Reserve University
Cleveland, OH

Caterpillar Tractor Co.
Peoria, IL

Chicago Urban Transportation District
Chicago, IL

Climax Molybdenum Co.
Ann Arbor, MI

Chi-Vit Co.
Oakbrook, IL

Chrysler Corp.
Detroit, MI

Colorado State University
Fort Collins, CO

Columbia Gas Systems
Columbus, OH

Columbia University
New York, NY

Combustion Engineering
Chattanooga, TN

Cordis Corp.
Miami, FL

Cornel University
Utica, NY

Corning Glass Works
Corning, NY

CTI Cryogenics
Waltham, MA

Deere and Co.
Moline, IL

Defense Supply Agency
Alexandria, VA

Department of Transportation
Washington, DC

Dert Industries
Paramus, NY

Desota, Inc.
Des Plaines, IL

Detrick Co.
Chicago, IL

Dow Chemical Co.
Midland, MI

E.I. DuPont de Nemours & Co.
Wilmington, DE

DuPont Instruments
Wilmington, DE

Eastman Kodak Co.
Rochester, NY

Electronic Technology
Hanscom Air Force Base, MA

Energy Resources Co.
Cambridge, MA

Engelhard Chemical Corp.
Carteret, NJ

Enirex Corp.
Patterson, NJ

Environment Information Center
New York, NY

Exxon Prod. Research Co.
Houston, TX

Exxon Research Center
Linden, NJ

Fiber Materials, Inc.
Biddeford, MA

Fluids Systems Laboratory
West Lafayette, IN

Ford Aerospace Corp.
Palo Alto, CA

Ford Motor Co.
Detroit, MI

Foxboro Co.
Foxboro, MA

General American Co.
Niles, IL

General Atomic Co.
San Diego, CA

General Electric Co.
Philadelphia, PA

General Electric Co.
San Jose, CA

General Electric Co.
Syracuse, NY

General Electric Co.
Worthington, OH

General Electric Research Laboratory
Schenectady, NY

General Foods Corp.
Tarrytown, NY

General Motors Corp.
Indianapolis, IN

General Motors Technical Center
Warren, MI

General Research Corp.
McLean, VA

Georgia Institute of Technology
Atlanta, GA

Global Engr. Documentation Services, Inc.
Santa Ana, CA

Goodyear Aerospace Inc.
Akron, OH

Goddard Space Flight Center
Greenbelt, MD

Grumman Aerospace Corp.
Bethpage, NY

Harris Thermal Transfer Products, Inc.
St. Tualatin, OR

Harrison Radiator Division/GM Corp.
Lockport, NY

Hercules Inc.
Magna, UT

Hewlett-Packard Co.
Palo Alto, CA

Hitco Corp.
Gardena, CA

Honeywell Radiation Center
Lexington, MA

Honeywell Research Center
Bloomington, MN

Hooker Chemical Co.
Niagara Falls, NY

Horizons Research Inc.
Cleveland, OH

Hughes Aircraft Co.
Culver City, CA

Huntington Alloys, Inc.
Huntington, WV

IBM Corp.
San Jose, CA

IBM/Materials Lab.
Endicott, NY

Idaho State University
Pocatello, ID

Indiana University
Bloomington, IN

Indland Division/GM Corp.
Dayton, OH

IRTA Corp.
San Diego, CA

ITEX Corp.
Lexington, MA

ITT Research Institute
Chicago, IL

Jet Propulsion Laboratory
Pasadena, CA

John Hopkins University
Laurel, MD

Kent State University
Ashtabula, OH

Keystone Carbon Company
St. Marys, PA

Lamar University
Beaumont, TX

Langley Research Center
Hampton, VA

Laser Analytics, Inc.
Lexington, MA

Lawrence Berkeley Lab.
Berkeley, CA

Libby Owens Ford Co.
Toledo, OH

Library of Congress
Science and Technology Div.
Washington, DC

Lockheed Missiles & Space Co.
Sunnyvale, CA

Los Alamos Scientific Laboratories
Los Alamos, NM

LUWA Corp.
Charlott, NC

McDonnell Douglas Corp.
St. Louis, MO

Marathon Oil Co.
Littleton, CO

Marquardt Co.
Van Nuys, CA

Marsh Products, Inc.
Batavia, IL

Marshall Space Flight Center
Huntsville, AL

Martin Mareitta Corp.
Baltimore, MD

Materials Research Corp.
Orangeburg, NY

McDonald Astronautics Co.
St. Louis, MO

Massey Engr.
Fort Atkinson, WI

Metals Research Corp.
Waterbury, CT

Metals Research Laboratory
New Haven, CT

Micropac Industries, Inc.
Garland, TX

Midwest Library Service
Maryland Heights, MO

MIT Lincoln Laboratories
Lexington, MA

Montana State University
Bozeman, MT

NASA Lewis Research Center
Cleveland, OH

Nashua Corp.
Nashua, NH

National Association of Home Builders
Rockville, MD

National Bureau of Standards
Washington, DC

National Homes Corp.
Lafayette, IN

National Materials Advisory Board/NAS
Washington, DC

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Cranbury, NJ

National Science Foundation
Washington, DC

National Semiconductor Corp.
Santa Clara, CA

Naval Material Command
Washington, DC

Naval Research Lab.
Washington, DC

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Annapolis, MD

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Columbus, Ohio 43201 (1)

Tactical Weapon Guidance and Control
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ATTN: Mr. C. Smoots
IIT Research Institute
10 West 35th Street
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Office of the Deputy Under Secretary
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Room 3B259, The Pentagon
Washington, D.C. 20301 (1)

Army Materials and Mechanics Research Center,
Watertown, Massachusetts 02172
THERMOPHYSICAL AND ELECTRONIC PROPERTIES
INFORMATION ANALYSIS CENTER (TEPIAC) - A
Continuing Systematic Program on Data Tables
of Thermophysical and Electronic Properties
of Materials
C. Y. Ho, Center for Information and Numerical
Data Analysis and Synthesis, Purdue University,
West Lafayette, Indiana 47906

Technical Report AMMRC TR 79-21, March 1979,
82 pp-illus-tables, Contract DSA900-77-C-3758
Final Report, 1 January 1977 to 31 December 1978

AD ____________

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Key Words
Thermophysical properties
Electronic properties
Electrical properties
Magnetic properties
Optical properties
Information Analysis Center
Data compilation, evaluation, analysis, and synthesis

This Final Report covers the activities and accomplishments of TEPIAC in the period 1 January 1977 to 31 December 1978. TEPIAC's activities reported herein include literature search, acquisition, and input of source information; document review and codification; material classification; information organization; operation of a computerized bibliographic information storage and retrieval system; data extraction and compilation; data evaluation, correlation, analysis, synthesis, and generation of recommended values; preparation and publication of handbooks, data books, properties literature retrieval guides, state-of-the-art reports, critical reviews, and technology assessments; development of a computerized numerical data storage and retrieval system; technical and bibliographic inquiry services; and current awareness and promotion efforts. TEPIAC covers 14 thermophysical properties and 22 electronic, electrical, magnetic, and optical properties of nearly all materials at all temperatures and pressures and in all environments. It is one of the most efficient and cost-effective Full-Service DOD Information Analysis Centers. During this 24-month contractual period, TEPIAC has screened 1,500,000 abstracts, scrutinized 92,000 potentially good entries, identified 24,800 pertinent references, acquired 20,784 research documents, reviewed, coded, and catalogued 11,336 documents, extracted and compiled 7,488 sets of property data, responded to 1041 inquiries, published or completed 3 volumes of data books with a total of 2,383 pages, 5 technical reports with a total of 824 pages, and 10 volumes of research literature retrieval guides with a total of 2,971 pages, and distributed 85,500 copies in 12 issues of the "Thermophysics and Electronics Newsletter."

Army Materials and Mechanics Research Center,
Watertown, Massachusetts 02172
THERMOPHYSICAL AND ELECTRONIC PROPERTIES
INFORMATION ANALYSIS CENTER (TEPIAC) - A
Continuing Systematic Program on Data Tables
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C. Y. Ho, Center for Information and Numerical
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Watertown, Massachusetts 02172
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INFORMATION ANALYSIS CENTER (TEPIAC) - A
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C. Y. Ho, Center for Information and Numerical
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West Lafayette, Indiana 47906

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Information Analysis Center
Data compilation, evaluation, analysis, and synthesis

This Final Report covers the activities and accomplishments of TEPIAC in the period 1 January 1977 to 31 December 1978. TEPIAC's activities reported herein include literature search, acquisition, and input of source information; document review and codification; material classification; information organization; operation of a computerized bibliographic information storage and retrieval system; data extraction and compilation; data evaluation, correlation, analysis, synthesis, and generation of recommended values; preparation and publication of handbooks, data books, properties literature retrieval guides, state-of-the-art reports, critical reviews, and technology assessments; development of a computerized numerical data storage and retrieval system; technical and bibliographic inquiry services; and current awareness and promotion efforts. TEPIAC covers 14 thermophysical properties and 22 electronic, electrical, magnetic, and optical properties of nearly all materials at all temperatures and pressures and in all environments. It is one of the most efficient and cost-effective Full-Service DOD Information Analysis Centers. During this 24-month contractual period, TEPIAC has screened 1,500,000 abstracts, scrutinized 92,000 potentially good entries, identified 24,800 pertinent references, acquired 20,784 research documents, reviewed, coded, and catalogued 11,336 documents, extracted and compiled 7,488 sets of property data, responded to 1041 inquiries, published or completed 3 volumes of data books with a total of 2,383 pages, 5 technical reports with a total of 824 pages, and 10 volumes of research literature retrieval guides with a total of 2,971 pages, and distributed 85,500 copies in 12 issues of the "Thermophysics and Electronics Newsletter."

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Watertown, Massachusetts 02172
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INFORMATION ANALYSIS CENTER (TEPIAC) - A
Continuing Systematic Program on Data Tables
of Thermophysical and Electronic Properties
of Materials
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