

CRYOGENIC INFORMATION CENTER

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ABSTRACT

The Cryogenic Information Center (CIC) is a not-for-profit corporation dedicated to preserving and distributing cryogenic information to government, industry, and academia. The heart of the CIC is a uniform source of cryogenic data including analyses, design, materials and processes, and test information traceable back to the Cryogenic Data Center of the former National Bureau of Standards. The electronic database is a national treasure containing over 146,000 specific bibliographic citations of cryogenic literature and thermophysical property data dating back to 1829. A new technical/bibliographic inquiry service can perform searches and technical analyses. The Cryogenic Material Properties (CMP) Program consists of computer codes using empirical equations to determine thermophysical material properties with emphasis on the 4-300K range. CMP's objective is to develop a user-friendly standard material property database using the best available data so government and industry can conduct more accurate analyses. The CIC serves to benefit researchers, engineers, and technologists in cryogenics and cryogenic engineering, whether they are new or experienced in the field.

INTRODUCTION

The CIC is a recently formed not-for-profit corporation dedicated to preserving and distributing cryogenic information to the government, industry, and academia. Though this corporation is new, it accesses a long history of information that is traceable back to the Cryogenic Data Center of the former National Bureau of Standards (NBS) [1]. The CIC holds a national treasure as its main asset. The heart of the CIC is a uniform, consistent source of cryogenic data that comprises previous analyses, design, materials and processes, and test information. The CIC's resources include the largest and most comprehensive collection of cryogenic-related articles, papers, and journals ever compiled, with citations dating back as far as 1829. Thanks to funding from NASA and the Department of Defense (DOD), this information was recovered and expanded to include current research and development (R&D) cryogenic activity.

1 FORMER NBS CRYOGENIC DATA CENTER

The former NBS maintained a database of cryogenic technical documents that served the national need well until the early 1980s. The electronic database was maintained by the Cryogenic Data Center of the Cryogenics Division of NBS, located in Boulder, Colorado. The database, maintained on a mainframe computer, was a highly specific bibliography of cryogenic literature and thermophysical properties that covered over 100 years of data.

In the early days of the Cryogenic Data Center, literature on cryogenics that was being generated by the Bureau, along with a few other government agencies, universities and companies, was being collected and catalogued by the data center. The period from 1950 to 1970 saw the peak of cryogenic research and development. The Cryogenic Data Center gathered all the technical papers generated at that time as well as retrieved historic documents on the early development of the field of cryogenics. By 1980, the data center had over 115,000 technical documents covering the period from 1829 to 1980.

In the early 1980s, the NBS implemented a change in its charter, and as a result, took on not only a new name, the National Institute of Standards and Technology (NIST), but also a new direction. The field of cryogenics was no longer to be a separate discipline, and the Cryogenic Data Center was disbanded. The database of bibliographic references was transferred from magnetic tape to floppy disks, and documents related to superconductivity/solid material properties were transferred to the Naval Research Laboratory in Washington, D.C., and eventually placed in storage at the National Archives. The fluid properties library, along with fluids research, was retained at NIST.

With this disbanding event, there was no centralized U.S. source of cryogenic technical data. Existing data were fragmented and dispersed, and coverage was incomplete for engineers and scientists. In the 15 years that followed the closure of the Cryogenic Data Center, there was a trend in which many experienced cryogenic engineers were either retiring or being relocated to other job specialties. During these moves, the departing engineers took their working tools and documents with them, leaving an information void for those remaining in their cryogenics groups. As new engineers were hired, they often were not aware of the historic research conducted by their predecessors. In addition, the lack of a home for the data collected by the Cryogenic Data Center meant the eventuality of losing this valuable resource. There was an obvious need in government and industry for a highly specific database to provide a uniform, consistent source of cryogenic data and access to previous analyses, design, materials and processes, and test data.

Commercial electronic databases are available with wide access to bibliographic citations including the field of cryogenics. There are several shortcomings of these electronic databases in that they provide access to only the most recent citations (7 to 10 years). They do not provide citation searches and/or access to documents from the 1950s to 1970s – a period when a wealth of cryogenic R&D data was generated and published for NASA/DOD projects.

By 1997, several individuals within the government and aerospace industry recognized requests for data and research on concepts conducted during the last generation. With the help of the Chemical Propulsion Information Agency (CPIA), a Defense Technical Information Center (DTIC), Technology Applications, Inc. (TAI) conducted an industry survey that demonstrated a need to retrieve and update the information contained in the former Cryogenic Data Center as well as a willingness to support this effort.

A proposal was submitted to NASA/Marshall Space Flight Center in 1997 by TAI and CPIA. This team, in collaboration with NIST, submitted a three-phase, three-year program that would (1) retrieve the information contained in the former Cryogenics Data Center maintained at NBS until 1980 and transfer these data to PC-based technology, (2) update the library to include current literature back to those entries contained in 1980, and (3) become a self-sufficient entity providing technical services to the cryogenic community.

Funding and in-kind support were provided by a combination of NASA Centers and DOD agencies. These sponsoring agencies are listed in the acknowledgement section of this paper. The first two phases of the contract have been completed, and the third phase is nearing completion with the recent formation of the Cryogenic Information Center. The contract will conclude this fall, thereby meeting the requirements of the contract deliverables, including CD-ROMs of the database.

2 THE CRYOGENIC INFORMATION CENTER (CIC)

As the effort to update the cryogenic database was nearly complete in the Cryogenic Information Retrieval System (CIRS) and all contractual milestones were being met, CPIA, TAI, and NIST determined that the best way to proceed was to form the not-for-profit Cryogenic Information Center. This center was created to sustain the database and provide services to the technical community. All of the assets related to the continuation of the effort are being transferred to the CIC. Telecommunication lines, Web address, and Web hosting development efforts are all underway in support of the CIC.

The CIC is organized in two levels. A three-member executive board will oversee day-to-day operations. An advisory board with about 12 representatives from government, industry, and academia will provide the general direction and long-term planning of the CIC. The advisory board plans to meet at least annually as part of either the Cryogenic Engineering Conference or the International Cryocooler Conference, with conferences alternating meetings every other year.

The products and services of the Cryogenics Information Center are available to all those requiring such information. Subscriptions, per-use fees, and product sales are the primary means of funding operations. Based on the support of government and industry, the CIC plans to continue as the primary source of information on fluids and materials at cryogenic temperatures. The database will be updated by incorporating new reports and documents as they become available. The center plans to make the database available through Web-based servers and third-party, Web-based information services.

Supplementing this CIRS, the CIC also provides bibliographic and technical inquiry services. To respond to requests for specific information in the field of cryogenics, the CIC has the staff and resources to research the entire field of related publications. This service can be a quick and inexpensive first option and may often provide the exact information needed to avoid the unnecessary expense of time and money on private literature searches by the engineer or scientist.

Technical services, such as design, thermal modeling, and other analyses, are also available to supplement or expand the firm's in-house capabilities. The CIC also provides an engineering design software program called the Cryogenics Material Properties (CMP) Program, which is described in the following section.

Plans for the future growth of the CIC include producing technical software codes, providing publication managers to various conferences that produce material related to the field of cryogenics, and conducting classes related to cryogenic engineering and safety.

3 CRYOGENIC INFORMATION RETRIEVAL SYSTEM (CIRS)

CIRS is an electronic database containing references to over 146,000 documents dealing with cryogenic engineering, materials development and properties, and applications. Unlike other electronic databases, CIRS contains data from 1950 to 1970, the most intensive period of cryogenic research and development.

CIRS originally contained about 115,000 references (some files were duplicates or corrupt) from the former NBS Cryogenic Data Center. A second release added references on fluids properties collected by NIST after the Cryogenic Data Center was disbanded, along with more recent references collected from CPIA's Propulsion Information Retrieval System (PIRS), NASA/RECON, and DTIC electronic databases. Table 1 shows the progression and volumes added to the database.

TABLE 1: Updates to the CIRS database

Month/Year	Number of Journals and Proceedings	Number of Bibliographic Citations	Number of Citations With Abstracts
September 1998	1	110,000	0
July 1999	10	133,000	5,758
January 2000	10	137,680	10,438
June 2000	11	140,500	26,248
July 2001	16	146,021	33,130

In 1998, the previous data of the NBS Cryogenic Data Center was transferred to CD-ROM and made available to the funding sponsors. Later that year, an update was provided that added current literature to the previous data. In 1999, a Windows-based search engine was incorporated, and over 10,000 new entries were added to the database. To date, over 18,000 entries have been added and over 17,000 entries have been updated from the original database. Over 9,000 abstracts have been added to the original database bibliographic entries. No other library or database has a more comprehensive collection of cryogenic-related articles, papers, and journals. Researchers seeking technical information in the field of cryogenics will not find a more inclusive set of data to meet their needs.

Priorities were set for updating and adding bibliographic references to the database. The highest priority was given to several long-term series, such as *Advances in Cryogenic Engineering*, *Cryocooler*, *Thermophysical Properties Symposium*, *International Cryogenic Engineering Conference*, *Applied Superconductivity Conference*, and the periodical journal *Cryogenics*.

Within this priority area, every publication available to us through personal collections and libraries was reviewed and added to the database. Abstracts were written or copied into the bibliographic references from the original NBS collection. Many meeting papers had been entered into the Cryogenic Data Center database from preprints collected at conferences and meetings, in the interests of immediacy. The references to these papers have now been changed to reflect their appearance in published proceedings. In addition, references and abstracts were added from publications after 1980 to bring coverage of these first-priority series up to date.

Several other series have been added to the CIRS database, including *International Conference on Cryogenics and Refrigeration*, *Cryogenic Optical Systems and Instruments Conference*, and periodical journals from *IEEE Transactions on Applied Superconductivity*, *Superconductor Science and Technology*, *Cryogenic Engineering (Japan)*, and *Journal of Low Temperature Physics*. Other series are currently under review for addition to CIRS.

Future efforts will include updating the original Cryogenic Data Center portion of the CIRS database by checking the references for accuracy, thoroughness, and current availability and by adding abstracts to these references. A particular effort will be expended on patents. The Cryogenic Data Center had referenced a large number of U.S. and foreign patents on cryogenic techniques, materials, and equipment; these references will be made much more valuable with the addition of abstracts to the bibliographic citation. Patents issued since 1980 can be found on other databases, but a complete collection of patents in the field of cryogenics is a planned addition to CIRS.

Figure 1 highlights the collection and span times of the database. CIRS gives the user the capability of simple searches and advanced searches by title, author, corporate facility (of the first author), reference source, date, and subject matter as found in the abstract, alone, or in any combination. It allows simple refinement or limiting of a search after review of an initial search. It provides means of printing formatted reports on the results of searches.

CIRS will continue to grow in number and completeness of references, as well as convenience of use as it becomes available by subscription on the Internet. CIRS is now and will continue to be the most complete and convenient source of bibliographic references to the literature of cryogenics.

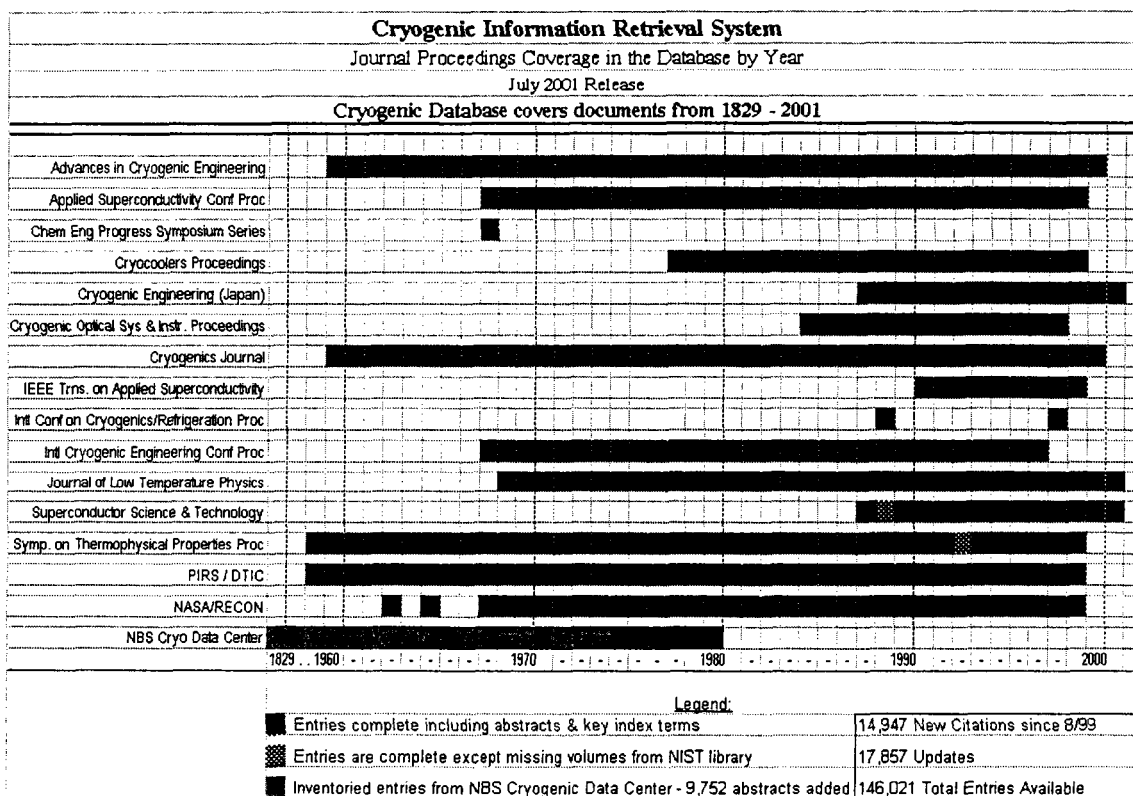


FIGURE 1: Journal and proceeding coverage in the database by year

4 CRYOGENIC MATERIAL PROPERTY (CMP) PROGRAM

The CMP Program is a user-friendly interface that provides access to data on various materials and properties at cryogenic temperatures. The data provided are directly traceable to NIST [2]. NIST is working to provide electronic access to material properties for cryogenic use. CMP makes available the material property data in a form convenient for engineers. CMP is currently only available for the Windows operating system.

The initial set of materials was selected for its common use in cryogenics. Currently, available properties include thermal conductivity, specific heat, and thermal expansion. Now that the initial materials set has been chosen, the available properties will be expanded to include yield strength, tensile strength, and elastic modulus.

Graphs or tables may be created for any property. The table option works much like a spreadsheet, and data can be selected and copied to other programs as desired. The user can create a graph of any property and has complete control over the appearance. Figure 2 shows a publication-quality graph created by CMP and imported directly into this document. Any number of graph or table windows can be open at one time allowing easy comparisons.

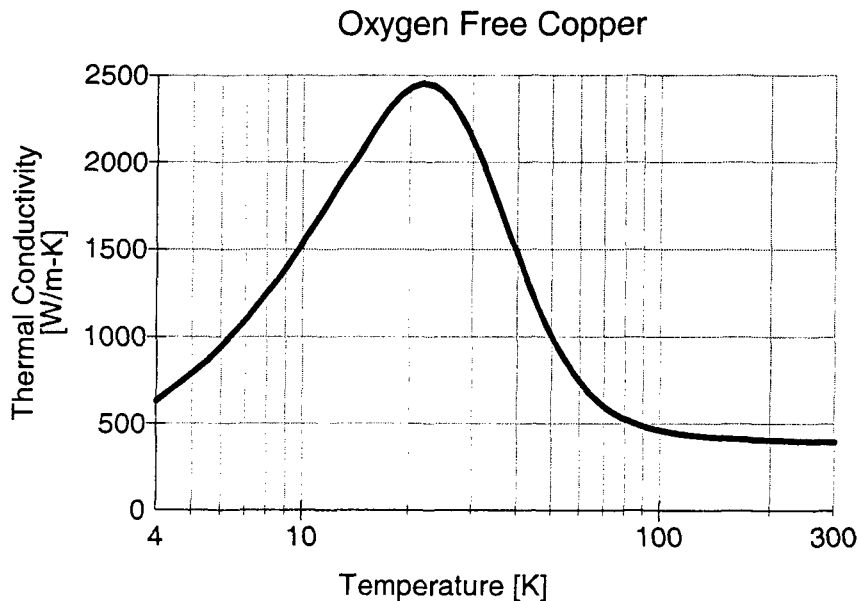


FIGURE 2: Graph created in CMP and directly imported into document

Two sets of units are available, SI and English. References are provided so the user can have confidence in the data. Limited room-temperature data is provided for each material and is based upon the manufacturer's information.

The initial set of materials includes: OFHC Copper; Aluminum - 1100, 6061-T6, 3003-F, 5083-O, and 6063-T5; Stainless Steel - 304, 304L, 310, and 316; 718 Inconel; Beryllium; Beryllium Copper; Titanium Ti-6Al-4V; Kevlar-49; Teflon, Polyamide (Nylon); G-10 fiberglass epoxy; Invar; Nickel Steels; Apiezon N; Molybdenum; Sapphire; Brass; Lead; Polyimide (Kapton); Platinum; and Indium.

Future plans include expanded temperature ranges, new materials, new properties, and enhancements to the user interface, such as an expanded set of selectable units. New properties may include electrical resistance and magnetic effects.

CONCLUSIONS

The government has funded a program to reconstitute and update the database of the former NBS Cryogenic Data Center. The CIC has recently been formed to be the clearing-house for cryogenic information. The CIRS can provide data that already exist and avoid repeating work already done. Exploitation of this personal resource may also provide valuable information that will maximize understanding of both the foundation and the starting point of proposed research programs. The CMP Program provides thermophysical material properties at cryogenic temperatures. Other services are available including bibliographic/technical inquiries, hardcopy document service, and technical support services.

The newly formed CIC requires the support of the cryogenics community to survive. To be self-sustaining, the CIC offers individual, corporate, and government subscriptions for purchase at reasonable prices, providing CD-ROMs, document copying, and technical services. The CIC staff is available to provide technical support to supplement in-house capabilities of the requesting firm or agency. Referrals are available to provide technical expertise in the cryogenic field of interest.

Executive and advisory boards are in place to provide day-to-day direction and strategic planning, respectively. Your comments to these CIC boards regarding needed cryogenic services are appreciated.

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