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DEVELOPMENT OF A MATERIALS PROPERTY DATA PROCESSING SYSTEM

TECHNICAL DOCUMENTARY REPORT NO. ASD-TDR-63-128

January 1963

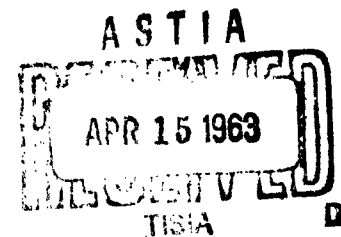
DIRECTORATE OF MATERIALS AND PROCESSES

Aeronautical Systems Division

Air Force Systems Command

Wright-Patterson Air Force Base, Ohio

Project No. 7381, Task No. 738103



(Prepared under Contract No. AF33(616)-7238
by the Technical Information Systems Division
Belfour Engineering Company, Suttons Bay, Michigan
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FOREWORD

This report was prepared by the Technical Information Systems Division of the Belfour Engineering Company, Suttons Bay, Michigan, under U.S.A.F. Contract No. AF 33(616)-7238. This contract was accomplished under Project No. 7381, Material Application, Task No. 738103, Data Collection and Correlation. The work was administered under the direction of the Applications Laboratory, Directorate of Materials and Processes, Aeronautical Systems Division, Wright-Patterson Air Force Base with D. M. Ingels, Lt/USAF acting as project engineer.

This report covers work conducted from March 15, 1960 to August 31, 1962.

ABSTRACT

This report discusses a mechanical properties information system including the operation of a fatigue of metals sub-system and the design-development and initial operation of other mechanical properties sub-systems. These sub-systems, employing punched card equipment and techniques, actively provide mechanical properties data and associated descriptive information of metals and reinforced plastics.

The System, sponsored by the USAF, is intended primarily for the use of Defense Agencies and their contractors.

Formats, codes and procedures utilized to store, retrieve and display mechanical properties of these materials are outlined.

This technical documentary report has been reviewed and is approved.



D. A. SHINN
Chief, Materials Engineering Branch
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I Introduction

A. Purpose

This report describes the results of an effort to provide mechanical properties information to qualified users and to develop procedures, processes, and techniques requisite to the establishment of an efficient information (mechanical properties) dissemination program. More specifically, this project has involved the operation of an existent fatigue of metals information sub-system and the design-development of compatible pilot sub-systems, capable of incorporating other mechanical properties of both metals and reinforced plastics. Information retrieved from these sub-systems has been made available in various immediately usable forms including graphic displays, tabulations, analyses and others.

B. Scope

Conventional and specialized libraries have long served as sources of information vital to the evaluation of materials. Short of extensive testing programs, there have been few alternatives to literature searches to produce sufficient data for the establishment of dependable design criteria. Conventional library techniques generally produce great quantities of report which require further searching, by the investigator, to reduce them to the specific information desired. This is not intended as a criticism of libraries. It is a fact that abstracts, keywords, descriptors, links-roles, etc., cannot economically provide the depth of indexing necessary to produce all and only the pertinent documents in response to a specific request. It is also true that much detail including numeric information may be "lost" in conventional indexing techniques. No system can retrieve what it does not recognize. Libraries are a necessary part of the information complex. Theories, proofs and philosophies need expression and discussion through the written word. However, the majority of the day-to-day decisions made by designers and/or engineers must be based on facts. Therefore, the need for specialized systems, capable of dealing with major segments of the overall materials information problem in an efficient manner, is apparent. Whether the material properties be electrical, mechanical, thermo-physical, or other, the ability to regenerate pertinent information from one or more documents at relatively high speed has become a necessity. This project has been primarily concerned with the establishment and operation of information sub-systems wherein the pertinent mechanical properties of metals and plastics are systematically stored and regenerated.

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II Discussion

A. Background

The processing and general dissemination of properties information for designers, engineers, and others, is not a new concept. Large and small organizations have, with varying degrees of success, applied systems, including all manner of storage media, retrieval methods, and equipment, to relieve technical personnel of the task of reviewing an enormous amount of printed matter to glean a few pertinent facts. However, to be even moderately successful, these systems are dependent on the general availability of applicable information from all sources within their discipline. This points up the need for specialized centers, capable of acquiring and storing in a quickly retrievable form, the significant and reliable information already generated. The ultimate mission of such centers would be one of providing data in response to specific materials questions, quickly, and in a form adapted to the interrogators' use. Ideally, specialized centers could eliminate or minimize the need for in-plant systems.

The Air Force, recognizing the need and value of such services to the aerospace industry, has sponsored programs necessary to the establishment of Data Centers. An early effort in this direction was conducted jointly by Parsons Corporation and Battelle Memorial Institute under Air Force sponsorship.* The results of that program which developed codes, formats, and procedures for storing and operating on metals fatigue test results and associated descriptive information have served as the nucleus of the program discussed herein.

B. Program Outline

The nature and aims of this program permitted a logical division of effort into two major areas. These are noted in the outline which follows:

1. Operate the fatigue information sub-system.
 - a. Edit and re-inventory original fatigue data file.
 - b. Update fatigue data file.
 - (i) Establish routine procedures for test data acquisition and review.

*Belfour, A.J., Hyler, W.S. "A System For Automatic Processing of Fatigue Data", 1959, AF 33(616)-3301, WADC TR 58-461.

c. Answer inquiries for specific fatigue information and disseminate fatigue data of general interest at regular intervals to a selected mailing list.

- (i) Analyses
- (ii) Graphic displays
- (iii) Tabulations
- (iv) Inventories

2. Design and develop additional pilot sub-systems for storing, retrieving and operating on mechanical properties (other than fatigue) of metals and reinforced plastics.

a. Design formats and codes for incorporating the descriptive information and results of mechanical properties tests.

- (i) Bearing
- (ii) Compression
- (iii) Creep
- (iv) Flexure
- (v) Impact
- (vi) Shear
- (vii) Tensile
- (viii) Others

b. Store mechanical properties information.

- (i) Establish routine procedures for acquisition and review of test data.
- (ii) Encode mechanical properties data.
- (iii) Inventory encoded data.

c. Answer inquiries for specific mechanical properties information and disseminate properties information of general interest.

- (i) Analyses
- (ii) Graphic displays
- (iii) Tabulations
- (iv) Inventories

C. Operation of the Metals Fatigue Sub-System

1. In order to familiarize and orient personnel with the formats and content of the original Fatigue System an inventory of the fatigue storage file was undertaken. As a result of the inventories it was obvious that editing and updating of this file was required prior to the initiation of an information dissemination program.

Major difficulties encountered with the old file, which dates back to 1957, included duplication of stored data, missing information, and in a few cases, data of questionable accuracy. Current fatigue test data was, of course, completely lacking in the file. Inactivity and frequent handling to and from the physical storage areas were probably responsible for many discrepancies.

2. To facilitate the editing process and to provide source documents for up-dating the file, an acquisition program was initiated. The first step included a review of published document announcements and applicable trade journals. Announcements from NASA, ASTIA, OTS, PLASTEC, G. P. O., and other bibliographic activities were reviewed by technicians experienced in materials evaluation and test procedures.

Based on abstracts, descriptors, and key words only those documents which appeared to contain materials and properties of current and near future interest were acquired. No attempt was made to obtain all of the available mechanical properties information since time and funds prohibited an exhaustive effort in this area. In fact, this rather limited acquisition provided documents in excess of the requirements of the encoding program.

Other published sources of properties information were investigated to assure an awareness of significant new material and process developments. Trade journals, reports of society proceedings, and periodicals were scanned for applicable new data or references to materials development and test programs.

Another potential source of materials information was explored. Several manufacturers, fabricators and materials evaluators were contacted regarding the availability of unpublished data. The success of this effort was limited. However, a similar program later sponsored by the Air Force has provided funds for the distribution of valuable but heretofore unpublished data. The value of such data must not be minimized. Too often, published reports contain only selected data which "looks good" and does not necessarily represent the true variability of materials or processes.

From the report library, documents containing preferred materials and properties were encoded per the applicable formats and codes. Tables I and II, pages 10 and 11, are summaries of metals fatigue and other mechanical properties of metals and plastics.

Editing or re-encoding of previously encoded fatigue data was accomplished as the reports containing these data were acquired.

Revisions, additions and improvements to the fatigue formats and codes were necessary. For example, new materials were added to existing codes, indications of edited and unedited data were required, and a completely revised and improved procedure for coding chemical composition was devised. These additions and revisions are presented in a supplement to "A System for Automatic Processing of Fatigue Data". (Copies of the revision and additions are included in the delivery items of the subject contract).

3. Dissemination of fatigue properties information was first accomplished in response to requests from airframe manufacturers and related organizations. Requests for fatigue data was, however, not extensive and a method of publicizing the availability of this service was necessary. To stimulate user interest, a series of Technical Notes (ASD TN 61-117, Part I through IV) presenting fatigue displays of "general" interest were prepared and distributed to prospective users and ASTIA. A variety of display forms and techniques were employed, including S/N curves, modified Goodman diagrams, and statistically determined probability of survival curves. Response to these Technical Notes more than doubled the direct mailing list. Approximately 125 copies are presently distributed by direct mailing. Although no actual accounting of distribution by ASTIA is available, an increase in the number of copies requested by that agency probably reflects increased demand. The success of this limited distribution of general Technical Notes indicates that an increased promotional effort will probably result in a significant increase in requests for specific information from the data files.

D. Design and Development of Additional Mechanical Properties Sub-System

1. Concurrent with the operation of the fatigue sub-system an effort was initiated to design compatible sub-systems for the storage, retrieval, and processing of other mechanical properties of metals and reinforced plastics. Based on the successful approach employed by the fatigue sub-system an attempt was made to design compatible formats and codes, utilizing IBM punched cards as the storage media. The emphasis was placed on metals, however, to insure maximum compatibility the problems involved in the unique composition and fabrication techniques of reinforced plastic materials were jointly considered. The resulting fixed formats, flexible

codes, and code expansion capability, by means of non-conventional coding, provide both compatibility and flexibility.

The acquisition of pertinent reports was accomplished by the effort described in paragraph C-2 of Section II to provide references for a review of current test programs and a source of encodable test results.

Formats for the storage of mechanical properties of metals were designed and developed first. These are outlined in Appendix I. The basic difference between these formats and the formats employed in the fatigue sub-system is the use of a dependent multiple card arrangement of stored information. Simply stated this means that more than one card is utilized to store the most pertinent information necessary to completely describe a material, test conditions, test procedures, and test results. Obviously, this allows a greater amount of descriptive detail than is permitted in a single eighty column IBM card. This advantage is somewhat off-set by the need to process additional cards. However, inspection of the format outlines, Appendices I and II, will indicate that a single card, referred to as card 1, is employed to store the common descriptive information of a set of specimens. A second card, card 2, is employed to store the test results associated with each specimen in the set. This minimizes the number of cards necessary to completely describe a set of specimens and the test results. In practice, the quantity of cards employed to describe a set of specimens is one more than the actual number of specimens in the set. (Creep test data is the only exception to this "rule").

The choice of properties and descriptive information included in each test material format are those which describe not only the mechanical properties of a material but the significant associated test procedures, test conditions, manufacturing processes, and composition to the extent that they are reported. Numeric and non-conventional alpha-numeric codes are provided to convert alphabetic information to a machine processable form.

The descriptive information and properties stored for each test type are best determined from a review of the various formats in Appendices I and II. Therefore, no listing of the properties and descriptive information will be presented here. A comparison of currently available mechanical properties test reports with the codes and formats will emphasize the comprehensive nature of the formats. Experience has proven that few reports, if any, contain detail in excess of the storage capacity of the formats. In fact, the majority of the reports committed to the system utilize 75% or less of the storage capacity.

The formats are of a type known as "fixed formats". As will be noted from the Appendices the formats are "fixed" for each test type within each of the two material categories (metals and reinforced plastics). This method permits variations in the formats for test types and further allows for the addition of test type formats without any disruption of the existing formats or stored information.

A unique feature of the storage of information in the manner provided by the formats is that like data from several reports may be merged without regard to author intent or bias. This is not generally true of either machine or manual indexing methods which are frequently at the mercy of report authors, indexers, or equipment. Appraisals of the content of a report may be divergent and thus valid data is overlooked. The more automatic or rigid the indexing procedures the more susceptible the system is to such "losses".

E. Document Storage and Retrieval

Supplementing the sub-system data files is a document library containing a wide variety of mechanical properties information. This library is divided into two sections, one containing documents which have been or are to be encoded in the mechanical properties systems and the other contains reference documents which do not contain encodable information, i.e., actual test data. Upon receipt of a document it is scanned and assigned an accession number within one of the above sections. Following identification, a brief summary of the contents of each document is coded and punched on cards. This summary includes materials, test types, test temperatures, and assorted keywords identifying related areas of interest. These punched cards perform two functions. They put supplemental information within "easy reach" and provide intermediate identification of the contents of encodable documents until such time as they are incorporated in the data storage files. Once this is accomplished the summary punched cards for these documents are no longer necessary since the main storage and retrieval system provides considerably more depth, detail, and flexibility of organization.

F. Labor Distribution and Schematic Flow Chart

A breakdown of cumulative effort expended on the seven major areas of project activity is presented in Table VI, page 24, and graphed in Figure 1, page 25. This distribution represents all phases of the total project. The balance of engineering technical, and clerical effort compares very favorably with a typical engineering service operation. Through normal expansion of the system it is anticipated that the design, development and revision effort will decrease sharply. This, coupled with an increase in the input-output areas would result in an even more favorable distribution.

Figure 2, page 26, schematically describes the flow of documents into the system and through the various stages necessary to encode, store, retrieve, operate on, control, and re-display merged mechanical properties data or the results of studies thereon. The equipment noted has been used successfully, however, this equipment may vary widely. Machine or manual code conversion would adapt the system to an even greater number of machines or combinations of machines.

III Conclusions and Recommendations

The sub-systems described in this report should not be confused with typical "non-conventional" document retrieval systems. The sub-systems are not specialized libraries, although they are capable of performing typical library functions, such as providing reference lists and retrieving documents. These functions are natural by-products and not primary goals. These sub-systems are designed to provide a means of bypassing time consuming and costly operations that inhibit the use of much stored knowledge by technical people who "have to meet the schedule". Identification, acquisition, and searching of pertinent documents, by investigators, for specific information is minimized and almost eliminated by these sub-systems that provide numeric and descriptive information in response to questions regarding materials, conditions, and properties. Admittedly, the output is oriented to the needs of the designer, engineer, and evaluation or applications people. However, researchers are often dependent on reported properties values, and associated variables, to intelligently initiate and/or thoroughly evaluate research programs.

The various forms utilized to display data or other output from the sub-systems described, may of course, represent varying degrees of post-retrieval processing and cost. The important point is, however, that the form or content is not fixed. Graphs, analyses, reference lists, and tabulations, etc., may be regenerated. The investigator may specify that form or combination of forms which permit him to effectively evaluate the data and make a decision based on that data and his over-all knowledge of the problem. Information centers should not attempt to solve the problem without a complete knowledge of attending conditions. Simply stated, these sub-systems provide the potential and raw material for decision making in response to direct interrogation of the applicable sub-system.

It is the opinion of those involved in the design-development and operation of these sub-systems that the approach employed is practical, economical, and valid. The products of the system have verified the belief that the procedures and techniques are more than adequate to efficiently serve the intended users. Continual stocking of the storage files and periodic re-evaluation of each sub-system must be recognized as normal maintenance requirements necessary for the efficient operation of any information system.

The potential of specialized Data Centers organized to provide information on a defined materials area, such as thermophysical properties, machinability, formability, etc. of various identified material types, demands serious consideration and study. Many specialized Centers, each responsible for a "segment" of information, co-ordinated under a single program, offers a logical solution to the increasingly critical materials information problem. The sub-systems discussed in this report provide the framework for the development of a Center capable of providing mechanical properties data of structural materials.

TABLE I
SUMMARY INVENTORY
MECHANICAL PROPERTIES (FATIGUE) OF METALS

<u>ALLOY</u>	<u>TEST TYPE</u>									<u>Total Specimens</u>
	<u>Conventional S/N</u>	<u>Conventional S/N Rerun</u>	<u>Step Test (2 Stress levels only)</u>	<u>Step Test (More than 2 stress levels)</u>	<u>Damage (2 Stress levels only)</u>	<u>Damage Test (more than 2 stress levels)</u>	<u>Sequence Test</u>	<u>Modified Prot</u>	<u>Prot Test</u>	
Aluminum	7984	38	453	794	110	254	568	0	66	10177
Copper	283	0	0	1080	0	0	0	0	101	1464
Corrosion and Heat Resistant	5589	16	28	1377	0	0	0	0	0	7010
Low Alloy Steel	11901	0	0	11690	0	485	0	190	1784	26050
Magnesium	451	0	0	35	0	0	0	0	0	486
Titanium	2808	7	0	656	52	0	0	29	119	3671
Cermets	77	0	0	0	0	0	0	0	0	77

TABLE II
SUMMARY INVENTORY
MECHANICAL PROPERTIES OF METALS AND PLASTICS

<u>MATERIAL</u>	<u>TEST TYPE</u>							Total Specimens
	Tension	Compression	Flexure	Shear	Bearing	Creep	Impact	
<u>Metals (Alloy)</u>								
Aluminum	2543	662	0	181	297	0	957	4640
Copper	156	25	0	13	23	0	9	226
Corrosion and Heat Resistant	3173	880	0	495	572	245	143	5508
Low Alloy Steels	5449	317	0	208	373	25	1660	8032
Magnesium	1096	261	0	100	133	14	0	1604
Titanium	8747	849	0	809	1069	75	1900	13449
<u>Plastics (Resin)</u>								
Epoxy	486	391	1675	37	254	175	0	3018
Melamine Formaldehyde	0	0	18	0	0	0	0	18
Phenolics	501	437	737	72	44	187	48	2026
Polyester	1531	1166	1695	281	1055	383	38	6149
Polyurethane	0	0	41	0	0	0	0	41
Silicone	403	276	371	57	23	71	0	1201
Resin Combinations	155	102	571	0	0	56	0	884
Unidentified Resins	3	0	6	0	0	0	0	9

TABLE III

SEARCHES - ASD REQUESTED

<u>Search No.</u>	<u>Date Initiated</u>	<u>Information Requested</u>	<u>Output</u>
400	10/61	Available information on Electro-Discharge Machining.	Applicable reference cited. Found as a result of complete search of fatigue card file and reference file.
401	12/61	Availability and Tabulation of information on long life fatigue of 2024 & 7075 aluminum.	21 S/N graphs (128 data points plotted) and reference list. One copy each of TN 61-117 Part I and TN 61-117 Part II, Section I.
402	3/61	Study on low cycle fatigue of miscellaneous materials. Primary requisite of failure less than 10^4 cycles.	49 S/N displays (2,911 data points plotted). Bibliography and tabulations.

Table III (Continued)

403	1/62	Effect of inclusions on the fatigue behavior of 2024 aluminum.	Reference list including possible source documents.
404	11/61	Fatigue of structural materials for handbook use, S/N curves displaying elevated temperature tests of axially loaded specimens.	Tabulation of all data from fatigue file which satisfied subject requirements.
405	3/62	S/N curves for all values of "R" of axially loaded sheet specimens tested at cryogenic, room and elevated temperatures, for several (8) materials.	107 S/N displays (2,199 data points plotted) of properties tables & graphs extracted from several references, & reference list.

Table III (Continued)

406	3/62	Fatigue properties of AM 350 stainless steel & 8 Al-1Mo-1V titanium alloy sheet. Axially loaded. Room temperature to 1000° F.	Portions of references reproduced, including copies of fatigue diagrams of AM350, SCT 850 tested at room temperature & 600° F. Also included were tables of mechanical properties of 8Al-1Mo-1V-titanium. List of applicable references attached.
407	6/62	Request for list of references containing heat and corrosion resistant materials and plastics from BEC library.	Tabulation of all applicable references. Details include document title, author(s), Contract No., Report No., date, ASTIA No., materials tested, type of test(s), test temperature and approximate No. of specimens tested.
408	6/62	Request for available fatigue data on 2024-T81 aluminum.	2 tables & reference list.

Table III (Continued)

409	7/62	Request for coefficient of thermal expansion & conductivity & poisson's ratio for copper-zirconium alloy.	Information located and phoned to ASD.
410	8/62	Request for available fatigue data on shafts.	Summary of available information sent Borg-Warner.

TABLE IV

SEARCHES - BEC INITIATED

<u>Search No.</u>	<u>Date Initiated</u>	<u>Information Requested</u>	<u>Output</u>
600	Periodically Updated	Mechanical Properties File Inventories	Periodic inventories (for internal use) of entire mechanical properties data file.
601	6/61	Routine (bi-monthly) Dissemination of Metals Fatigue Information.	Room temperature fatigue properties of aluminum alloys tested at zero mean stress and with rotating bending loads, no TN number assigned. (6 S/N displays, 599 data points plotted).
602	8/61	Routine (bi-monthly) Dissemination of Metals Fatigue Information	Technical Note 61-117, Part I, room temperature fatigue properties of 2024-T3 & T-4 aluminum plate, bar and extruded stock tested at zero mean stress. (12 S/N displays 3,545 data points plotted).

Table IV (Continued)

603		Not Assigned	
604	11/61	Routine (bi-monthly) Dissemination of Metals Fatigue Information.	Technical Note 61-117, Part II, Section I. Room and elevated temperature fatigue properties of corrosion and heat resis- tant materials. (23 graphic displays, 873 data points plotted).
605	11/61	Room Temperature Fatigue Properties of Aluminum.	Data displayed as Goodman diagrams. Result of a study conducted to show additional presentation potential. (7 displays, 105 data points plotted).
606	11/61	Series of graphs for display of system potential to assign cause of scatter.	42 S/N curves (13,521 data points) plotted. Not distributed.

Table IV (Continued)

607	2/62	Routine (bi-monthly) Dissemination of Metals Fatigue Information.	Technical Note 61-117 Part III, Section I. Effect of ultimate tensile strength on fatigue behavior of AMS 6415 steel tested at room temperature with zero mean stress and rotary beam loading. (12 graphic displays, 4,531 data points plotted).
608	4/62	Routine (bi-monthly) Dissemination of Metals Fatigue Information	Technical Note 61-117 Part IV, Section II. Effect of loading on room temperature fatigue behavior of various forms of 7075-T6 aluminum with one associated probability of survival curves. (14 graphic displays, 1,008 data points plotted).

Table IV (Continued)

609	6/12	Routine (bi-monthly) Dissemination of Metals Fatigue Information.	Technical note 61-117, Part V, Section III. Effect of notch factors (and types) on the fatigue behavior of 7075-T6 sheet aluminum specimens axially loaded and tested at various mean stress levels. (12 displays, 463 data points plotted).
610		Not Assigned	
611	8/62	Search for availability of mechanical properties data of Rene' 41.	Tabulation summarizing information available from mechanical properties data file.

TABLE V

SEARCHES OTHER THAN ASD OR BEC INITIATED

<u>Search No.</u>	<u>Requestor</u>	<u>Date of Request</u>	<u>Information Requested</u>	<u>Output</u>
--	Sikorsky Aircraft	3/61	Fatigue of notched and unnotched AMS 6260 & 6415 with UTS range of 140-200 ksi, and a general description fatigue system.	Graphic displays and discussion of fatigue system and services available.
--	Bell Aircraft	3/61	General fatigue information, typical displays of data, graphs and tabulations.	3 fatigue diagrams on aluminum and discussion of fatigue system and services available.
--	Sikorsky Aircraft	7/61	Properties data on SAE 9310 low alloy steel.	Fatigue diagram with 150 plotted points with reference list.

Table V (Continued)

800	Parsons Corporation Aircraft Division	9/61	Static and dynamic properties of PH steels.	4 S/N diagrams (34 data points plotted) and reference list.
801	Norair Division of Northrop	10/61	Elevated temperature fatigue properties of aluminum. 7075-T6 and 2024 (all tempers).	Portions of 7 applicable references reproduced.
802	Parsons Corporation Aircraft Division	11/61	Effect of surface grinding on fatigue properties of 4130 normalized steel.	One reference describing the effect of grinding procedures retrieved.
803	Bendix Aerospace	3/62	Fatigue properties of Chrome-moly steels in the U.T.S. Ranges 160-180 ksi and 260-280 ksi.	Tabulation of data (12 displays, 896 data points plotted) in the required ranges by test types.
804	Canadair Ltd.	12/61	Long life fatigue data (life exceeding 10^7 cycles) of 2024 and 2075 aluminum.	20 S/N diagrams (1,865 data points plotted) and list of references.

Table V (Continued)

805	Parsons Corporation Aircraft Division	1/62	Tensile and fatigue properties of AM350 and PH steels.	4 tables reproduced from summary data references.
806	Bendix Aerospace	1/62	Fatigue properties of 4130 and 4340 steel in the 160-180 ksi, U.T.S. range. Rotary beam and axial loading at room temperature.	12 S/N diagrams (1,521 data points plotted) and ref- erence list.
807	Bendix Aerospace	1/62	Fatigue properties of chrome-moly steel AISI 4340 in the 260-280 ksi U.T.S. range	8 diagrams (2,961 data points) plotted with reference list and discussion.
808	Bendix Aerospace	2/62	Continuation of previous (Bendix) study on AISI 4340 steel in the 260-280 ksi, U.T.S. range.	5 modified Goodman diagrams (58 data points plotted) and associated descriptive in- formation.
809	North American Aviation	5/62	Fatigue data on 18 corrosion and heat resistant alloys for establish- ing a rating program.	10 S/N diagrams (184 data points plotted), summary sheet and reference list.

Table V (Continued)

810	Super Tool, Division of Universal American Corporation.	7/62	General information on carbides.	3 applicable references cited.
811	Battelle Memorial In- stitute	8/62	Fatigue and creep data on selected alloys for ANC-5 Handbook	35 tables summarizing avail- able information also in- cluded were 40 diagrams.
812	Boeing-Wichita	8/62	Tensile and yield strength of 2014-T6 aluminum after exposure at room temperature to 800° F.	7 stress-temperature graphs (87 data points plotted) and list of references.

TABLE VI

LABOR DISTRIBUTION
AF 33(616)-7238

Project Area	Distribution of Expended Time - Percentages by Area -			
	Engineering	Technical	Clerical	Total
1. <u>Administration</u> - All effort expended on administrative records, reports, correspondence, conferences, planning, etc.	8.6	1.5	.6	10.7
2. <u>Library & Literature Acquisition</u> - Time expended acquiring, searching, sorting, cataloging, indexing and storing of all documents, books, papers, etc..	1.2	3.9	10.1	15.2
3. <u>Data Input</u> - All phases of data reduction-conversion from encoding through storage of unit records (cards) are included in this area of activity.	3.5	21.5	12.7	37.7
4. <u>Data Output</u> - All study, analysis, machine processing, tabulating, etc., necessary to produce an answer, solution or other end product such as a graph, tabulation, listing, discussion or any combination of these.	8.5	6.0	2.9	17.4
5. <u>Dissemination</u> - Non-technical work associated with the preparation, presentation and distribution of Output, Such efforts shall include typing, reproduction, binding or packaging of the Output.	.8	1.0	1.6	3.4
6. <u>Methods & Systems</u> - This area of activity includes all efforts expended on study, evaluation, design and development of methods, routines or procedures necessary to the accomplishment of project goals. Formats, codes and any other rules, plans or practices.	5.8	3.6	1.0	10.4
7. <u>Equipment & Facilities</u> - Time spent on the study, evaluation, maintenance or repair, of equipment or facilities.	1.0	3.0	1.2	5.2
	29.4	40.5	30.1	100.00

FIGURE 1
LABOR DISTRIBUTION
GRAPHIC DISPLAY

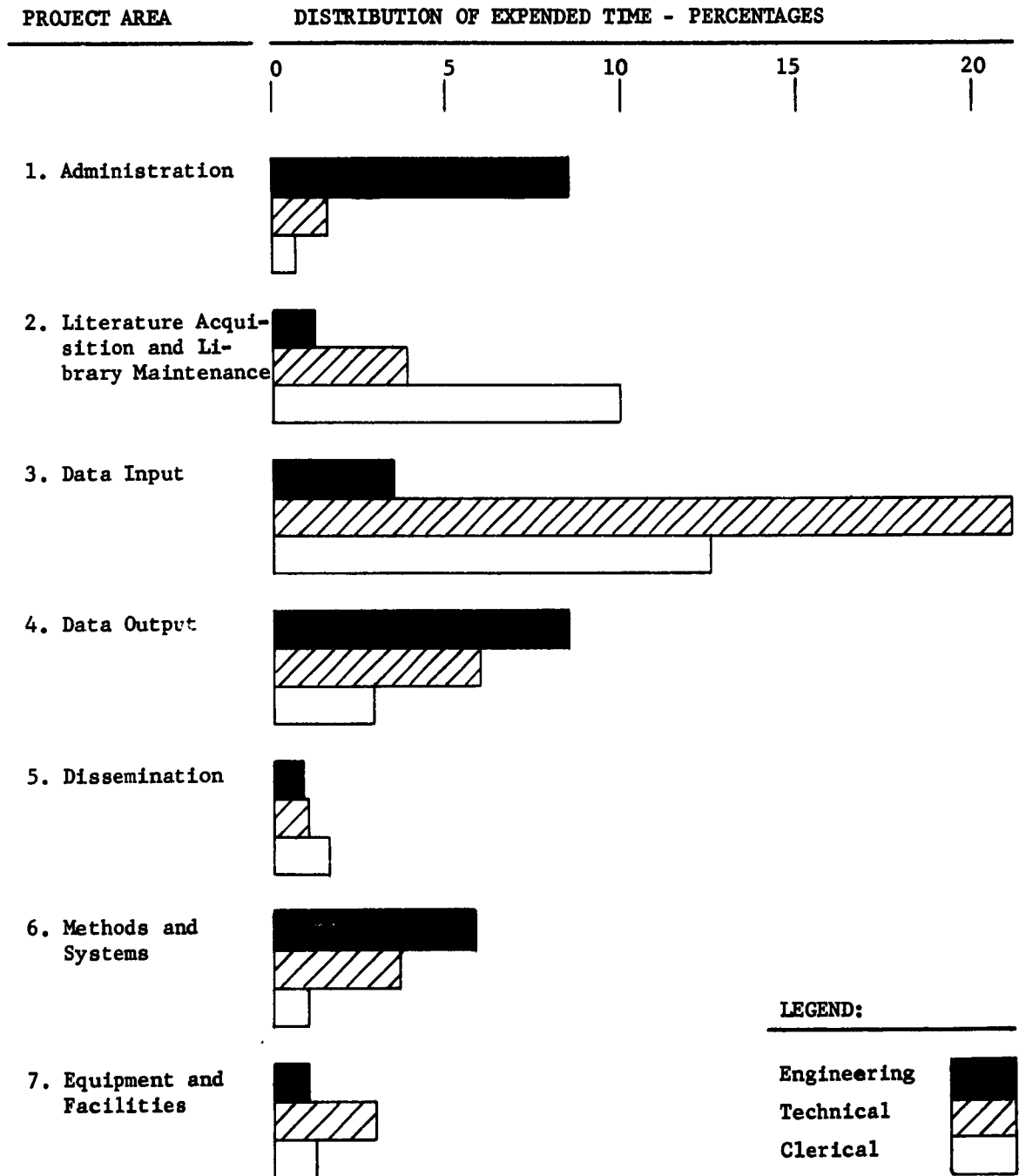
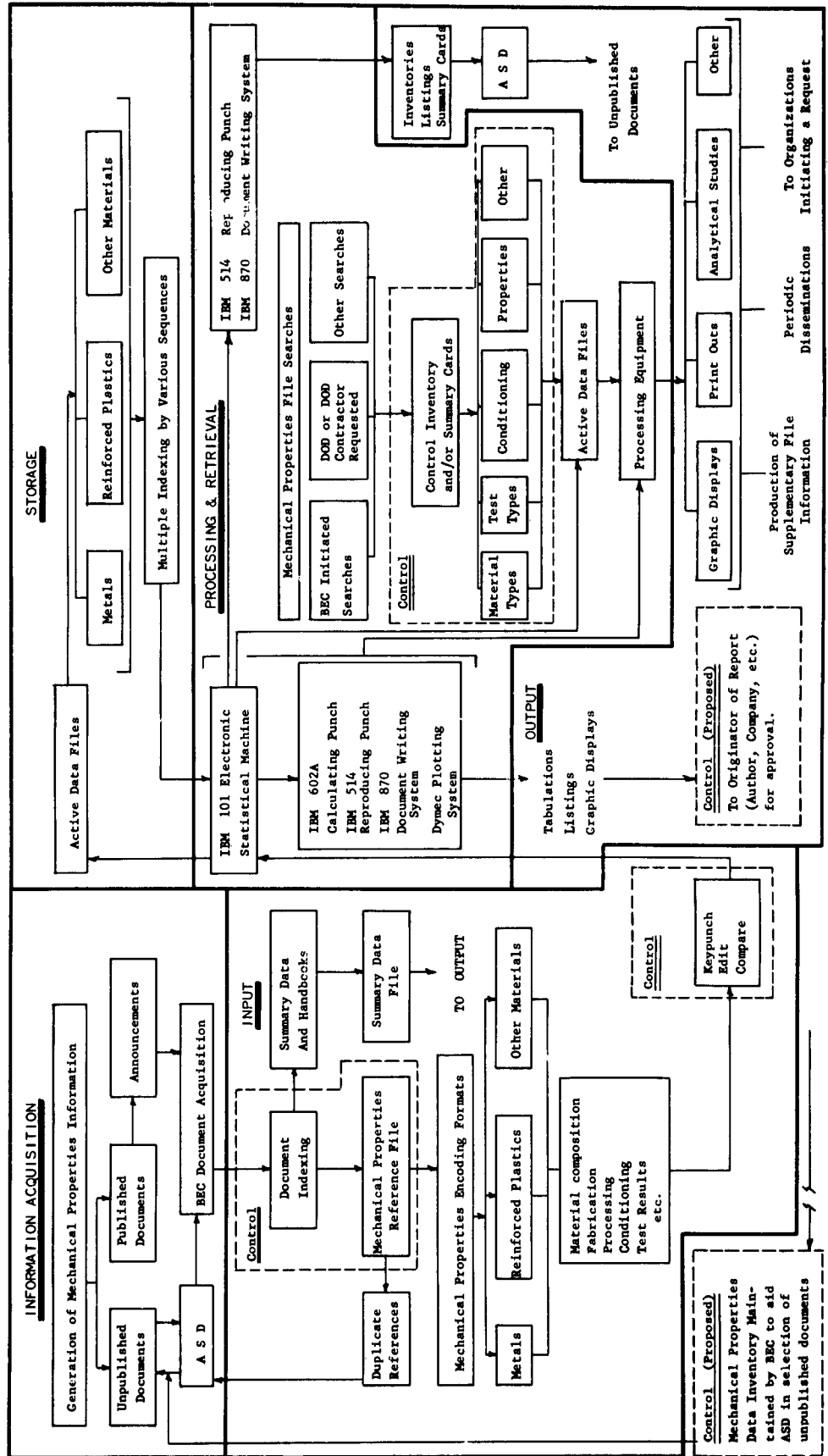


FIGURE 2
 SCHEMATIC FLOW CHART
 MECHANICAL PROPERTIES INFORMATION PROCESSING SYSTEM
 AF 33 (616)-7238



APPENDIX I
CODE AND FORMAT OUTLINES
MECHANICAL PROPERTIES OF METALS

APPENDIX I

Discussion

The following code and format outlines are not intended to serve as an operating manual. Abbreviated field descriptions and typical code entries are provided to familiarize potential users with the kind of information that is available from the metals mechanical properties sub-systems.

Card 1, a materials description card, is the first card of a basically two card system. On this card, a standard 80 column IBM card, is stored such information as melt and heat-treat procedures, fabrication and machining processes, surface conditioning, surface finish, and material composition common to a set of test specimens.

Card 2, also a standard IBM card, includes in addition to identification linking it with card 1, specimen fabrication, geometry and dimensions, pre-test conditioning, test equipment, environment and results.

These formats are referred to as "fixed formats" where the number and arrangement of the columns is fixed and unalterable. Each "bit" of information is entered into a specific column or group of columns. Changes in decimals and/or units for expansion or conversion, etc., are accomplished by the use of non-conventional zone punching. Visual identification of these cards and those of other sub-systems are identified by color coding and corner cuts. To facilitate machine separation of number 1 and 2 cards a card sequence number has been included.

FIELD 1.0 BIBLIOGRAPHIC IDENTIFICATION

1.1 Reference Number

Code 1.1 identifies a reference number assigned to the source of information from which the encoded data is extracted.

1.2 Test Type

Code 1.2 identifies each type of test(s) encoded from the report.

1.3 Material Identification

An AMS (Aeronautical Material Specifications - SAE) number is used to identify a material wherever possible. If a material cannot be identified by an AMS number, code 1.3 provides for assigning the material a permanent number.

1.4 Material Type

Code 1.4 identifies the encoded material type, i.e., Low Alloy Steels, Heat and Corrosion Resistant Materials, Aluminum, etc.. This material type classification facilitates machine separation of metal alloys and other materials.

1.5 Unit Number

A number is assigned arbitrarily to each identical unit of a forming method for the purpose of identifying this unit from all others within a single test report.

1.6 Number of Specimens

The total number of specimens encoded for each test type from a single unit.

FIELD 2.0 METALLURGICAL PROPERTIES

2.1 Melting Practice

Code 2.1 defines the melting practice used in casting ingots from which the basic material is fabricated.

2.2 Heat Treatment (Final)

Code 2.2 defines the heat-treatment schedules employed in making the unit. The code is subdivided in accordance with the principal alloy types.

2.3 Type of Hardness Test

Code 2.3 describes the type of hardness test applied to the unit.

2.4 Hardness Number

The hardness value of the material in terms of Vickers Hardness Numbers (5 kilogram load). Thus, all numbers (if other than Vickers) will be converted to Vickers prior to entry.

FIELD 3.0 PRIMARY AND SECONDARY OPERATIONS

3.1 Primary Operation

Code 3.1 details major fabrication processes in preparing material from which the unit is made.

3.2 Secondary Operation

Code 3.2 lists major categories considered as secondary operations in preparing the specimens from the material.

3.3 Secondary Operation

Code 3.3 presents additional information on secondary operations in preparing specimens.

FIELD 4.0 SURFACE CONDITIONING

4.1 Surface Condition

Code 4.1 lists the final operation involved in preparing the surface of the panel or unit.

Direction of machining or polishing scratches, i. e., transverse or longitudinal is also indicated.

4.2 Surface Finish

Describes the surface finish in terms of microinches, rms, which results from the last operation in making the unit.

4.3 Grain Size

Code 4.3 consists of an ASTM (ferrous and nonferrous) grain size conversion chart for all types of measurement determinations. Code numbers opposite the grain size chart indicate the average (weighted) size.

4.4 Grain Direction

Code 4.4 indicates the direction of the grain of the unit, with relation to the rolling direction.

FIELD 5.0 MATERIAL DENSITY

The density of the material is given in lbs/in³.

FIELD 6.0 MATERIAL COMPOSITION

6.1 Element Identification

Code 6.1 lists the various elements. When encoding the elements they are listed in decreasing order according to the quantity (per-cent by weight).

6.2 Chemical Composition

Indicates the per-cent (by weight) of each of the above (code 6.1) listed elements.

FIELD 7.0 CARD SEQUENCE INDICATOR

Used to indicate the card sequence of a multiple card format.

FIELD 8.0 REMARKS

Code 8.0 contains pertinent remarks concerning the unit described.

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Tensile

Tensile Test conforming to Federal Test Standard 121a, Method 211.1

Tensile Test conforming to ARTC-13-T - 1957

Compression

Flexure

Shear

Interlaminar Shear

Johnson Shear

Double Pin Shear

Punch Shear

Sheet Shear

Bearing

Bearing - Tension

Bearing - Compression

Tensile Creep

Bearing Creep

Compressive Creep

Charpy Impact Test

Izod " "

Tensile " "

Code 1.3 MATERIAL IDENTIFICATION - LOW ALLOY STEELS METALS - Card 1

AISI 4130 Extrusions

AISI 4130 "

1025 Steel Sheet

AISI 4330 Extrusions

AISI 4340 "

AISI 6150 "

AMS 6470 "

AMS 6263 "

AISI 8620, "

AISI 8630 "

AISI H-11 "

Vascojet 1000 Extrusions

300 M Steel

Ladish D6 AC

Chro - Mow Tool Steel Sheet (Crucible)

Thermold - J Tool Steel Sheet (Universal Cyclops)

Peerless - 56 Tool Steel Sheet (Crucible)

SAE 1020 Steel Sheet

AISI 4130 Sheet

AISI 4130 Sheet - Normalized

MBMC #1 (Missile Boosters Material Committee) High Silicone, Low Alloy
Steel Sheet and Plate

Commercially pure iron bar

Code 1.3 MATERIAL IDENTIFICATION

CORROSION RESISTANT & HIGH TEMPERATURE STEELS METALS - Card 1

Type 422 Modified Bar

Type 431 Stainless Steel Extrusions

Type 418 Stainless Steel Extrusions

Type 410 Stainless Steel Extrusions

AISI 301 Stainless Steel Extrusions

AM 350 Stainless Steel Extrusions

AM 355 Stainless Steel Extrusions

AM 355 Stainless Steel Sheet 5547 - 8 high

17-7 PH Steel Extrusions

A 286 Steel Extrusions

AM 350 Stainless Steel Sheet

D-979 Sheet (Fe-15Cr-4.4. Ni - 4Mo - 5Ti - 1 Al - 3W)

AISI 301 Sheet

Waspalloy Sheet

HWD #2 - Bar Cr 5.25, Mo 1.35, V.50, Si 1.0, C .37 (Nominal)

Halcomb 218 5 Cr-Mo-V Hot work die steel - Sheet

Thermold A " " "

Invar - sheet (36% nickel)

Rene' 41 sheet

310 Stainless Steel - Sheet

Monel "K" Sheet

Type 420 Stainless Sheet and Plate

Type 422 Stainless Sheet and Plate

Code 1.3 MATERIAL IDENTIFICATION

HEAT RESISTANT-NON CORROSIVE STEEL)

METALS - Card 1

321 Stainless Mil - S - 6721A Sheet (5510)

Alloy based on Fe-Al-Mn-C Bar

T 304 - Bar

19-9DL - Bar

A - 286 - Bar

PH15-7Mo Extrusions

Rene' 41 "

Rene' 41 Bar

Inconel X

Inconel 702 Bar

AM 355 Sheet (5547A or 5548A (High Strength)

Inconel X - Plate (5542)

UDIMET 500 - Bar

AM 355 - Plate (5549)

PH15-7Mo - Plate (5520)

UDIMET 500 - Plate

Code 1.3 MATERIAL IDENTIFICATION ALUMINUM ALLOYS METALS - Card 1

X2020 T6 Sheet
X2020 T6 Extrusion
X2020 T6 Rolled Bar
2024 - T81 Sheet
2014 - T6 Sheet (2049)
2014-T6 Aluminum - clad sheet & plate, Specification QQ-A-255
2014-T6 Aluminum - rolled bar, rod, & shapes - Specification QQ-A-266
2024 Aluminum - Sheet and Plate
2024-T4 Aluminum - Coiled Sheet
Clad 2024-T4 Aluminum - Coiled Sheet
Clad 2024-T6 Aluminum - Sheet
Clad 2024-T81 Aluminum - Sheet
Clad 2024-T86 Aluminum - Sheet
2024-T42 Aluminum - Extrusions
2024-T81 Aluminum - Extrusions
2024-T42 Aluminum - Tubing
2024-T81 Aluminum - Tubing
5052-H36 Aluminum - Sheet
5052-H38 Aluminum - Sheet
7075-T652 Aluminum - Hand Forging
7075-T6 Aluminum - Die Forging
7178-T6 Aluminum - Sheet and Plate
40-E Aluminum Alloy - Sand Casting (QQ-A-601 Class 17M)
C355-T61 Aluminum Alloy Casting, MIL-C-21180(ASG)- Class I
C355-T61 Aluminum Alloy Casting, MIL-C-21180(ASG)- Class II
C355-T61 Aluminum Alloy Casting, MIL-C-21180(ASG)- Class X

Code 1.3 MATERIAL IDENTIFICATION - ALUMINUM ALLOYS (Continued) METALS - Card 1

C355-T61 Aluminum Alloy Casting, MIL-C-21180(ASG)-Class XI
C355-T61 Aluminum Alloy Casting, MIL-C-21180(ASG)-Class XII
A355-T61 Aluminum Alloy Casting, MIL-C-21180(ASG)-Class I
A355-T61 Aluminum Alloy Casting, MIL-C-21180(ASG)-Class II
A355-T61 Aluminum Alloy Casting, MIL-C-21180(ASG)-Class X
A355-T61 Aluminum Alloy Casting, MIL-C-21180(ASG)-Class XI
A355-T61 Aluminum Alloy Casting, MIL-C-21180(ASG)-Class XII
AIMAG35 Aluminum Alloy Casting, QQ-A-601 (Class 26)
M 257 APM 5% Al₂ O₃, Alcoa Al Powder Metals
M 470 APM 10% Al₂ O₃ " " "
M 430 APM 14% Al₂ O₃ " " "
M 486 APM 0.5% Al₂O₃ " " "
7.8% Fe, .2% each of Cr, Ti, V, Zr
2024-T81 Plate
2024-T86 Plate
2219-T62 Sheet and Plate
2219-T81 " "
2219-T87 " "
2219-T6 " "
2219 Aluminum Sheet Plate Forgings
2014-T6 Alclad Sheet
7075-T6 Wrought (Summary data - all shapes)
2024-T4 Wrought " "
2024-T81 Wrought " "
2024-T86 Wrought " "
2014-T6 Wrought " "

Code 1.3 MATERIAL IDENTIFICATION - ALUMINUM ALLOYS (Continued) METALS -Card 1

2618-T61 Wrought (Summary data - all shapes)

X2219-T6 Wrought " "

M237 Aluminum Powder Metallurgy

M257 " "

M276 " "

355-T51

A355-T51

142 - T77

XA 140-F

Code 1.3 MATERIAL IDENTIFICATION TITANIUM ALLOYS METALS - Card 1

Ti 6Al 4V - Rolled (Sheet)

Ti 6Al 4V - Castings

B120 VCA - Sheet

Ti-Al-V-Sn-X System of experimental alloys

Ti-4Al-3Mo1V - Sheet. Don't change to AMS

Ti-2½Al - 16V Sheet

RC 70A

RC 130A

Ti-8Al-1Mo-1V sheet

Ti-8Mn - C110M Sheet (4908)

Ti-2Al-6Mo Sheet

Ti-4Al-2V-1Mo 1Cr Sheet

Ti-Al-Cb-System of Experimental Alloys

Ti-Al-V-X System of Experimental Alloys

Ti-140A Sheet --Annealed

Commercially Pure Titanium MIL-T-7993, Sheet, Strip & Plate

6Al-4V Titanium Alloy Sheet (Heat Treated & Aged)

2.5 Al - 16V Titanium Alloy Sheet

Code 1.3 MATERIAL IDENTIFICATION - MAGNESIUM ALLOYS METALS- Card 1

FS-1-H24 Sheet (QQ-M-44 a)
AZ63 Cast Plate - as cast
AZ63 Cast Plate - T2 (Stabilized)
AZ63 Cast Plate - T4 (Heat Treated)
AZ63 Cast Plate - T6 (Heat Treat & Aged)
AZ31 (FS1 - H) QQ-M-44 Sheet
ZH62 Magnesium Casting
AZ31B Magnesium - Bar, Rod, and Solid Shapes
AZ31B Magnesium - Hollow Shapes
AZ31B Magnesium - Tubes
AZ61A Magnesium - Hollow Shapes
AZ61A Magnesium - Tubes, WWT-829
AZ63A-T5 - Magnesium Alloy Casting
AZ80A-F - Magnesium Extruded Bars, Rods, and Solid Shapes
AZ80A-T5 - Magnesium Extruded Bars, Rods, and Solid Shapes
AZ80-F - Magnesium Forgings
AZ80-T5 - Magnesium Forgings
AZ81-T4 - Magnesium, Sand Castings
AZ81-T4 - Magnesium, Permanent - Mold Castings
AZ91C-F - Magnesium Sand Casting
AZ91C-T4 - Sand Casting
AZ91C-T5 - Sand Casting
AZ916-F - Permanent Mold Casting
AZ91C-T4 - Permanent Mold Casting
AZ91C-T5 - Magnesium, Permanent Mold Casting

Code 1.3 MATERIAL IDENTIFICATION - MAGNESIUM ALLOYS - (CONTINUED) METALS-Card 1

AZ91C-T6 - Magnesium, Permanent Mold Casting
AZ92A-F - Magnesium, Sand Casting
AZ92A-T4 - Magnesium, Sand Casting
AZ92A-T5 - Magnesium, Sand Casting
AZ92A-F - Magnesium, Permanent Mold Casting
AZ92A-T4 - Magnesium, Permanent Mold Casting
AZ92A -T5- Magnesium, Permanent Mold Casting
AZ33A-T5- Magnesium, Permanent Mold Casting
M1A Magnesium Bar, Rod, and Solid Shapes, Cond. F
M1A Magnesium Hollow Shapes, Cond. F
M1A Magnesium Tubes, Cond. F
M1A Magnesium Forgings, - Cond. F
ZH62A - T5 Magnesium Sand Casting
ZK60A-F Magnesium Extruded Rods, Bars, and Solid Shapes
ZK60A-F Magnesium, Hollow Shapes
ZK60A-T5 Magnesium, Hollow Shapes
ZK60A-F Magnesium, Tubes
ZK60A-T5 Magnesium, Tubes
AM100A-F Magnesium, Permanent Mold Casting
AM100A-T4 Magnesium, Permanent Mold Casting
AM100A-T61 Magnesium, Permanent Mold Casting
HK31-H24 Magnesium -bar

Code 1.3 MATERIAL IDENTIFICATION COPPER ALLOYS METALS - Card 1

Aluminum Bronze, QQ-B-671 - Class 1, as Cast Casting

Aluminum Bronze, QQ-B-671 - Class 2, as Cast Casting

Aluminum Bronze, QQ-B-671 - Class 3, as Cast Casting

Aluminum Bronze, QQ-B-671 - Class 4, as Cast Casting

Aluminum Bronze, QQ-B-671 - Class 2, Heat Treated Casting

Aluminum Bronze, QQ-B-671 - Class 3, Heat Treated Casting

Aluminum Bronze, QQ-B-671 - Class 4, Heat Treated Casting

Manganese Bronze, QQ-B-726 - Class B, Casting

Manganese Bronze, QQ-B-726 - Class D, Casting

Phosphor Bronze, QQ-B-691 (Composition 6)

Beryllium Copper, QQ-C-530 Full Hard, Bars

Beryllium Copper, QQ-C-533 Full Hard, Strip

Beryllium Copper Sheet

Code 1.3 MATERIAL IDENTIFICATION MISCELLANEOUS METALS - Card 1

Uranium - Pure - Rolled Plate

Plutonium - Pure -Castings

F48 (Cb-15W-5Mo-1Zr)

Cb74 (Cb-10W-5Zr)

D41 (Cb-20W-10Ti-6Mo)

D31 (Cb-10Ti-10Mo)

Electroformed Nickel Sheet

Commercially pure Cobalt - bar

Commercially pure Nickel - bar

Low Alloy Steels & Carbon Steels

Corrosion and Heat-Resistant Alloys

Aluminum Alloys

Titanium Alloys

Magnesium Alloys

Copper Alloys

Others (see material identification)

Open hearth

Electric furnace

Vacuum furnace

Consumable electrode furnace

Induction furnace

Air melted

Arc furnace

Gas furnace

Electron beam melted

Electron beam melted in furnace

Double vacuum melted

This code provides for assignment of code numbers to detailed heat treatment schedules as reported. For ease in encoding, decoding, etc., materials are blocked according to the following types:

Low Alloy & Carbon Steel

Corrosion & Heat Resistant Alloys

Aluminum Alloys

Titanium Alloys

Magnesium Alloys

Copper Alloys

Miscellaneous

Unspecified

Vickers, diamond pyramid

Rockwell C

Rockwell B

Rockwell T, 45kg load

Rockwell N, 45kg load

Brinell, 3000 kg load, 10-mm ball

Brinell, 500 kg load, 10-mm ball

Rockwell A

Cast

Extruded

Forged and swaged

Hot rolled

Cold rolled

Hot drawn

Cold drawn

Sintered

Hot-cold worked

Rolled (no additional information)

Forged (no additional information)

Cold finished

Cold worked - aged

Wrought

Hard rolled

Electro formed, deposited electrolytically

Forming Operations

Bent

Stretched

Drawn

Stretch wrapped

Rolled

Roll formed

Vacuum hot pressed

Vacuum cast

Warm pressed

Warm pressed and forged

Pressureless vacuum sintered

Forged

Hot rolled

Cold rolled

Machining Operations

Lathe turned or bored

All surfaces milled

Milled surface

Milled edges

All surfaces shaped

Shaped surface

Shaped edges

All surfaces ground

Ground surface

Ground edges

Drill

Surface Working

Surface rolled

Shot peened

Tumbled

Grit blasted

Mechanical polished

Electropolished

Mechanically descaled

Chemically polished

Forming Operations

Bent

Stretched

Drawn

Stretch wrapped

Rolled

Roll formed

Cold rolled

Hot rolled

Forged

Machining Operations

Lathe turned or bored

All surfaces milled

Milled surface

Milled edges

All surfaces shaped

Shaped surface

Shaped edges

All surfaces ground

Ground surface

Ground edges

Drill

Surface Working

Surface rolled

Shot peened

Tumbled

Grit blasted

Mechanical polished

Electropolished

Finish ground.

Finish machined.

As cast.

As rolled.

Bare metal - as received with Heat treat scale.

Bare metal - as received with Heat treat scale. Condition plus anodize (Mil-A-8625A, Type 1) 5-10% chromic acid. Ph 0.7 at 90°F for 30 minutes at 40 volts.

Bare metal - as received with Heat treat scale. Condition plus chemical film coating per (Mil-C-5541) Alodine 1000 sealer.

Metal with heat treat scale removed with stripping solution, 100 cc sulphuric acid, 35 gm chromic acid per liter of water at 180°F for 5 minutes. Water rinse, 1 minute in 20% nitric acid, water rinse.

Metal with heat treat scale removed with stripping solution, 100 cc sulphuric acid, 35 gm chromic acid per liter of water at 180°F for 5 minutes. Water rinse, 1 minute in 20% nitric acid, water rinse. Anodized per (MIL-A-8625A, Type 1) plus chemical film per (Mil-C-5541). See 06 & 07.

Metal with heat treat scale removed with stripping solution, 100 cc sulphuric acid, 35 gm chromic acid per liter of water at 180°F for 5 minutes. Water rinse, 1 minute in 20% nitric acid, water rinse. Anodized per Mil-A-8625A, Type 1.

Metal with heat treat scale removed with stripping solution, Turco number 2897 - 10 oz/gal at room temperature 5-10 minutes rinse in cold water.

Metal with heat treat scale removed with stripping solution, Turco number 2897 - 10 oz/gal at room temperature 5-10 minutes rinse in cold water. Anodized per (Mil-A-8625A) and sealed with chemical film per Mil-C-5541).

Metal with heat treat scale removed with stripping solution, Turco number 2897 - 10 oz/gal at room temperature 5-10 minutes rinse in cold water. Sealed with chemical film per (Mil-C-5541).

Clean & coat with Turco number 4367. Scale inhibitor.

Clean & coat with Turco number 4367. Scale inhibitor, and vapor blast.

Clean & coat with Turco number 4367. Scale inhibitor, and pickle in nitro fluoric acid.

Vapor blast.

Code 4.3, Grain SizeMetals - Card 1

<u>ASTM Number</u>	<u>ASTM Ferrous Grain Size Grains per in.² of Image at 100X</u>	<u>ASTM Nonferrous Grain Size Average Grain Diameter in mm</u>
Not given -	Not given	Not given
-3	0.06	- -
-2	0.12	- -
-1	0.25	- -
0	0.50	- -
1	1.00	- -
2	2	- -
3	4	- -
4	8	- -
5	16	- -
6	32	- -
7	64	- -
8	128	- -
9	256	- -
10	512	- -
11	1024	- -
12	2048	- -
--	--	0.010
--	--	0.015
--	--	0.025
--	--	0.035
--	--	0.045

<u>ASTM Number</u>	<u>ASTM Ferrous Grain Size Grains per in.² of Image at 100X</u>	<u>ASTM Nonferrous Grain Size Average Grain Diameter in mm</u>
--	--	0.065
--	--	0.090
--	--	0.120
--	--	0.150
--	--	0.200
--	--	0.300
--	--	0.400
--	--	0.500
--	--	0.600
--	--	0.700
--	--	0.800
--	--	0.900
--	--	1.000

Longitudinal

Transverse

45°

This code provides for the assignment of code numbers to each element thus enabling the encoder to completely describe the chemical composition of the material.

See report for heat number.

See report for additional heat treat information.

See report for additional element identification.

See Pre-test conditioning for aging information (2nd card)

Analysis is average of limits found in several samples.

Composition is nominal.

Hand forged stock length equals to or less than 3 times width.

Hand forged stock length more than 3 times width.

See report for significant reduction ratio information.

See report for significant pouring temperature and mold coatings.

Material supplied by United States Steel Corporation.

Material supplied by Ingersoll Steel Division of Borg Warner.

See report for forging temperature.

See report for rolling temperature.

Additional information given in previous report.

See report for pre-test conditioning operations.

CARD 2
FORMAT AND CODE OUTLINES
MECHANICAL PROPERTIES OF METALS

FIELD 1.0 BIBLIOGRAPHIC IDENTIFICATION

1.1 Reference Number

Code 1.1 identifies a reference number assigned to the source of information from which the encoded data is extracted.

1.2 Test Type

Code 1.2 identifies each type of test encoded from the report.

1.3 Material Identification

For identification of metals either an AMS number or a coded number representing a material not identified by an AMS number will be used.

1.4 Material Type

Code 1.4 identifies the encoded material type, i.e., low alloy steels, heat and corrosion resistant materials, aluminum, etc.. This classification facilitates machine separation of the metal alloys and other materials.

1.5 Unit Number

A number assigned to each identical unit of fabrication for the purpose of identifying this unit from all others within a single report.

1.6 Set Number

A number assigned to each group of specimens, selected from a single unit, which have been conditioned and tested under identical conditions.

1.7 Number of Specimens in a Set

The total number of specimens in a set. Also serves to indicate

where averages of specimens are given.

1.8 Specimen Number

An identification number assigned to each specimen of a set.

Also serves as an indicator of specimen averages.

FIELD 2.0 SPECIMEN DESCRIPTION

2.1 Orientation of Material Fibers or Grains to the Major Axis of the Specimen

Defines the angle of the major axis of the specimen in relation to directional properties exhibited by the material.

2.2 Specimen Configuration

Describes the general shape of the specimen.

2.3 Notch Factor

The theoretical notch factor given for a specified notched specimen.

2.4 Fabrication Procedure

Code 2.4 describes the type machine, blade, abrasive disc or other instrument utilized in cutting the specimen.

2.5 Specimen Length

Pertinent lengthwise dimension of the specimen.

2.6 Specimen Width-Maximum

The maximum width, diameter, or area of the specimen test section (critical area).

2.7 Specimen Width - Maximum

The smallest diameter or width of the test section of a notched

specimen (maximum width minus notch diameter or depth).

2.8 Specimen Thickness

The thickness in the test section of the specimen.

2.9 Surface Finish

Code 2.9 describes the surface finish in the test section of the specimen.

FIELD 3.0 PRE-TEST CONDITIONING

3.1 Pre-Test Conditioning

Code 3.1 describes the conditioning a unit, a set of specimens or an individual specimen was subjected to prior to testing.

3.2 Pre-Test Conditioning Time

The total time which the part was subjected to pre-test conditioning.

3.3 Pre-Test Conditioning Temperature

Maximum temperature to which the specimen was subjected to during pre-test conditioning.

FIELD 4.0 MATERIAL HARDNESS

4.1 Hardness

Vickers Hardness (5 kilogram load) is reported to the nearest whole number. This reading, compared with the unit hardness (card 1), reflects any changes in hardness resulting from specimen fabrication and/or pre-test conditioning.

FIELD 5.0 TEST PROCEDURE

5.1 Test Equipment

Code 5.1 describes the basic test machine or combination of machines used for the test.

5.2 Instrumentation

Code 5.2 describes the special instrumentation used for reading specimen deformation.

5.3 Orientation of Major Axis of Specimen to Load

Code 5.3 describes the orientation of the major axis of the specimen in relation to the applied load.

FIELD 6.0 TEST CONDITIONS

6.1 Load Rate

Describes the rate of loading which the specimen was subjected to.

6.2 Test Temperature

Maximum temperature to which the specimen was subjected to during testing.

FIELD 7.0 TEST RESULTS

7.1 Tensile and Compression Test

7.1.1 Pre-Stress Type

Code 7.1.1 describes the type of pre-stress applied to the specimen.

7.1.2 Pre-Stress Magnitude

The maximum magnitude of pre-stress, psi, to which the specimen was subjected.

7.1.3 Ultimate Stress

Ultimate stress, psi.

7.1.4 Elongation at Failure

Percent elongation at failure.

7.1.5 Yield Stress or Proportional Limit Stress

Yield stress (0.2% offset) or proportional limit stress. Where both are reported, Yield Stress shall take precedence.

7.1.6 Modulus of Elasticity

Youngs modulus of elasticity, psi.

FIELD 7.0 TEST RESULTS

7.1 Shear Test

7.1.1 Pre-Stress Type

Code 7.1.1 describes the type of pre-stress applied to the specimen.

7.1.2 Pre-Stress Magnitude

The maximum magnitude of pre-stress, psi, to which the specimen was subjected.

7.1.3 Ultimate Stress

Ultimate Stress, psi.

7.1.4 Yield Stress

Yield Stress, psi.

7.1.5 Proportional Limit

Proportional limit stress, psi.

7.1.6 Modulus of Rigidity

Modulus of rigidity, psi.

FIELD 7.0 TEST RESULTS

7.1 Bearing Test

7.1.1 Pre-Stress Type

Code 7.1.1 describes the type of pre-stress applied to the specimen.

7.1.2 Pre-Stress Magnitude

The maximum magnitude of pre-stress, psi, to which the specimen was subjected.

7.1.3 Ultimate Stress

Ultimate bearing stress, psi.

7.1.4 Yield Stress

Yield stress, psi.

7.1.5 Edge Distance Ratio

Ratio of edge distance to the bearing hole diameter.

7.1.6 Bearing Hole Diameter to the Stress Ratio

Ratio of diameter of bearing hole to the thickness of the sheet or plate.

FIELD 7.0 TEST RESULTS

7.1 Izod and Charpy Impact Tests

7.1.1 Pre-Stress Type

Code 7.1.1 describes the type of pre-stress applied to the specimen.

7.1.2 Pre-Stress Magnitude

The maximum magnitude of pre-stress, psi, to which the specimen was subjected.

7.1.3 Impact Strength

Impact strength, ft. - lbs.

7.1.4 Velocity

Linear velocity (at point of impact), feet per second.

FIELD 7.0 TEST RESULTS

7.1 Tensile Impact

7.1.1 Pre-Stress Type

Code 7.1.1 describes the type of pre-stress applied to the specimen.

7.1.2 Pre-Stress Magnitude

The maximum magnitude of pre-stress, psi, to which the specimen was subjected.

7.1.3 Impact Strength

Tensile impact strength, ft. - lbs.

7.1.4 Elongation

Total elongation, per cent.

7.1.5 Area Reduction

Total reduction in area, per cent.

FIELD 7.0 TEST RESULTS

7.1 Creep Test

7.1.1 Applied Stress

The initial stress applied to the creep specimen.

7.1.2 Rupture Time

Total Time to Rupture

7.1.3 Deformation Units

Code 7.1.3 lists the units used to report creep deformation.

7.1.4 Initial load Deformation

Deformation resulting from initial loading.

7.1.5 Deformation at Rupture

Deformation at rupture or at end of test if specimen did not fail.

FIELD 8.0 FAILURE DESCRIPTION

Code 8.0 describes the type of break or failure of a specimen.

FIELD 9.0 CARD SEQUENCE

Used to indicate the card sequence of a multiple card format.

FIELD 10.0 REMARKS

Code 10.0 contains pertinent remarks concerning data described by the card.

FIELD 1.0* BIBLIOGRAPHIC IDENTIFICATION

- 1.1 Reference Number
- 1.2 Test Type
- 1.3 Material Identification
- 1.4 Material Type
- 1.5 Unit Number
- 1.6 Set Number
- 1.7 Number of Specimens
- 1.8 Specimen Number

* Where a third card is necessary for reporting additional test data this field is simply a repeat of Field 1.0 of the preceding card (Card 2).

FIELD 2.0 thru 6.0

Fields 2.0 thru 6.0 pertaining to specimen description, conditioning, and test set up are omitted from this card since they are described on the preceding card (Card 2).

FIELD 7.0 TEST RESULTS

7.1 Creep Test Results

7.1.1 Applied Stress

The initial stress applied to the creep specimen.

7.1.2 Time to Rupture or Termination of Test

The total time to rupture or end of test.

7.1.3 Deformation on Loading

Initial deformation upon loading.

7.1.4 Area Change

Total area change in per cent.

7.1.5 Deformation

Incremental reading of deformation.

7.1.6 Time

Incremental time measurements or assignments.

7.1.7 Area Change

Total area change per each deformation and time increment.

7.1.8 Deformation

7.1.9 Time

7.2.0 Area Change

7.2.1 Deformation

Field 7.0 TEST RESULTS - continued

7.2.2 Time

7.2.3 Area Change

7.2.4 Deformation

7.2.5 Time

7.2.6 Area Change

FIELD 8.0 NOT USED

FIELD 9.0 CARD SEQUENCE

Used to indicate the card sequence of a multiple card format.

FIELD 1.0 BIBLIOGRAPHIC IDENTIFICATION

1.1 Reference Number

1.2 Test Type

1.3 Material Identification

1.4 Material Type

1.5 Unit Number

1.6 Set Number

1.7 Number of Specimens

1.8 Specimen Number

Where a fourth card is necessary for reporting additional test data this field is simply a repeat of Field 1.0 of the preceding cards (Cards 2 and 3).

FIELDS 2.0 THRU 6.0

Fields 2.0 thru 6.0 pertaining to specimen description, conditioning, and test setup are omitted from this card since they are described on a preceding card (Card 2).

FIELD 7.1 CREEP TEST RESULTS - Continued

7.2.7 Deformation

7.2.8 Time

7.2.9 Area Change

7.3.0 Deformation

7.3.1 Time

7.3.2 Area Change

7.3.3 Deformation

7.3.4 Time

7.3.5 Area Change

7.3.6 Deformation

7.3.7 Time

7.3.8 Area Change

7.3.9 Deformation

7.4.0 Time

7.4.1 Area Change

FIELD 8.0 NOT USED

FIELD 9.0 CARD SEQUENCE

Used to indicate the card sequence of a multiple card format.

Tensile

Tensile Federal Specification 151 - 211.1

Tensile ARTC - 13 - T

Compression

Flexure

Shear

Johnson Shear

Double, Pin Shear

Punch Shear

Sheet Shear

Bearing

Bearing - Tension

Bearing - Compression

Tensile Creep

Bearing Creep

Charpy Impact

Low Alloy Steels & Carbon Steels

Corrosion & Heat Resistant Alloys

Aluminum Alloys

Titanium Alloys

Magnesium Alloys

Copper Alloys

Others (See Material Identification)

Rectangular

Standard tensile coupon (rectangular net section).

Rectangular sheet shear specimen slotted.

Standard sheet compression specimen ends square and flat.

Standard coupon with tabs on the sides for strain gages.

Rectangular with hole perpendicular to face centered near one end.
(Standard bearing test specimen)

Cylindrical

R1 Configuration of Federal Test Method Standard # 151a .
(Standard tensile specimens)

Standard cylindrical tensile specimen

Smooth, notched cylindrical specimen

Short cylinder or disc - major axis perpendicular to face.

Standard round notched tensile specimen 60° notch .012 root radius.

Tubular.

Rectangular, notched - No other information.

Rectangular, 60° V notch .005 root radius.

Rectangular, notched Charpy V notched specimen 45° - .25 mm radius .

ASTM Standard - E23-47T - Type A .

Rectangular, 60° V notch tensile specimen.

Rectangular, bearing specimen.

Cylindrical, notched, no other information.

Cylindrical V notched .

Cylindrical V notched - 60° notch .006 radius .

Tubular, notched, no other information.

Machined, no other information .

Lathe turned standard tensile specimen .

Surface ground.

Machined to shape, hole drilled & reamed.

Lathe turned compression specimen, ground square, & parallel on ends.

Machined to shape, ends ground square & flat & parallel.

Lathe turned.

Clad surface milled off both faces of specimens.

Machined to tensile coupon shape -- holes drilled in ends for bolt on clamps or pin & clevis type grips.

Milled.

Specimen blanked with die.

Specimen blanked, edges deburred and polished.

Specimen machined, edges deburred, filed & polished.

Specimen machined, edges deburred & polished.

Specimen blanked, edges polished.

Specimen blanked, edges filed & polished.

Specimen blanked, edges and faces of specimen polished.

Specimen blanked, edges and faces of specimen ground.

Specimen blanked, edges and faces polished.

Machined to shape, edges polished.

Machined to shape, edges filed & polished.

Machined to shape, edges polished & faces ground.

Conditioning not given.

Reheated after process anneal to simulate hot straightening.

Reheated after process anneal plus refrigeration.

Reheated after RH950 heat treatment.

Reheated after simulated braze cycle (step aged).

Reheated after simulated braze cycle (step aged), plus refrigeration.

Reheated after simulated braze cycle (step aged), plus refrigeration and age.

Aged (900^oF - 72 hours - AC).

Stability exposure.

Pickled in HF.

Exposed in gas atmosphere.

Exposed in gas atmosphere at 2000 psi.

Exposed in gas atmosphere at 35000 psi.

Exposed in air atmosphere at 2000 psi.

Exposed in air atmosphere at 35000 psi.

Above room temperature & Pre-Stress in direction of test loading.

Elevated temperature.

Heated to temperature within 10 seconds with special unit.

Heated in vacuum.

Exposed to salt spray (Na Cl).

Subzero temperatures.

Elevated temperature under 40 ksi pressure.

Exposed to heat and stress together.

Aged at 975^oF for 4 hours then exposed to elevated temperature as shown.

Aged at 925^oF for 12 hours.

Annealed

Exposed to thermal blast (short high temp.) then to salt spray 20% NaCl for 10 days.

Exposed to thermal blast - aged 24 hours - re-exposed to thermal blast - Aged 24 hours then tested.

See report

Hydraulic Testing Machine

Baldwin Universal Testing Machine

Hydraulic Testing Machine, Spherical Head

Hydraulic Testing Machine with test oven.

Hydraulic Testing Machine with strain rate pacer & test oven.

Testing Machine with double shear jig.

Screw driven testing machine with resistance heating.

Mechanical Testing Machine.

Mechanical Testing Machine, templin type grips.

Marquardt Universal Testing Machine (Universal) self resistance heating, horizontal movement bolt through grips, same specimen compression & tension.

Marquardt Universal Testing Machine with compression jig. Ceramic rollers to prevent buckling.

Testing Machine, templin grips, test oven.

Testing Machine, templin type grips.

Testing Machine, spherical head.

Testing Machine - Pin connected clamp on device.

" " Compression jig to keep specimens from buckling.

" " " " " " " in test oven.

Testing machine with bearing test jig.

Testing machine, templin grips, high speed resistance heater and controller. High rate loading capacity.

Instron Testing Machine with test oven.

Testing Machine with rapid radiant heating device & templin grips.

Testing Machine with pin and clevis type grips.

Riehle Universal Testing Machine - Metals.

Universal Testing Machine.

Testing Machine with punch shear jig .75" in diameter.

Tension impact machine.

Charpy impact test machine.

Sonntag Universal impact test machine.

Tatnall Model RL-6 creep machine.

Hounsfield Transometer.

Standard creep machine.

Standard creep machine with test oven.

See report for instrumentation details.

Marten's Mirrors.

Tuckerman Optical strain gage.

Baldwin PSM Extensometer Microformer system.

Load Cell with SR-4 strain gages & 4 springs with SR-4 gages.

Testing Machine's dial or calibration only.

Strain gages.

Rosette type AR-7 (Metaelectric) strain gage.

Baldwin (PSH-8M) high magnification extensometer and low magnification extensometer.

Baldwin microformer system.

Microformer extensometer.

Extensometer and autograph recorder, stress or load strain.

Dial gage.

Compressometer, see report for details.

Peters PS 5M- Microformer extensometer and autograph.

Peters PSH-8M " " extension & autograph.

Microformer Extensometers - to fit small studs on side of specimen-
Stress Strain Recorder (Oscilloscope & Camera) welded thermocouples to
control high speed heating apparatus, fan to control thermal Gradient
through net section.

SR-4 type strain gages, XY Recorder.

Automatic timer.

Beattie varitron 35mm model E camera to record strain vs time measurements.

Pre-yield and post-yield extensometers activated by SR - 4 Strain gages.

Card 5.3 ORIENTATION OF MAJOR AXIS OF SPECIMEN TO LOAD METALS - Card 2

0°

15°

30°

45°

60°

75°

90°

No pre-stress

Tension - pre-stress

Tensile pre-strain. Strain in in/in.

Tensile pre-strain. Strain in % -

Tensile creep

Compressive creep

Inch/inch x 100

% of 2 inch gage length

% gage length unknown

% of hole diameter

No failure

See report for failure description.

Tensile

Tensile - flat granular fracture accompanied by spark and localized melting.

Compression

Ruptured at edge of hole.

Failed in radius of specimen

Failed in threads of specimen

Failed in pinhole of specimen

Pre-test temperatures are simulated hot straightening temperatures.

See report for further heat treat details.

Test results for thickness of .188 in.

Test results for thickness of .188 in.

See report for further load rate details.

Heat of unit.

Tail of unit.

Imperfection in specimen.

Inclusion in specimen.

Crack in specimen.

Broke at gage mark.

Values obtained from another source, by contractor of this report.

Tested one hour after exposure.

Tested 24 hours after exposure --- aged at room temperature.

Tested 72 hours after exposure --- " " "

Grip failed or slipped.

Specimens were pre-strained before heat treatment.

Tested immediately after thermal blast.

Control test.

Minimum thickness given.

Yield strength taken as 2% of hole diameter off set from the straight line portion of load-deformation curve. Extensometer set from center line of hole to grip.

Test results for thickness of .063.

Cross sectional area 25 sq. in.

Cross sectional area 32 Sq. in.

See report for test atmosphere.

Tested in gas atmosphere.

See report for test procedure.

See report for pre-stress deformation.

See report for cross sectional area limits.

Die forgings.

Hand forgings - length 3 times width.

Hand forgings - length 3 times width.

Secondary modulus given.

See report for % elongation values.

Information pertaining to tensile tests were given in references 2,3,4,5 and 8 of progress report number 9.

Procedure for testing and description of the test equipment were given in references 4 and 5 of Progress Report 9.

Procedure for testing and description of the test equipment were given in references 2,3 and 6 of Progress Report 9.

See second card for additional information.

See report for initial loading rate.

Data taken from graphs.

APPENDIX II

CODE AND FORMAT OUTLINES

MECHANICAL PROPERTIES OF REINFORCED PLASTICS

APPENDIX II

Discussion

The following code and format outlines are not intended to serve as an operating manual. Abbreviated field descriptions and typical code entries are provided to familiarize potential users with the kind of information that is available from the reinforced plastics mechanical properties sub-systems.

Card 1, a materials description card, is the first card of a basically two card system. On this card, a standard 80 column IBM card, is stored such information as base resin and percent content, additions, type and amount of reinforcement, fabric finish, fabrication procedure, cure and post cure technique, resin content, density, etc.

Card 2, also a standard IBM card, includes in addition to identification linking it with card 1, specimen fabrication, geometry and dimensions, pre-test conditioning, test equipment, environment and results.

These formats are referred to as "fixed formats" where the number and arrangement of the columns is fixed and unalterable. Each "bit" of information is entered into a specific column or group of columns. Changes in decimals and/or units for expansion or conversion, etc., are accomplished by the use of non-conventional zone punching. Visual identification of these cards and those of other sub-systems are identified by color coding and corner cuts. To facilitate machine separation of number 1 and 2 cards a card sequence number has been included.

FIELD 1.0 BIBLIOGRAPHIC IDENTIFICATION

1.1 Reference Number

Code 1.1 identifies a reference number assigned to the source of information from which the encoded data is extracted.

1.2 Test Type

Code 1.2 identifies each type of test(s) encoded from the report.

1.3 Base Resin

Code 1.3 identifies the resin or combination of resins used in the fabricated unit.

1.4 Material Type

Code 1.4 identifies the encoded material as plastics. This classification facilitates machine separation of the plastics cards from cards representing other materials.

1.5 Unit Number

A number is assigned arbitrarily to each identical unit of fabrication for the purpose of identifying this unit from all others within a single report.

1.6 Number of Specimens

The total number of specimens encoded for each test type from a single unit.

FIELD 2.0 MATERIAL DESCRIPTION

2.1 Resin Quantity

The volume of the mixed batch of resin from which the unit being described was fabricated.

2.2 Additives and Amount of Additions

Code 2.2 identifies the additives used in compounding the final resin mixture and the amount of each addition.

2.3 Reinforcement

2.3.1 Reinforcement Type

Code 2.3.1 identifies the type of material or combination of materials used to reinforce a lay-up.

2.3.2 Form of Reinforcement

Code 2.3.2 describes the form and commercial designation or weave of the reinforcement used.

2.3.3 Fabric Finish

Code 2.3.3 describes the chemical treatment applied to a reinforcing material to improve its characteristics.

2.3.4 Reinforcement Orientation

Describes the arrangement of the reinforcement plies in a unit of fabrication.

2.3.5 Amount of Reinforcement

The amount of reinforcement, i.e., plies or layers. A ply is defined as a single layer of any one type or form of reinforcement.

FIELD 3.0 FABRICATION

3.1 Mixing Sequence

Code 3.1 describes the order in which the additives were mixed with the resin.

3.2 Method of Impregnation

Code 3.2 describes the method used in applying the resin to the reinforcement.

3.3 Pre-Stress Type

Code 3.3 describes the type of stress which the reinforcement was subjected to during or immediately prior to fabrication.

3.4 Pre-Stress Magnitude

The maximum amount of stress applied to the reinforcement during or prior to fabrication.

FIELD 4.0 CURE TECHNIQUE

4.1 Cure Time

Cure time at maximum temperature.

4.2 Cure Temperature

Maximum cure temperature, degrees Fahrenheit.

4.3 Cure Pressure

Maximum cure pressure, psi.

4.4 Cure Pressure, Type Application

Code 4.4 describes the type pressure applied during the cure cycle.

4.5 Heat-up Rate

Heat-up rate, degrees Fahrenheit per minute.

4.6 Cooling Rate

Cooling rate, degrees Fahrenheit per minute.

FIELD 5.0 POST-CURE TECHNIQUE

5.1 Post-Cure Time

Post cure time to nearest hour at maximum temperature.

5.2 Post-cure Temperature

Maximum post-cure temperature, degrees Fahrenheit.

5.3 Post-Cure Pressure

Maximum post-cure pressure, psi.

5.4 Post-cure Pressure, Method of Application

Code 5.4 describes the method used to apply pressure to the fabricated part during post-cure operation.

FIELD 6.0 UNIT PROPERTIES

6.1 Resin Content

Resin content to the nearest one-tenth percent.

6.2 Method, Resin Content Determination

Code 6.2 describes the method used in determining the resin content of the part.

6.3 Density

Density in lbs/in³. Convert specific gravity to density if necessary.

FIELD 7.0 CARD SEQUENCE

Used to indicate the card sequence of a multiple card format.

FIELD 8.0 REMARKS

Code 8.0 contains pertinent remarks concerning the unit described.

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Tensile

Tensile test conforming to Federal Specification LP 4066 Method 1011

Tensile test conforming to ASTM D638-58T test procedures

High speed Tensile test - to failure in approximately 7-10 milli seconds.

Compression

Compression test conforming to Federal Specification LP 4066 Method 1021

Flexure

Flexure test conforming with Federal Specification L-P406b Method 1031.1

Flexure test ASTM D 790-58T

Shear

Interlaminar Shear

Johnson Shear

Panel Shear

Computed edgewise Shear values from tension data 45° - 0°

Shear test conforming to Federal Specification LP 4066 method 1041

High speed Interlaminar Shear - failure in 7-10 milli-seconds

Bearing

Bearing - Tension LP 406b-1051

Bearing - Compression

Creep, Tension

Creep, Bearing

Creep, Tension test under water

Creep, Flexure

Creep, Flexure test under water

Fatigue

Impact

Izod Impact test conforming to Federal Specifications LP 4066 Method

3-M Scotchply No. 1002

Epon 828

Epon 1001

Diglycidyl ether of bisphenol (DEBA)

Epon 820

F - 160

Epon 1031 - made by Shell Company

MIL - R 9300

Epoxy - no other information

Narmco 1174/3 heat resistant epoxy

Bakelite 3001 -- Union Carbide

Diepoxy Kapoxite 159 - Koppers

B stage Resin 207 -- Bakelite -- Union Carbide

Epon 815 - Shell

Epi Rez 504 - Jones - Dabny

Epozide 201 - Union Carbide Company

X-12000 Epoxide Resin

X-12100 Epon - Shell

Epon X-80100

Epon X-15100

Code 1.3 IDENTIFICATION OF RESIN (SILICONE) PLASTICS - Card 1

D. C. 2106 (Dow Corning)

D. C. 2104 (Dow Corning)

D. C. - R - 7141

D. C. 2104-V-11 Dow Corning

Code 1.3 IDENTIFICATION OF RESIN (POLYESTER) PLASTICS - Card 1

Polyester Resin, no other information

Resin 1 - Styrene alkyd type, high temperature, high viscosity, contact pressure laminating resin of the polyester type.

High temperature setting - high viscosity laminating resin of polyester (diallyl phthalate-alkyd) type.

Resin 3 - laminating resin of polyester type to be incorporated with styrene monomer.

Resin 4 - styrene monomer polyester - type, high temperature, low viscosity laminating resin catalyzed for cure at room temperature.

Resin 5 - a high temperature - setting diallyl phthalate pre-polymer applied in an acetone solution and allowed to dry completely before curing.

General purpose polyester, conforming to type I - Specification MIL-R 7575 and formulated for room temperature curing.

10% non rigid polyester, 90% regular rigid polyester.

Selectron 5003

Paraplex p-43 - Rhom & Haas Company

Plaskon 911-11

Vibrin X-1047 (Vibrain 135) polyester-triallyl cyanurate (TAC)
Naugatuck Chemical Division, U. S. Rubber Company

Dryply 81

Laminac 4232 (Pd1-7-669) polyester-triallyl cyanurate - American Cyanamid Co.

Forest Products Laboratory- Resin #2 - styrene-alkyd polyester. High temperature setting LOW viscosity laminating resin.

Vibrin X-1068 - polyester resin

Selectron 5016

Laminac 4115, American Cyanamid

Paraplex P43, Rohn & Haas

Marco 28v, Marco Chem. (celanese)

Dap 65/55

Laminac 4202

Code 1.3 IDENTIFICATION OF RESIN (PHENOLIC) PLASTICS - Card 1

CTL - 91LD

Bakelite BV 17085

Resin 9 - High Temperature laminating resin-phenolic type

Phenolic Resin - no other information

Ironside No. 101

BVO 11946

984 - RPD (R/M Style) - Raybestos - Manhattan, Inc.

Conolon 506 - Narmco, Inc.

CTL 37-9X

SC 1008 - Monsanto

Bakelite BRL-2741 - Phenolic Resin

91 LD - American Reinforced Plastic Company, Los Angeles, California

Code 1.3 IDENTIFICATION OF RESIN (POLYURETHANES) PLASTICS - Card 1

Hylene T(TDI) with 2 Butene 1, 4 diol - Formula 48
4 carbon unsaturated glycol.

Code 1.3 IDENTIFICATION OF RESIN
(MELAMINE FORMALDEHYDE RESINS) PLASTICS - Card 1

Melmac 405

Code 1.3 IDENTIFICATION OF RESIN (COMBINATIONS) PLASTICS - Card 1

33 parts Epon 1001 + 67 parts Plyophen 5023

Epon 1001/plyophen

Epon 1001/plyophen 5023 (43/57 ratio)

X-80100 + 828 Epon

Epon x 12100 + plyophen 5023

Epon x 12100 + Novolac - see report for ratio

Code 2.2.1 ADDITIVES (Trade name, chemical composition, etc) PLASTICS - Card 1

This code provides for assignment of code numbers to curing agents, catalysts, fillers, solvents and diluents as reported.

Code 2.3.1 TYPE REINFORCEMENT (ASBESTOS)

PLASTICS - Card 1

40-RPD Raybestol Manhattan Pyrotex - Style 40 RPD felt

41-RPD (R/M Pyrotex Style) --prepreg felt

PL - 2258 paper - Johns Mansville

Code 2.3.1 TYPE REINFORCEMENT (Glass-Borosilicate) PLASTICS - Card 1

Special high modulus glass YM31A made by Owens Corning and woven into 181 style cloth.

Special Low dielectric glass 6-6-4 silicon dioxide boricoxide.

Glass flake 'E' glass flake by Owens Corning.

Style Y 227 glass fabric (British equivalent to 181)

"	221	"	"	"	143
"	93A	"	"	"	128
"	346	"	"	2/2 twill	
"	314	"	"	"	

Code 2,3,1 TYPE REINFORCEMENT (COMBINATIONS) PLASTICS - Card 1

181, 143, 162

112, 143

112, 162

112, Glass cloth honeycomb

1000, 1½ oz. glass mat, 1000 (Style 1000 glass fabric sand)

Novabestos No. 7412 -- Mat

M 503 - Mat & parallel strand mat - Fiberglass Corporation

184 & Parallel strand mat 660B

M 513 Mat & 143 cloth

Mat with cloth facings

Woven roving with cloth facings

Code 2,3,1 TYPE OF REINFORCEMENT (Glass-Borosilicate) PLASTICS - Card 1

181

143

162

182

184

112

128

120

HM - 18

116

M-503

164

183

57 X

81

ECC 181

183

Style 1000 glass cloth

Glass-Flakes

Unbonded Fibrous Glass

Straight glass fibers

Woven Roving

Glass-fabric honeycomb core - 1/4 inch cell size

Fiber glass mat

Woven glass fiber fabric

Code 2.3.1 TYPE REINFORCEMENT (CERAMIC)

PLASTICS - Card 1

Code 2.3.1 TYPE REINFORCEMENT (MISCELLANEOUS) PLASTICS - Card 1

Cotton

Balsa

Code 2.3.2 FORM OF REINFORCEMENT (WOVEN CLOTH) PLASTICS - Card 1

Woven cloth - no other information

Unidirectional weave with a warp-to-fill strength of about 8 to 1.

Satin weave fabric, approximately equal strength in warp and fill directions.

Warp-to-fill ratio of about 3 to 2

Plain weave

4 - Harness satin weave

Unidirectional weave (Crowfoot satin)

Fine weave

Coarse weave

Satin weave

Unidirectional weave fabric - warp to-fill- Strength 11 to 1

Crowfoot satin weave

Combination of woven fiber glass types

Balanced square weave

2/2 twill

16 shaft satin weave

181 - 15×10^3 yd/lb filaments

Mat - no other information

Mat - mechanically bonded

Mat - resin bound

Mat - glass fibers

Resin sized, mechanically bonded, fiberglass mat

Felt, mechanical properties vary in the ratio of 3 to 2 when going from the longitudinal to the transverse direction.

Felt

Asbestos felt

High solubility polyester binder glass mat - 1½ oz

Low solubility glass mat - 1½ oz

Woven roving, 25-27 oz equal directional properties

Chopped strand mat (2 oz) high solubility polyester binder

Asbestos paper

Roving - no other information

Unbonded straight glass fibers - unidirectional

Pre-impregnated unidirectional fibers. (Various elements and/or oxides added to basic glass forming oxide -- MgO, Al₂O₃ and SiO₂.
See report for further details.)

Honeycomb - no other information

No. 47 glass-cloth honeycomb with 1/4 in. cell size cut to 0.275 inch thickness

Woven fiber glass, roving

Code 2,3,2 FORM OF REINFORCEMENT (COMBINATIONS) plastics - Card 1

Satin weave fabric, approximately equal strength in warp and fill directions; unidirectional weave with a warp-to-fill strength of about 8 to 1; and a warp-to-fill ratio of about 3 to 2.

Crowfoot satin and plain weave glass fabric.

80% chopped glass fibers -- 20% asbestos fiber mat, Novabestos No. 7412.

2 oz. glass mat faced on both sides with one ply of 1000 cloth.

Woven roving faced on both sides with one ply of 1000 style cloth.

Two layers of Style 1000 glass cloth, 5 plies of 1½ oz glass mat with low solubility polyester binder, 2 more plies of Style 1000 glass cloth.

5 plies of M503 mat & 1 ply of parallel strand mat.

1 ply of parallel strand mat, 5 plies of M503 mat & 1 ply of parallel strand mat.

2 plies of parallel strand mat, 5 plies of M503 mat & 1 ply of parallel strand mat.

2 plies of pre-stressed parallel strand mat, 5 plies of M503 mat & 2 plies of pre-stressed parallel strand mat.

2 plies of parallel strand 660B mat, 4 plies 184 & 2 plies of parallel strand 660B mat.

1 ply of 143, 5 plies of M503 mat & 1 ply of 143.

Glass flakes .1 to .2 in. diameter 26% fines.

This code provides for assignment of code numbers to Fabric Finishes as reported.

Random (No planned orientation)

Isotropic (0° , 60° , 120°)

Crossplied (45° , 0°)

Unidirectional (Fibers)

Isotropic (0° , 30° , 60° , 90°)

Parallel Laminated (Warp) Orthotropic

Crossplied (30°), natural axis (reference axis) midway between each group of parallel laminations.

Crossplied (90°)

Aeolotropic

Laminations numbers 1, 2, 4, 5, 7, 9, 10, 12 and 13 were laid up with the warp direction parallel to the axis of reference; laminations numbers 3 & 11 making an angle of 110° ; laminations numbers 6 & 8 making an angle of 140° with the same axis. Angles measured positively counter clockwise direction from reference axis.

Laminations 1, 6 & 12 were of 162-114 fabric and were laid up with their warp direction making an angle of 0° to an axis of reference; laminations 3, 5, 8 & 10 were of 143-114 fabric making an angle of 10° ; and laminations 2, 4, 7, 9 & 11 were of 181-114 fabric making an angle of 140° with the same axis. The angles were measured positively in a counter clockwise direction.

Parallel laminated with alternated plies.

Core material and facings parallel laminated.

Glass flakes oriented as nearly parallel as practically possible.

Unidirectional straight glass fibers

Loosely packed

Pre-impregnated, sequence unknown

Curing agent added to resin

Curing agent & catalyst added to resin

Catalyst added to resin

Catalyst and Diluent added to Resin

Diluent added to Resin

Resin heated and catalyst added

Pre-impregnated, method unknown-pre-fabricated, as supplied

Pre-impregnated, "B" stage

Pre-impregnated, see report for method

Vacuum box

Brush, roller, squeegee, dipped, sprayed, poured, (manual)

Automatic, bath, spray

"B" stage - See report for details

Void free bag molding technique

Method not given

No pre-stress applied

Tension

Outside plies pre-stressed

None, no pressure applied

Pressure bag & mold, vacuum bag, autoclave

Platen press, hot press, oil filled steel bladder

Matched metal mold in a press

Contact Pressure

Pressed to stops

No Pressure applied

Post-cure accomplished by same method as cure
(see code a 4.4)

Supported with 1/2 of mold

Unsupported

Code 6.2 RESIN CONTENT DETERMINATION

PLASTICS - Card 1

Ignition (burn-off)

Weight & dimension estimate

Test made by manufacturer or supplier -- method not reported

Weighed before and after impregnation.

Complex post cures -- See report.

Post cured but details not reported.

Glass fabric oven dried before fabrication (see report for details).

Glass fabric exposed 7 days and fabricated at 30% relative humidity 80°F.

Glass fabric exposed 30 days and fabricated at 30% " "

Glass fabric exposed 7 days at 30% relative humidity, 80°F then dried at 250°F for 1 hour just prior to fabrication at standard room conditions.

Glass fabric exposed 30 days at 30% relative humidity, 80°F then dried at 250°F for 1 hour just prior to fabrication at standard room conditions.

Glass fabric exposed 7 days and fabricated at 65% relative humidity 80°F.

Glass fabric exposed 30 days and fabricated at 65% relative humidity 80°F.

Glass fabric exposed 7 days at 65% relative humidity 80°F then dried at 250°F for 1 hour just prior to fabrication at standard room conditions.

Glass fabric exposed 30 days at 65% relative humidity, 80°F then dried at 250°F for 1 hour just prior to fabrication.

Glass fabric exposed 7 days and fabricated at 97% relative humidity 80°F.

Glass fabric exposed 30 days and fabricated at 97% relative humidity 80°F.

Glass fabric exposed 7 days at 97% relative humidity then dried at 250°F for 1 hour just prior to fabrication at standard room conditions.

Glass fabric exposed 30 days at 97% relative humidity then dried at 250°F for 1 hour just prior to fabrication at standard room conditions.

Stabilizer added - must see report .

CARD 2

FORMAT AND CODE OUTLINES

MECHANICAL PROPERTIES OF REINFORCED PLASTICS

FIELD 1.0 BIBLIOGRAPHIC IDENTIFICATION

1.1 Reference Number

Code 1.1 identifies a reference number assigned to the source of information from which the encoded data is extracted.

1.2 Test Type

Code 1.2 identifies each type of test encoded from the report.

1.3 Material Identification

Code 1.3 (plastics) identifies the resin used in fabricating the unit.

1.4 Material Type

Code 1.4 identifies the encoded material as plastics. This classification facilitates machine separation of the plastics cards from cards representing other materials.

1.5 Unit Number

A number assigned to each identical unit of fabrication for the purpose of identifying this unit from all others within a single report.

1.6 Set Number

A number assigned to each group of specimens, selected from a single unit, which have been conditioned and tested under identical conditions.

1.7 Number of Specimens in a Set

The total number of specimens in a set. Also serves to indicate

where averages of specimens are given.

1.8 Specimen Number

An identification number assigned to each specimen of a set. Also serves as an indicator of specimen averages.

FIELD 2.0 SPECIMEN DESCRIPTION

2.1 Orientation of Material Fibers or Grains to the Major Axis of the Specimen

Defines the angle of the major axis of the specimen in relation to directional properties exhibited by the material.

2.2 Specimen Configuration

Describes the general shape of the specimen.

2.3 Notch Factor

The theoretical notch factor given for a specified notched specimen.

2.4 Fabrication Procedure

Code 2.4 describes the type machine, blade, abrasive disc or other instrument utilized in cutting the specimen.

2.5 Specimen Length

Pertinent lengthwise dimension of the specimen.

2.6 Specimen Width-Maximum

The maximum width, diameter, or area of the specimen test section (critical area).

2.7 Specimen Width - Maximum

The smallest diameter or width of the test section of a notched

specimen (maximum width minus notch diameter or depth).

2.8 Specimen Thickness

The thickness in the test section of the specimen.

2.9 Surface Finish

Code 2.9 describes the surface finish in the test section of the specimen.

FIELD 3.0 PRE-TEST CONDITIONING

3.1 Pre-Test Conditioning

Code 3.1 describes the conditioning a unit, a set of specimen, or an individual specimen was subjected to prior to testing.

3.2 Pre-Test Conditioning Time

The total time which the part was subjected to pre-test conditioning.

3.3 Pre-Test Conditioning Temperature

Maximum temperature to which the specimen was subjected to during pre-test conditioning.

FIELD 4.0 MATERIAL HARDNESS

4.1 Hardness

Barcol hardness is reported to the nearest whole number. This reading, compared with the unit hardness (card 1), reflects any changes in hardness resulting from specimen fabrication and/or pre-test conditioning.

FIELD 5.0 TEST PROCEDURE

5.1 Test Equipment

Code 5.1 describes the basic test machine or combination of machines used for the test.

5.2 Instrumentation

Code 5.2 describes the special instrumentation used for reading specimen deformation.

5.3 Orientation of Major Axis of Specimen to Load

Code 5.3 describes the orientation of the major axis of the specimen in relation to the applied load.

FIELD 6.0 TEST CONDITIONS

6.1 Load Rate

Describes the rate of loading which the specimen was subjected to.

6.2 Test Temperature

Maximum temperature to which the specimen was subjected to during testing.

FIELD 7.0 TEST RESULTS

7.1 Izod and Charpy Impact Tests

7.1.1 Pre-Stress Type

Code 7.1.1 describes the type of pre-stress applied to the specimen.

7.1.2 Pre-Stress Magnitude

The maximum magnitude of pre-stress, psi, to which the specimen was subjected.

7.1.3 Impact Strength

Impact strength, ft. - lbs.

7.1.4 Velocity

Linear velocity (at point of impact), feet per second.

FIELD 7.0 TEST RESULTS

7.1 Tensile Impact

7.1.1 Pre-Stress Type

Code 7.1.1 describes the type of pre-stress applied to the specimen.

7.1.2 Pre-Stress Magnitude

The maximum magnitude of pre-stress, psi, to which the specimen was subjected.

7.1.3 Impact Strength

Tensile impact strength, ft. - lbs.

7.1.4 Elongation

Total elongation, per cent.

7.1.5 Area Reduction

Total reduction in area, per cent.

FIELD 7.0 TEST RESULTS

7.1 Tensile, Compression and Flexure

7.1.1 Pre-stress Type

Code 7.1.1 describes the type of pre-stress applied to the specimen.

7.1.2 Pre-stress Magnitude

The maximum magnitude of pre-stress,psi, applied to the specimen.

7.1.3 Ultimate Stress (Maximum fiber stress-flexure)

Ultimate stress, psi.

7.1.4 Initial Proportional Limit

Initial proportional limit stress psi.

7.1.5 Secondary Proportional Limit

Secondary proportional limit stress, psi.

7.1.6 Yield Stress

Yield stress, psi.

7.1.7 Initial Modulus

Initial modulus, psi.

7.1.8 Secondary Modulus

Secondary modulus, psi.

FIELD 7.0 TEST RESULTS

7.1 Bearing Test

7.1.1 Pre-Stress Type

Code 7.1.1 describes the type of pre-stress applied to the specimen.

7.1.2 Pre-Stress Magnitude

The maximum magnitude of pre-stress, psi, to which the specimen was subjected.

7.1.3 Ultimate Bearing Strength

Ultimate bearing strength, psi.

7.1.4 Proportional Limit Stress

Proportional Limit stress, psi.

7.1.5 Bearing Strength

Bearing strength (4% deformation of bolt diameter), psi.

7.1.6 Edge Distance Ratio

Ratio of edge distance to the bearing hole diameter.

7.1.7 Side Distance Ratio

Ratio of the side distance (distance from side edge of specimen to center line of bolt hole) to the diameter of the bolt hole.

FIELD 7.0 TEST RESULTS

7.1 Shear Test

7.1.1 Pre-Stress Type

Code 7.1.1 describes the type of pre-stress applied to the specimen.

7.1.2 Pre-Stress Magnitude

The maximum magnitude of pre-stress, psi, to which the specimen was subjected.

7.1.3 Ultimate Shear Strength

Ultimate shear strength, psi.

7.1.4 Proportional Limit Stress

Proportional limit stress, psi.

7.1.5 Yield Stress

Yield stress, psi.

7.1.6 Modulus of Rigidity

Modulus of rigidity, psi.

FIELD 7.0 TEST RESULTS

7.1 Creep Test

7.1.1 Applied Stress

The initial stress applied to the creep specimen.

7.1.2 Rupture Time

Total time to rupture.

7.1.3 Deformation Units

Code 7.1.3 lists the units used to report creep deformation.

7.1.4 Initial Load Deformation

Deformation resulting from initial loading.

7.1.5 Deformation at Rupture

Deformation at rupture or at end of test if specimen did not fail.

FIELD 8.0 FAILURE DESCRIPTION

Code 8.0 describes the type of break or failure of a specimen.

FIELD 9.0 CARD SEQUENCE

Used to indicate the card sequence of a multiple card format.

FIELD 10.0 REMARKS

Code 10.0 contains pertinent remarks concerning data described by the card.

FIELD 1.0* BIBLIOGRAPHIC IDENTIFICATION

- 1.1 Reference Number
- 1.2 Test Type
- 1.3 Material Identification
- 1.4 Material Type
- 1.5 Unit Number
- 1.6 Set Number
- 1.7 Number of Specimens
- 1.8 Specimen Number

* Where a third card is necessary for reporting additional test data this field is simply a repeat of Field 1.0 of the preceding card (Card 2).

FIELD 2.0 thru 6.0

Fields 2.0 thru 6.0 pertaining to specimen description, conditioning, and test set up are omitted from this card since they are described on the preceding card (Card 2).

FIELD 7.0 TEST RESULTS

7.1 Creep Test Results

7.1.1 Applied Stress

The initial stress applied to the creep specimen.

7.1.2 Time to Rupture or Termination of Test

The total time to rupture or end of test.

7.1.3 Deformation on Loading

Initial deformation upon loading.

7.1.4 Area Change

Total area change in per cent.

7.1.5 Deformation

Incremental reading of deformation.

7.1.6 Time

Incremental time measurements or assignments.

7.1.7 Area Change

Total area change per each deformation and time increment. (See 7.1.5 and 7.1.6 above).

7.1.8 Deformation

7.1.9 Time

7.2.0 Area Change

7.2.1 Deformation

7.2.2 Time

7.2.3 Area Change

7.2.4 Deformation

7.2.5 Time

7.2.6 Area Change

FIELD 8.0 NOT USED

FIELD 9.0 CARD SEQUENCE

Used to indicate the card sequence of a multiple card format.

FIELD 1.0 BIBLIOGRAPHIC IDENTIFICATION

1.1 Reference Number

1.2 Test Type

1.3 Material Identification

1.4 Material Type

1.5 Unit Number

1.6 Set Number

1.7 Number of Specimens

1.8 Specimen Number

Where a fourth card is necessary for reporting additional test data this field is simply a repeat of Field 1.0 of the preceding cards (Cards 2 and 3).

FIELDS 2.0 THRU 6.0

Fields 2.0 thru 6.0 pertaining to specimen description, conditioning, and test set up are omitted from this card since they are described on a preceding card (Card 2).

FIELD 7.1 CREEP TEST RESULTS - Continued

7.2.7 Deformation

7.2.8 Time

7.2.9 Area Change

7.3.0 Deformation

7.3.1 Time

7.3.2 Area Change

7.3.3 Deformation

7.3.4 Time

7.3.5 Area Change

7.3.6 Deformation

7.3.7 Time

7.3.8 Area Change

7.3.9 Deformation

7.4.0 Time

7.4.1 Area Change

FIELD 8.0 NOT USED

FIELD 9.0 CARD SEQUENCE

Used to indicate the card sequence of a multiple card format.

Tensile

Tensile test conforming to Federal Specification LP 4066 Method 1011

Tensile Test conforming to ASTM D638-58T test procedures

Compression

Compression test conforming to Federal Specification LP 4066 Method 1021

Flexure

Flexure test conforming with Federal Specification L-F406b Method 1031.1

Flexure test ASTM D 790-58T

Shear

Interlaminar Shear

Johnson Shear

Panel Shear

Computed edgewise shear values from tension data 45° - 0°

Shear test conforming to Federal Specification LP 4066 method 1041

Bearing

Bearing - Tension LP 406b-1051

Bearing - Compression

Creep - tension

Creep, bearing

Impact

Izod impact test conforming to Federal Specifications LP 4066 Method 1071

Plastics and Plastic Laminates

Others (see Material Identification)

Rectangular ends, square and flat.

Normal necked down tensile coupon.

Necked down fatigue specimen - 4 inch radius .5 in. min.
No straight net section.

Rectangular necked down compression specimen.

Rectangular - ends rounded (for a column test) about an axis parallel to width.

Tension specimen conforming to L-P-406b method 1011.

Rectangular - hole centered in and to face.

Flexure specimen conforming to L-P-406b method 1031 -

Rectangular tensile - creep coupon -- conforms to L-P-406b method 1011A --
22in x lin. with 2.25 x .30 in. net section 3 in. radius taper.

Izod impact specimen conforming to L-P-406b method 1071B.

Shear specimen conforming to L-P-406b method 1041.

Cylindrical

Tubular

Formed Cross -- For panel shear.

Rectangular, notched, no other information.

Compression specimen conforming to L-P-406b method 1021.

Rectangular interlaminar shear block.

Rectangular interlaminar shear specimen conforming to ARTC #11 Test Method VI
8" x 1" with parallel slots half way through on opposite faces, and holes in
the ends for pins.

Tubular, notched, no other information.

Machined, no other information

1/8" emery wheel rotated at 1770 rpm

Emery wheel -- on shaper

Surface grinder, end ground flat and perpendicular to faces

Machined, drilled - reamed

Steel circular saw

Metal cutting band saw

Carborundum wheel in table saw.

Cut out and ends rounded on emery wheels

Pin holes perpendicular to face in ends drilled and reamed. Slots cut with 1/8" thick carborundum wheel dressed square and flat, deep enough to sever center ply.

Walker Turner band saw

Tensile coupons milled to shape in a Tensilkut machine.

Coupons cut to shape on a pantograph die sinking machine (5/16" two blade cutter at 4450 rpm)

Cut out with a band saw, machined & polished (emery cloth).

See report

As machined

Surface sanded smooth and flat.

Unsanded -- as laid up or cut or machined.

No pre-test conditions given.

30% Relative Humidity.

Normal room exposure (05) under 5000 psi tension.

Less than 50% relative humidity.

55 ± 5% " "

65 ± 5% " "

75 ± 5% " "

85 ± 5% " "

95 ± 5% " "

Immersed in water.

" in boiling water.

" in water under 5000 psi tension.

" in sea water, North Carolina - tested wet.

Immersed in sea, North Carolina, dried 4 weeks 80°F before testing.

Outdoor exposure

Immersed in Ethylene glycol (non-corrosive).

" Hydrocarbon Fluid.

As received - implying several days storage or shipping at room or seasonal temperatures and normal humidity.

Immersed in chemicals.

Immersed in Anti-icing Fluid (IPA).

Temperature below 0°F.

Elevated temperature - no humidity mentioned.

Exposed to elevated temperature before and during testing after normal room temperature aging.

Heated rapidly with dielectric heating device immediately before and during testing (see report for details).

Loaded to a constant load then heated with infra-red units to test temperature.

The following are for specimens which have been pre-test conditioned followed by reconditioning to original state of equilibrium. (At least 2 week at 050% relative humidity -- room temperature.

Less than 50% relative humidity.

55 ± 5% relative humidity

65 ± 5% " "

75 ± 5% " "

85 ± 5% " "

95 ± 5% " "

Outdoor exposure

" " Artic

" " Jungle

" " Salt Air

" " Arid

" " Temperate

Alternating low and high relative humidity.

Hydraulic testing machine (No other information).

Hydraulic testing machine, Templin type grips.

Hydraulic testing machine, Spherical head.

Hydraulic testing machine with test oven.

 " " " " bearing test device.

 " " " " compression jig (#39) in oven.

Mechanical testing machine (No other information).

Mechanical testing machine, Templin type grips.

Testing machine, Templin type grips, high speed heating device and container.

Testing machine, Templin grips, load maintainer, heating device.

Testing machine, Templin grips in test oven.

Testing machine, Templin type grips.

Testing machine, Spherical head.

Testing machine-pin connected clamp on device.

Testing machine with compression jig.

Testing machine with Spherical heads in oven.

Compression jig (see report) between Spherical heads in test oven.

Bearing test jig in oven.

Instron testing machine with test oven.

Tinius Olsen Plastiversal test machine -- jig not described.

Tinius Olsen Plastiversal with tensile test grips (Templin).

Universal testing machine (No other information).

Flexural jig - simple beam test conforms to Federal Specifications L-P-406 - Method 1031.

Flexure jig (No other Information).

Flexure jig - 16 to 1 thickness to length ratio. Radii not given.

Flexure jig in test oven.

Contact edges of end supports 1/8 inch radius and center loading piece with a 3/8 inch radius.

Radius of center loading piece and supports 1/8 inch radius.

Contact edges of end supports 1/8 inch radius and center loading piece with a 1/4 inch radius.

Contact edges of center loading piece and end supports 1/4 inch radius.

Contact edges of 1/8 inch radius and center loading 1/2 inch radius.

Contact edges of 1/8 inch radius and center loading 1 inch radius.

Compression jig of 1/2 inch square steel bars. Conforms with Federal Specifications LP406b - 1021.

Compression jig of 5/16 square bars at each end with 4 times thickness unsupported in cent.

Compression jig to restrain from buckling per method #1021.1 Federal Specification LP-406b.

Panel shear apparatus (See report)

Glue line shear apparatus.

Test equipment and methods conform to Federal Specifications LP-406b for test type.

Johnson Shear Tool

Interlaminar shear jig for slotted specimens to conform to ARTC #11 Test Method VI.

Column test jig- a compression jig with grooved plates to fit rounded end flexural specimens.

Flexure jig 17 to 1 span-thickness ratio. Two point loading separated by two times the thickness with rollers on inch overlap.

Special compression test jig to keep specimens from buckling. Equipment with electric heat on one side and cold air on the other to create a gradient through test specimen. Temperature shown is average through specification.

Compression jig with high speed heating device, between spherical heads.

Test machine with Johnson double shear tool (set or dry).

Standard creep testing machine.

Standard creep testing machine with test oven.

Creep testing machine with compression jigs.

Creep testing machine with compression jigs in test oven. (Cage to change tension to compression-brace to prevent buckling).

Special tensile creep testing machine for wet or dry testing. See report.

Special creep - flexure test machines (dry)

Special flexure creep test machines for wet testing. See report.

See report for instrumentation details.

Load-elongation data taken during test - no other details.

No instrumentation other than the testing machines dial.

Test machines dial and heat controller operating on thermo-couples on specimen section.

Strain gages.

Rosette type AR-7 (Metaelectric) strain gage. 0° to warp load reported.

Metaelectric gage - strain gage SR 4

Tuckerman strain gage - 1 inch

Tinius Olsen type U-1 - strain instrument and recorder.

Tinius Olsen type S-2 - strain instrument and recorder.

Compressometer -- connected to recorder (see report for details)

Dial gage.

Compressometer, see report for details.

Extensometer, tripolitis type connected to recorder of load deformations, curves.

Platinum strip extensometer - observed through window in oven with filar microscope (if used in oven).

Electronic recording system employing bonded strain gages and a dial gage to check deflection.

Templin -- stress strain recorder and extensometer.

Special extensometer for wet creep tests employing mirrors. (See report for details)

Timer shut off by failure of creep specimen. No other instrumentation.

Southwick - Peters PD-1 Deflectometer coupled to load deflection curve recorder operated by glass rod touching bottom of specimen.

Strain gage extensometer. Hounsfield type (British)

Code 5,3 ORIENTATION OF MAJOR AXIS OF SPECIMEN TO LOAD PLASTICS - Card 2

0°

15

30

45

60

75

90

Results are average of several orientations of specimen to load.

No pre-stress

Tension - 1 cycle

Tension - 10 or more cycles (see remarks)

Constant tension during exposure

Tension - from 2-10 cycles

Compression

Compression - 10 or more cycles (see remarks)

Inch/inch x 100

% of 2 inch gage length

Percent

Percent of hole diameter.

Tension accompanied by interlaminar shear.

Crushing of fibers and transverse shear following some delamination.

Diagonal tension failure accompanied by splitting.

Tension failure.

Interlaminar shear

Complete delamination

Crushing failure to end

Crushing failure to side

Shear (compression)

Hardness values given are for exposed side after pre-test conditioning.

Specimens were facings removed from a sandwich fabrication.

Conditioning and test temperatures are average of gradients through specimen.

Conditioned at least 4 months at 100% relative humidity and 100°F after exposure.

Average value of set of several tests.

Minimum value in set of several tests.

Maximum value in set of several tests.

Values are for bundles of from 3 to 5 specimens unbonded, tested together.

Values are for bundles of from 3 to 5 specimens bonded together.

Since material has no real orientation or complex orientation columns 19 and 20 gives orientation of major axis (to which load is applied) to arbitrary axis of panel, and column 54 gives orientation of strain gage to this major and load axis.

Specimens were loaded and unloaded continuously 4 times to obtain poisson's ratio.

Specimens were heated to desired temperature than loaded to failure while temperature remained constant.

Specimens were loaded to desired stress then heated to failure while stress remained constant.

Specimens were loaded to desired deformation and then heated to failure while distance between bearing surfaces remained constant.

Control test

Tested at Forest Products Laboratory.

Tested at Naval Ordnance Laboratory.

Early failure of creep test may have been caused by jar.

Wrinkle pressed in surface with .015" wire - across specimen.

Wrinkle pressed in surface with .030" wire - across surface of specimen.

Lap joints in alternate layers of reinforcement across center of specimens.

Aeronautical Systems Division, Dir/Materials and Processes, Applications Lab.
Wright-Patterson AFB, Ohio
Rpt. No. ASD-TDR 63-128. DEVELOPMENT OF A MATERIALS PROPERTY DATA PROCESSING SYSTEM.
Final report, Dec 62, 170pp. incl. tables and figures.

Unclassified Report

This report discusses a mechanical properties information system including the operation of a fatigue of metals sub-system and the design-development and initial operation of other mechanical properties sub-systems. These sub-systems, employing punched card equipment and techniques, actively provide mechanical properties data and associated descriptive information of metals and rein-

(over)

forced plastics.

The System, sponsored by the USAF, is intended primarily for the use of Defense Agencies and their contractors.

Formats, codes and procedures utilized to store, retrieve and display mechanical properties of these materials are outlined.

1. Information processing
2. Materials Information
- I. AFSC Project 7381 Task 738103

II. Contract AF33(616)-7238

III. Belfour Engineering Co., Suttons Bay, Michigan

IV. R.C. Braden and C.S. Wright

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