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Development and Implementation of a Mechanical Properties Data Storage and Retrieval System

M. K. Booker
B.L.P. Booker

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OAK RIDGE NATIONAL LABORATORY

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METALS AND CERAMICS DIVISION

DEVELOPMENT AND IMPLEMENTATION OF A MECHANICAL PROPERTIES DATA STORAGE AND RETRIEVAL SYSTEM

M. K. Booker and B.L.P. Booker

JUNE 1976

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ABSTRACT

The design of modern elevated-temperature operating systems requires a thorough knowledge of the mechanical properties of the construction materials involved. Such knowledge can require the generation and analysis of massive amounts of mechanical properties data. To aid in the management of these data, a computerized Mechanical Properties Data Storage and Retrieval System has been established. This system includes capabilities for a computerized processing of raw test data into a usable form. Processed data are placed in on-line disk storage for easy remote Teletype access. The ORLOOK computer program allows generalized searches of the data base and efficient retrieval of relevant data. Retrieved data may be received in a variety of forms, including tabular, graphical, etc. Numerical and statistical analysis of stored data may be done directly through the ASEND and APEND computer programs.

I. INTRODUCTION

Successful design of elevated-temperature operating systems requires an extensive knowledge of the mechanical properties of the materials of which the systems are to be constructed. Also, of course, selection of a proper construction material requires understanding of the properties of various materials. Such requirements mean that successful design depends on large quantities of data from mechanical properties tests. When the properties of several forms of several different materials are of interest, the amount of data required can be massive.

In the case of nuclear reactor systems, the amount of data required can be particularly large. To meet these requirements, extensive test programs are being conducted around the world in an effort to characterize the behavior of the materials of interest in nuclear systems design. The amount of these data, combined with the fact that they come from many sources, makes efficient management difficult. Great amounts of data can be lost, forgotten, or simply ignored. In order to assure the best possible design use, the data must be centrally collected, sorted, systematized, and disseminated to those who need them. Furthermore, all of these tasks must be performed quickly and efficiently. The problem of handling such large amounts of data immediately suggests use of the modern digital computer.

Modern computers are particularly well-suited to the processing of large amounts of data. They are fast, efficient, and can perform any number of operations upon the data, outputting them in whatever form might be most useful.

With all of this in mind, the Mechanical Properties Data Storage and Retrieval System (DSRS) was established at ORNL. This report will describe the general features of the system, including purposes, operation, and possible future directions.

II. GENERAL FEATURES OF DSRS

DSRS is a computerized system for the storage, manipulation, and retrieval of mechanical properties data. As such, it consists of several different phases. The first phase consists of the collection, screening, and input of data to the system. Next comes the stage of searching and sorting the actual computer file of stored data and, finally, the output of the data in useful forms.

Input of data to DSRS consists of (1) locating useful data; (2) transferring the data with all available relevant test information to punched cards; (3) processing of these cards through programs which check for errors and then write the data on a magnetic tape; (4) final transfer of the data in a format meaningful to the ORLOOK[1] computer program to a permanent on-line disk file for direct user access. The details of this input procedure are discussed in Sect. III. Input data include results from tensile, creep, fatigue, impact, slow-bend, and relaxation tests, although other types of tests can easily be added.

Searching the file to locate and isolate particular data is accomplished through the ORLOOK computer program. The procedures involved are described in ref. 1 and in Sect. IV. Basically, the user simply describes the data that he is interested in (following instructions given in Sect. IV), and ORLOOK locates these data and creates a separate subset containing them. The user then proceeds from there, performing whatever operations on this subset that he wishes.

Output of DSRS data may be received in several forms. Output of desired data may be received at the Teletype or at the line printer in a format similar to the structure of the on-line file, at the line printer in tabular format through the ADTABLE[2] program, or in graphical form through the ADPLOT[3] program. Output procedures are described in Sect. IV. Procedures for automatic data analysis are described in Sect. V.

III. DATA INPUT PROCEDURES

A first step in the successful operation of a data storage and retrieval system is the establishment of a useful, well-characterized data base. Criteria considered in the input of data to DSTS include the following: (1) Are the data from a relevant test on a material of interest in design applications? (2) Are the data well-documented;

that is, are the procedures and definitions used in generating the data clear, and were they acceptable? (3) Is storage on DSRS likely to increase the usefulness of the particular data? (4) Do the data fit generally accepted trends?

Of these criteria, number (2) is the hardest to meet, while number (4) is sometimes not known or even necessarily mandatory. Still, no data are input unless they meet at least criteria (1) and (3), while priority is given to data which also meet criteria (2) and (4). Thus, the following priorities for data input have been established:

1. ORNL-generated data,
2. data generated on subcontract for ORNL,
3. data privately supplied to ORNL by parties which generated the data,
4. data from the literature which are needed for some particular application.

By necessity, input procedures for data from different types of sources are initially somewhat different. Initial procedures for processing each of the four above types of data are discussed in the next section.

Data from tensile, creep, fatigue (including creep-fatigue), impact, relaxation, and slow-bend tests are presently stored on the system, although additional types of tests could be added easily. Tables 1 and 2 give a current summary of data stored on the system, although it must be realized that the system is constantly growing and the numbers in the tables are constantly changing.

Table 1. Mechanical Properties ORNL Data Base — Data Summary April 1, 1976

Material	Number of Individual Tests						
	Tensile	Creep	Fatigue	Impact	Slow Bend	Relaxation	Total
304 SS	838	437				11	1286
316 SS	215	53					268
2 1/4 Cr-1 Mo	430	74	59	73	18		654
Incoloy 800	102						102
308 SS	61	13					74
Hastelloy X	34						34
9 Cr-1 Mo	18						18
INOR-8		691					691
Other	360	3		83	38		392
Total	2058	1271	59	156	56	11	3611

Table 2. Mechanical Properties Supplemental Data Base — Data Summary April 1, 1976

Material	Number of Individual Tests			
	Tensile	Creep	Fatigue	Total
2 1/4 Cr-1 Mo	221	577	384	1182
316 SS	9	171	236	416
304 SS	11	45	469	525
Inconel 718	156	187	207	550
Inconel 800[a]	306	345	209	860
Incoloy 800H	173	137	67	377
A 533-B	77			77
1 Cr-1 Mo 1/4 V	1		4	5
Total	954	1462	1576	3992

[a]Including former grades 1 and 2.

A. Initial Processing

Once data have been earmarked for input to DSRS, the next step in the input procedure is to transfer the data, with all necessary accompanying information, to punched computer cards. This step may be carried out in several ways. The most common way is for someone to transcribe the information onto the applicable DSRS Data Input Form. The information on these forms is keypunched, and the step is complete. Figures 1—5 show the currently used Data Input Forms, while part B of this section describes their use in more detail.

Data from private sources and from the literature are generally processed using Data Input Forms. However, there are exceptions. For instance, data in tabular formats are often keypunched directly, especially if a great number of data are involved. Simple conversion programs then transfer the data from these cards to DSRS formatted cards, thus saving the labor of manually transcribing the data from the original tables to DSRS input forms.

More options are available, of course, in the processing of subcontracted data and especially of ORNL data. In these cases, actual raw test output such as strip charts and *X*-*Y* recordings are available. Clearly, all salient test characteristics can be manually read and/or

MECHANICAL PROPERTIES DATA STORAGE FORM
TENSILE ORNL-DWG 76-8244

Field	Code	Units
Test Number	< >	
Specimen Number	<NØ>	
Type of Test	<TY>	
Institution/Program/Date/Engineer/Technician	<IP>	
Temperature	<TE>	(°C)
Environment	<EN>	
Material	<MA>	
Heat Number	<HN>	
Alloy Base	<AB>	
Heat Treatment	<HT>	
Specimen Description	<SD>	
Comments	<CM>	

Irradiation Data:

Field	Code	Units
Experiment No.	<EX>	
Irradiation Temp.	<IT>	(°C)
Fluence	<FL>	(N/cm²)
Reactor and Position	<RP>	

Nominal Properties <NP> Proportional Limit (psi); .02% Offset Yield (psi); Apparent Modulus (psi)

Engineering Properties

Field	Code	Units
.2% Offset Yield	<EY>	(psi)
Ultimate Stress	<US>	(psi)
Fracture Stress	<FS>	(psi)
Uniform Elongation	<UE>	(%)
Total Elongation	<ET>	(%)
Reduction of Area	<RA>	(%)
Upper / Lower Yield	<UL>	(psi)
Elongation in 4D	<ED>	(%)
Nominal Strain Rate	<SR>	(%/min)

True Properties

Field	Code	Units
Ultimate Stress	<TU>	(psi)
Fracture Stress	<TF>	(psi)
Uniform Elongation	<TL>	(%)
Total Elongation	<TT>	(%)

Extensometer Results

Field	Code	Units
Modulus	<YM>	(psi)
Proportional Limit	<PL>	(psi)
.02% Offset Yield	<YO>	(psi)
.2% Offset Yield	<Y2>	(psi)
Extensometer Class	<EC>	

Stress <SE> (psi) Total Strain <SN> (%)

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Fig. 1. DSRS Tensile Data Input Form.

ORNL-DWG 76-8245

MECHANICAL PROPERTIES DATA STORAGE FORM
FATIGUE

Test Number < >

Specimen Number <NØ>

Type of Test <TY>

Institution/Program/Date/Engineer/Technician <IP> ; ; ; ;

Field	Code	Units	Field	Code	Units
Temperature	<TE>	(°C)	Irradiation Data:		
Environment	<EN>		Experiment No.	<EX>	
Material	<MA>		Irradiation Temp.	<IT>	(°C)
Heat Number	<HN>		Fluence	<FL>	(N/cm^2)
Alloy Base	<AB>		Reactor and Position	<RP>	
Heat Treatment	<HT>				
Specimen Description	<SD>				
Comments	<CM>				
Mode of Control	<LM>		Stress Range at: (cycles)	<SS>	
Strain Range	<ED>	(%)	(→1)		(psi)
Mean Strain	<ET>	(%)	(→2)		(psi)
Wave Form	<WF>		(→10)		(psi)
Hold Mode	<HM>		(→100)		(psi)
Hold Time	<TI>	(hrs)	(→1000)		(psi)
Ramp Strain Rate	<SR>	(%/sec)	(→Nf/2)		(psi)
Frequency	<FQ>	(Hz)	Cycles to Failure	<CF>	
Elastic Modulus	<YM>	(psi)	Time to Failure	<RT>	(hrs)
0.02% Offset Yield Stress	<YO>	(psi)	Maximum Tensile Stress at Nf/2	<TS>	(psi)
0.2% Offset Yield Stress	<Y2>	(psi)	Maximum Compressive Stress at Nf/2	<MC>	(psi)
Initial Stress Amplitude	<AS>	(psi)	Elastic Strain Range at Nf/2	<EL>	(%)
Initial Strain Amplitude	<NS>	(%)	Plastic Strain Range at Nf/2	<EP>	(%)
Saturation Stress Range	<ST>	(psi)	Cycles to First Decrease in Stress Range	<CD>	
Number Cycles at Saturation	<CS>		Cycles to 5% Reduction in Stress Range	<C5>	
Saturation Maximum Stress Amplitude	<MS>	(psi)			
Saturation Stress Amplitude at 0.1 Hold Time	<SH>	(psi)			
Saturation Minimum Stress Amplitude	<MN>	(osi)			

TX-4666 (8-74)

Fig. 2. DSRS Fatigue Data Input Form.

MECHANICAL PROPERTIES DATA STORAGE FORM

ORNL-DWG 76-8246

CREEP

Field	Code	Units
Test Number	< >	
Specimen Number	< NØ >	
Type of Test	< TY >	
Institution/Program/Date/Engineer/Technician	< IP >	
Temperature	< TE >	(°C)
Environment	< EN >	
Material	< MA >	
Heat Number	< HN >	
Alloy Base	< AB >	
Heat Treatment	< HT >	
Specimen Description	< SD >	
Comments	< CM >	
Stress	< ST >	(psi)
Minimum Creep Rate	< CR >	(%/hr)
Rupture Time	< RT >	(hrs)
Time Discontinued	< TD >	(hrs)
Time to Third Stage Creep	< SC >	(hrs)
Primary Creep Strain	< PS >	(%)
Total Elongation	< ET >	(%)
Quality of Test	< QT >	
Extensometer Class	< EC >	

Irradiation Data:

Field	Code	Units
Experiment No.	< EX >	
Irradiation Temp.	< IT >	(°C)
Fluence	< FL >	(N/cm^2)
Reactor and Position	< RP >	

Loading Data:

Field	Code	Units
Elastic Strain on load	< EL >	(%)
Plastic Strain on load	< EP >	(%)
Loading Method	< LM >	
Reduction of Area	< RA >	(%)

UCN-10990B
(3 1-74)

Fig. 3. DSRS Creep Data Input Form.

ORNL-DWG 76-8247

MECHANICAL PROPERTIES DATA STORAGE FORM
IMPACT-SLOW BEND

Test Number < > Specimen Number < NO > ____________ Type of Test < TY > ____________

Institution/Program/Date/Engineer/Technician < IP > ________; ________; ________; ________; ________

Temperature < TE > ____________ ; (°C)

Environment < EN > ____________

Material < MA > ____________

Heat Number < HN > ____________

Alloy Base < AB > ____________

Irradiation Data:

Experiment No. < EX > ____________
Irradiation Temp. < IT > ____________ ; (°C)
Fluence < FL > ____________ ; (N/cm^2)
Reactor and Position < RP > ____________

Heat Treatment < HT > ____________

Specimen Description < SD > ____________

Comments < CM > ____________
____

Specimen Orientation Code < SO > ____________

Specimen Location:
< DG > ____________ ; (deg.)
< X > ____________ ; (in.)
< Y > ____________ ; (in.)
< Z > ____________ ; (in.)
< T1 > ____________ ; (t)

Depth of Precrack < PC > ____________ ; (in.)

Speed < SP > ____________ ; (ft/sec,in/min)
Total Fracture Energy < FE > ____________ ; (ft-lbs)
Lateral Expansion < LE > ____________ ; (in.)
Fracture Appearance < FA > ____________ ; (% Fibrous)
Fracture Toughness Param. < FP > ____________ ; (kpsi-in. ½)
Slope Elastic Portion < SL > ____________ ; (lbs/in)
Load-Time Trace < TA > ____________ ; (yes or no)

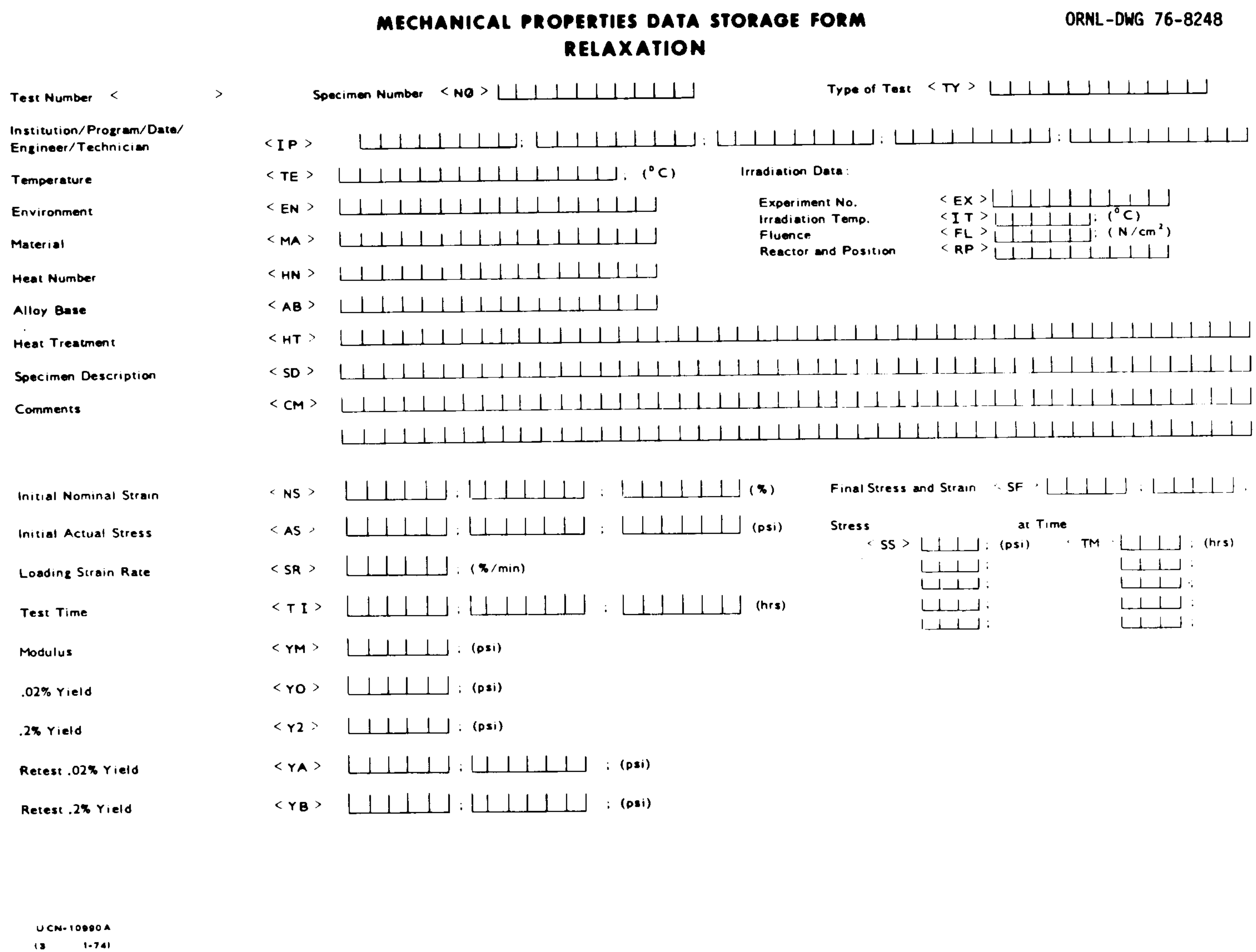
		Start of Fast Fracture	Fracture Arrest	Maximum	General Yield
Load at	< LD >	________ ; (lbs)	________ ; (lbs)	________ ; (lbs)	________ ; (lbs)

		Fast Fracture	Max. Load
Deflection to	< DD >	________ ; (in.)	________ ; (in.)

		Fast Fracture	Max. Load
Energy to	< EG >	________ ; (ft-lbs)	________ ; (ft-lbs)

UCN-10890C
(3 1-74)

Fig. 4. DSRS Impact—Slow—Bend Data Input Form.



MECHANICAL PROPERTIES DATA STORAGE FORM
RELAXATION

ORNL-DWG 76-8248

Test Number < >
Specimen Number < NØ >
Type of Test < TY >
Institution/Program/Date/Engineer/Technician <IP> : : : :
Temperature < TE > ; (°C)
Irradiation Data:
Experiment No. < EX >
Irradiation Temp. <IT> ; (°C)
Fluence < FL > ; (N/cm²)
Reactor and Position < RP >
Environment < EN >
Material < MA >
Heat Number < HN >
Alloy Base < AB >
Heat Treatment < HT >
Specimen Description < SD >
Comments < CM >
Initial Nominal Strain < NS > ; ; (%)
Final Stress and Strain < SF > ; .
Initial Actual Stress < AS > ; ; (psi)
Stress at Time
< SS > ; (psi) < TM > ; (hrs)
Loading Strain Rate < SR > ; (%/min)
Test Time < TI > ; ; (hrs)
Modulus < YM > ; (psi)
.02% Yield < YO > ; (psi)
.2% Yield < Y2 > ; (psi)
Retest .02% Yield < YA > ; ; (psi)
Retest .2% Yield < YB > ; ; (psi)

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(3 1-74)

Fig. 5. DSRS Relaxation Data Input Form.

calculated from this raw output and then transcribed onto DSRS Data Input Forms. Indeed, this procedure at present is followed for relaxation, impact, slow-bend, and (to some extent) creep tests. However, here again computerization can decrease needed labor.

A relatively new aspect of DSRS is the development of auxiliary data processing programs which aid in the interpretation and translation of raw test output into useful data, and concurrently prepare the data for input to DSRS. At present, there are two programs, TENSIS and ORFAN, for the analysis, respectively, of tensile and fatigue (including creep-fatigue) data. Use of these programs is described in detail in separate reports,[4,5] but will be described briefly in parts C and D of this section.

B. DSRS Data Input Forms

Use of DSRS Data Input Forms is mainly self-explanatory, although a few comments are in order. As seen in Figs. 1–5, the forms include the one to three letter identifiers, with brief explanations. More detailed information on these identifiers can be found in refs. 6 and 7. Basically, an identifier is a label which serves to "tag" data stored on the computer as being for a particular quantity. For example, a number stored as 36000 is meaningless unless it is labeled, for example, by <*Y*2> to denote that it is a 0.2% offset yield strength in psi.

The blanks on the forms in which data are entered are separated into individual spaces for purposes of convenience in keypunching. References 6 and 7 contain guidance for the determination of actual entries. Note that for certain identifiers containing textual information, only particular entries are acceptable. The entries in these fields are scanned by an ADSEP[8] "dictionary," as described in the next section, to check their contents. These fields include <AB> (alloy base); <EN> (test environment); <IP> (source reference); <MA> (material); <TA> (availability of load-time trace in impact—slow-bend tests); and <TY> (type of test). If it is necessary to make an entry in one of these fields other than those currently allowable, the dictionary can easily be changed accordingly. Semicolons are used as delimiters to separate the different segments of "structured" fields (fields with more than one segment). Thus, a semicolon (;) should never be entered as data in these fields. Structured fields included <AS>, <DG>, <EG>, <IP>, <LD>, <NS>, <SE>, <SN>, <SS>, <TI>, <TM>, <UL>, <YA>, <YB>.[6]

In addition, the characters < and > are used to enclose identifiers and should never be entered as data in any field.

C. Use of TENSIS

Chart recordings of load vs crosshead displacement, or *X*-*Y* recordings, of load vs specimen extension, constitute the initial output of conventional tensile tests. To be useful, these recordings must be converted to actual stress and strain, and salient test characteristics, such as yield strength, etc., must be read from them. Automatic testing systems to facilitate this conversion have been described,[9] but such systems are not generally available. In addition, before and after test measurements of the specimen are used to determine quantities such as reduction in area and total (inelastic) elongation. General procedures for the determination of the values of the various identifiers to be input to DSRS are described in ref. 7.

To aid in the processing of raw tensile data, the TENSIS[5] computer program has been developed. TENSIS accepts load-extension points from the load-displacement and *X*-*Y* charts of a test, then calculates the corresponding engineering stress-strain values. The program then calculates the relevant DSRS identifiers (Fig. 1). Output consists of a printed table of data and punched cards for input to DSRS. True stress—true strain values can also be calculated, and plots of engineering stress-strain and true stress-strain curves can be plotted. Output of log-log plots of true stress vs true plastic strain is also available. Sample TENSIS plots are shown in Figs. 6—8.

ORNL-DWG 76-8249

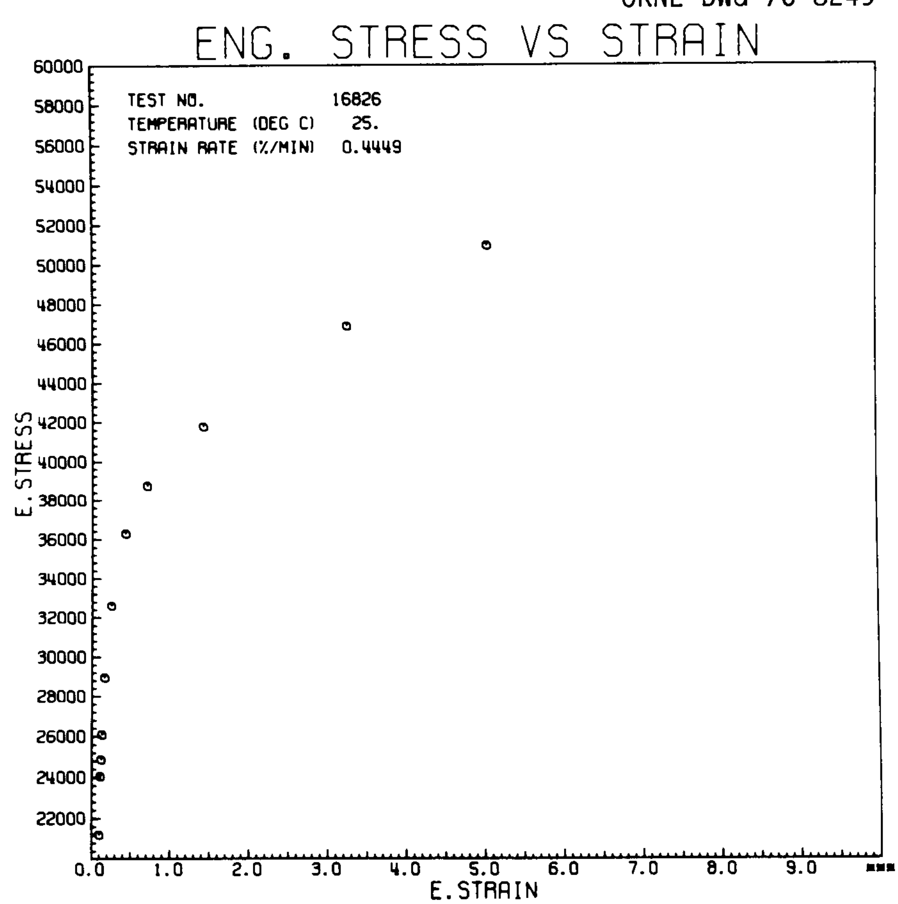

Fig. 6. Example Plot of Engineering Stress-Strain Data from TENSIS.

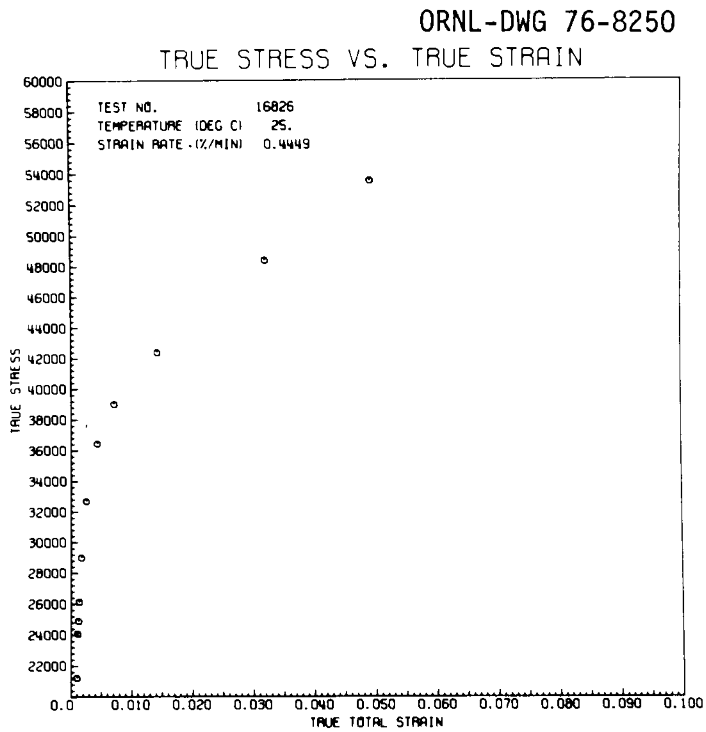

Fig. 7. Example Plot of True Stress-Strain Data from TENSIS.

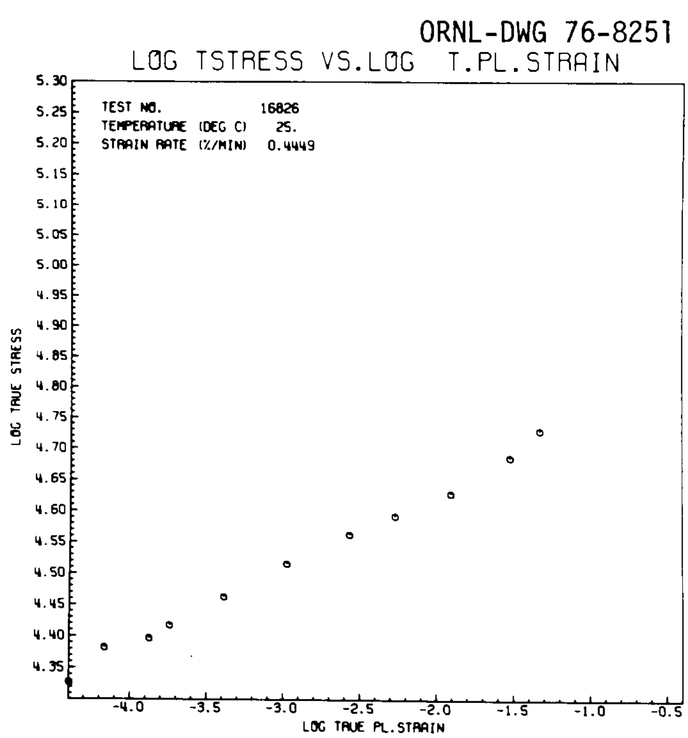

Fig. 8. Example Log-Log Plot of True Stress vs True Plastic Strain Data from TENSIS.

D. Use of ORFAN (Oak Ridge Fatigue Analysis Program)

Analogous to the TENSIS computer program for tensile test data is the ORFAN program for the processing of fatigue and creep-fatigue data. ORFAN takes input readings from strip charts and hysteresis loops, converts the readings to stress, strain, etc., and outputs tables of data, punched cards for input to DSRS, punched cards for use in analytical programs, and plots of data. Figures 9–13 show typical ORFAN plots for a test with a hold period at peak tensile strain. In addition, ORFAN has the ability to perform direct analysis of hold-time fatigue data by the methods of linear damage summation[10] and strain range partitioning.[11] A full explanation of the many options available in the ORFAN program can be found in ref. 4.

ORNL-DWG 76-8252

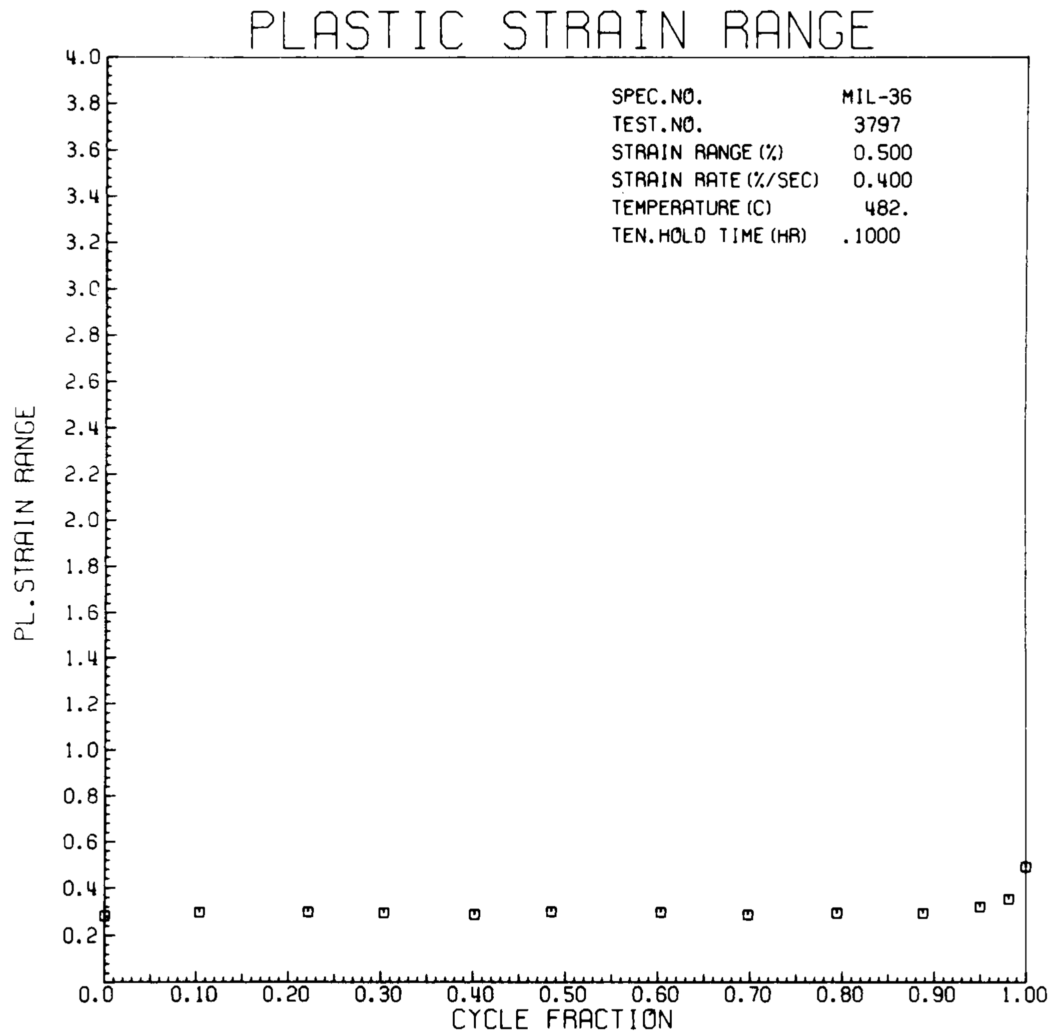

Fig. 9. Example Plot of Plastic Strain Range (%) vs $\frac{N}{N_f}$ from ORFAN.

ORNL-DWG 76-8253

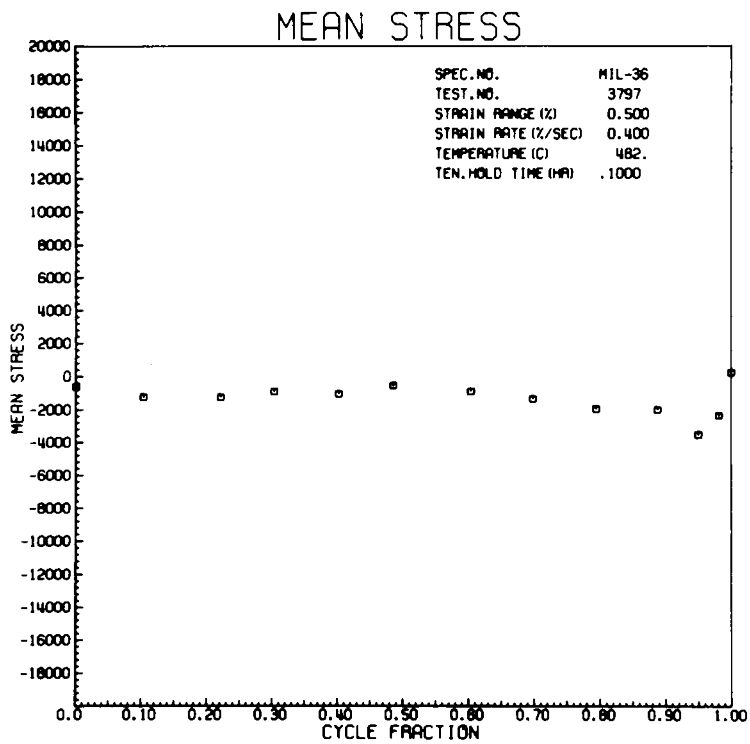

Fig. 10. Example Plot of Mean Stress (psi, positive-tensile) vs $\frac{N}{N_f}$ from ORFAN.

ORNL-DWG 76-8254

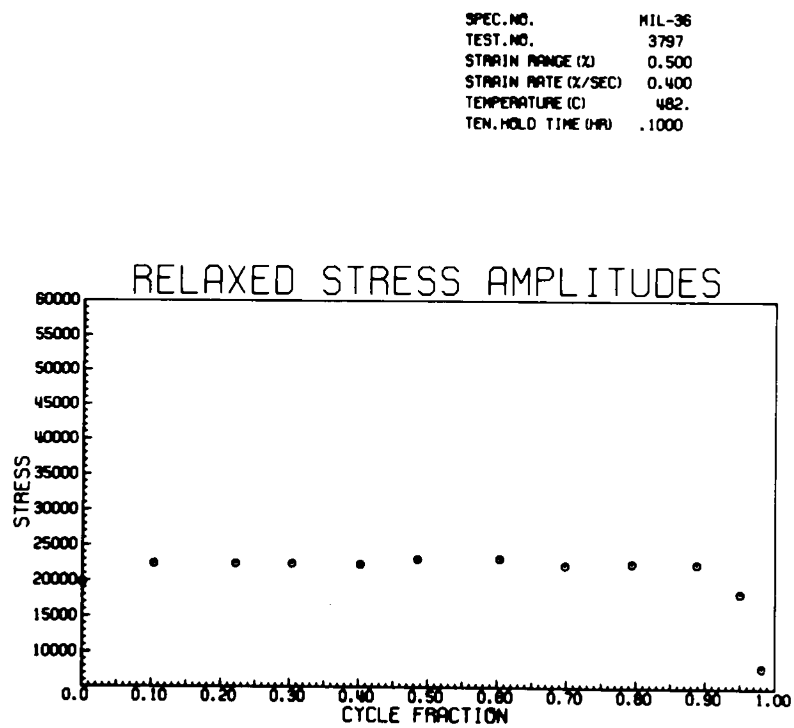

Fig. 11. Example Plot of Relaxed Stress Amplitude (Stress At End of Hold Time) vs $\frac{N}{N_f}$ from ORFAN.

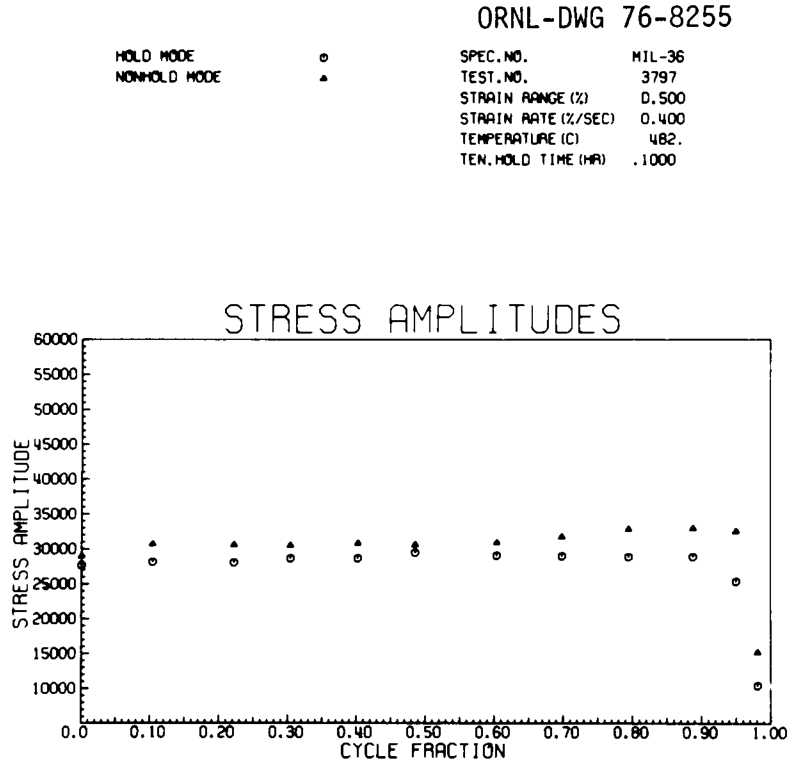

Fig. 12. Example Plot of Stress Amplitude (psi) vs $\frac{N}{N_f}$ from ORFAN.

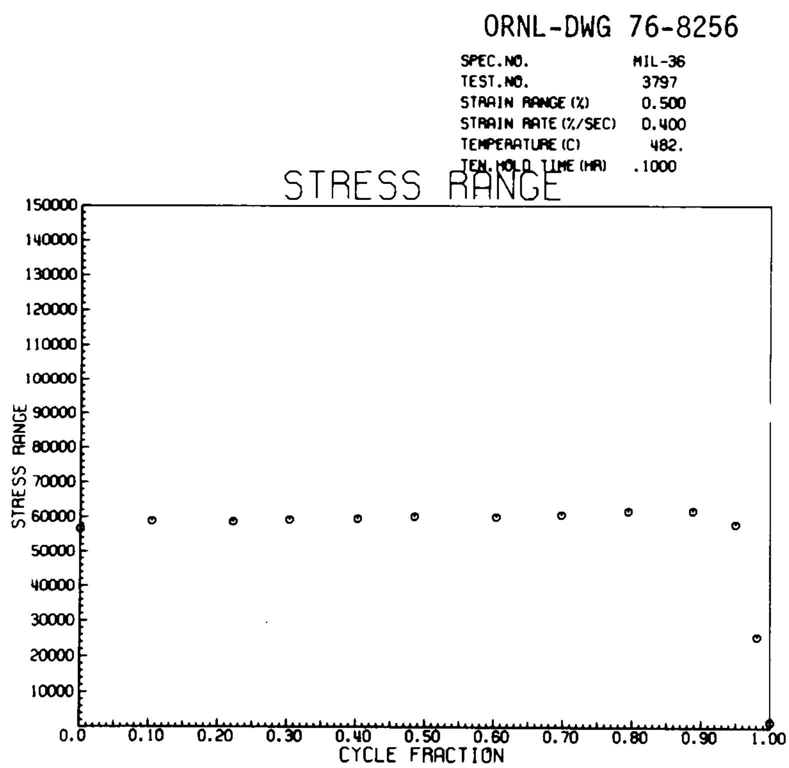

Fig. 13. Example Plot of Stress Range (psi) vs $\frac{N}{N_f}$ from ORFAN.

E. Computer Storage

Once data for input to DSRS are punched onto computer cards (whether by keypunching from DSRS Data Input Forms, punching through TENSIS or ORFAN, or conversion from cards punched from tabular data, etc.) these data must next be transferred to the DSRS on-line disk file.

The initial step in this process consists in writing the data onto a magnetic tape in a format accessible and understandable by ORLOOK, ADTABLE, ADPLOT, and other programs. This step is accomplished by means of the ADSEP[8] computer program, which is a generalized data-set building and editing program used with ORCHIS[12] data bases. After data cards are read into the computer, the test fields under "dictionary" control are checked by an ADSEP dictionary routine which resides in permanent disk storage. If any violations are found, the data are rejected. Thus inconsistent or confusing terminology is avoided.

Once accepted by the dictionary, the data are read by ADSEP and transformed into an orderly, consistent file structure. A file contains an initial Header Record, Individual Data Records, and a Terminal Record. Further information on file structure may be found in refs. 1 and 8, but here it is sufficient to say that ORLOOK and other programs can access the data.

The data are next written onto magnetic tape in the converted format. This procedure can be used to add new tests to the DSRS data base, add new data to tests already stored on DSRS, or alter or amend data already stored. Likewise, information which is deemed obsolete or useless can be erased from the file in another variation of this same procedure.

These steps are accomplished by using a system of three cycled tapes. New information read into the system through ADSEP is merged with the contents of the latest data tape and written onto the next tape in the cycle. The data on the old tape are saved. Thus, in addition to the updated tape, there exists at all times a backup tape which is complete except for the latest update, and a tape complete except for the two latest updates.

Finally, the latest update tape is copied onto the permanent on-line disk file by scratching the old disk file and rewriting the contents of the updated tape onto the disk. The entire cycle is illustrated in Fig. 14.

F. Verification Procedures

Other than the dictionary check of certain text fields, at present there are no automatic procedures for the checking or verification of input data. However, some check of input data is, of course, desirable. The current procedures used to do so are commonsense checks.

First, the data input forms are visually scanned for inconsistencies, and questionable data are checked before input. Types of errors which might be uncovered in this step include unreasonable numerical data

ORNL-DWG 76-8257

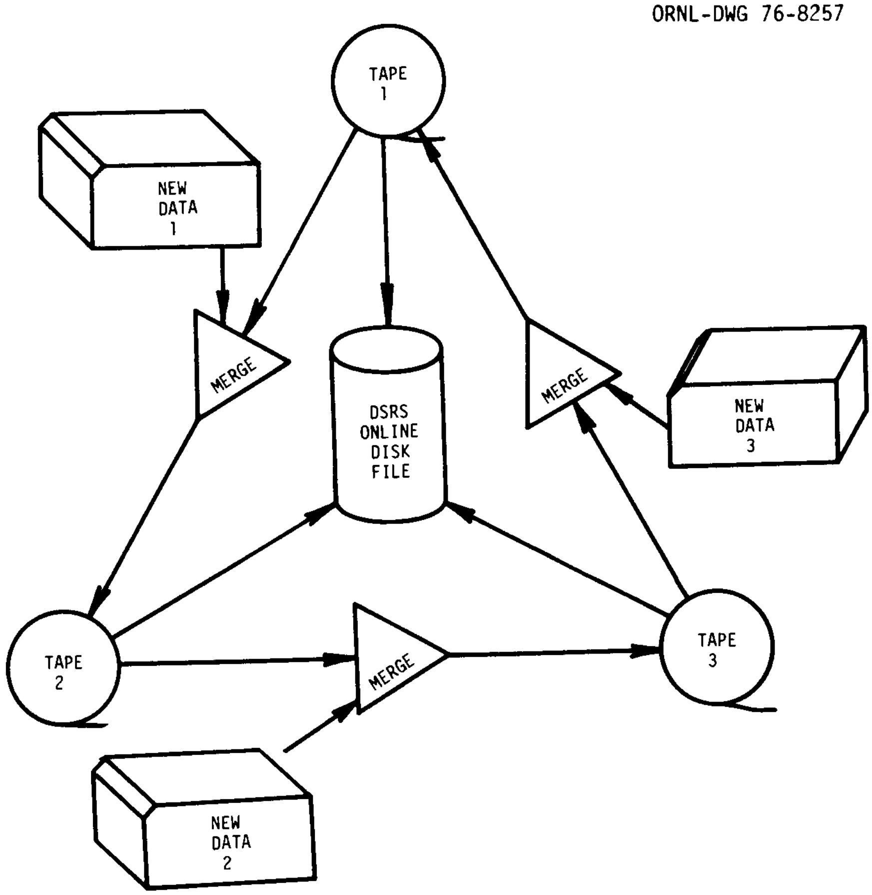

Fig. 14. Flow Diagram Illustrating DSRS Tape Cycling.

(unreasonable magnitudes or inconsistencies such as a 0.2% offset yield strength greater than an ultimate tensile strength, etc.) and unusual-looking text entries in the <HN> (heat number), <HT> (heat treatment), and other fields.

Periodic checks are conducted by computer, as well. Accessing the disk file by Teletype, ORLOOK is asked to locate all tests containing various unreasonable data, such as <RA> (reduction in area) greater than 100%. Any such data found are then corrected as previously described.

Inconsistencies in retrieved data can be identified by examination of output from ADTABLE or ADPLOT. A check of the <CM> (comments) or other fields often yields a valid reason for such deviations.

G. Material Characteristics Information

A check of Figs. 1–5 gives a quick idea of the types of mechanical properties data stored in DSRS. One might note, however, that the only material characteristic information includes items such as <MA> (material),

<AB> (alloy base), <HN> (heat number), or <HT> (heat treatment). In many cases, such information is inadequate. To fulfill the need for further information on material characteristics, a separate file is maintained to contain such information.

Figure 15 displays the form used to input data to this material characteristics file. Note that this file is maintained separately from the mechanical properties files. The three entries allowable for the chemical composition information correspond to ladle analysis, vendor check analysis, and laboratory check analysis. As is the usual case with structured DSRS fields, missing data are indicated by an entry of a negative sign followed by three or more nines, although five nines are recommended. Thus, if the ladle and laboratory carbon analyses were available for a given heat, but the vendor check analysis was not available, the <C> entry might be

<C> 0.05; −99999; 0.048;

Data taken from the literature and other such sources can often cause problems in availability of material characteristic information. For instance, often only one chemical analysis is given, and its source might be unclear. In this case, only one entry would be made in the field for each element. Then (and in the case of any unusual occurrences), explanation should be made in the <CM> (comments) field. If the heat number is unknown, an <AA> (series label) can be assigned in its place to identify a particular lot of material. Problems can occur when data on the same lot of material come from different sources, when the fact that all the different sets of data are for the same lot of material is often unclear. Still, when the heat number is unknown, an attempt at identification is helpful. In any case, <AA> numbers are assigned by DSRS personnel only, to help avoid duplicate numbers for different heats or different numbers for the same heat.

It should be noted that the DSRS material information file is relatively new and does not contain information on all of the material on which data exists in the mechanical property data files.

H. Weld Metal Data

For the processing of data involving weld material, an additional file is maintained to store the relevant background information concerning each weld tested. Thus, each mechanical properties test involving weld material will be stored with the weld number of the weld. Knowing this number, one can then search the weld characterization file for information such as welding procedure, welding conditions, joint geometry, etc.

MECHANICAL PROPERTIES DATA STORAGE FORM

ORNL-DWG 76-8258

MATERIAL CHARACTERISTICS

1.

RECORD NUMBER <   >

SERIES LABEL <AA>

HEAT NUMBER <HN>

MATERIAL <MA>

PRODUCT FORM <PF>

VENDOR <VE>

ASTM GRAIN SIZE NO. <GS>

2. YOUNG'S MODULUS <YM> ;

POISSON'S RATIO <PR> ;

HARDNESS <HD> ;

MICROSTRUCTURE <MS>

HEAT TREATMENT <HT>

COMMENTS <CM>

CHEMISTRY

3.

<FE> ; ; ;

<C> ; ; ;

<CR> ; ; ;

<V> ; ; ;

<NB> ; ; ;

<MN> ; ; ;

<AL> ; ; ;

<BE> ; ; ;

<MG> ; ; ;

4.

<N> ; ; ;

<NI> ; ; ;

<MØ> ; ; ;

<TI> ; ; ;

<P> ; ; ;

<B> ; ; ;

<H> ; ; ;

<Ø> ; ; ;

<SI> ; ; ;

Fig. 15. Example Input Form for DSRS Materials Characteristics File.

IV. RETRIEVAL AND OUTPUT OF DATA

The real usefulness of a computerized data management system is seen in the results which the system produces. In the case of DSRS, these results include output of data in various forms so as to facilitate use of the data in procedures such as material comparison, correlation, design calculations, etc. Such output consists first in locating the data of interest, then choosing a method of data output. Search of the DSRS data file to locate particular subsets of data is accomplished through ORLOOK, while output may be received through ORLOOK, ADSEP, ADTABLE, or ADPLOT.

A. Data Search and Retrieval

The DSRS on-line disk files are accessed and searched through direct Teletype communication with the ORLOOK computer program in the time-sharing teleprocessing environment of the IBM 360 model 75 computer located in the Computing Center at the Oak Ridge National Laboratory. Some of the DSRS-related applications of ORLOOK will be discussed here, while more general information can be found in ref. 1.

1. General features of ORLOOK

The ORLOOK user interacts with the program through remote terminal telephone-line hookup and a series of user-initiated verblike commands and ORLOOK-initiated queries, acknowledgments, and error messages. A terminal-to-ORLOOK interface program using the telecommunications access method (TCAM) facilitates terminal input and output. ORLOOK operates on "time-sharing," which means that several programs may be executing concurrently in the same core memory region by swapping back and forth from disk storage into the same memory region. This swapping is controlled by the IBM 360 model 75 time-sharing option (TSO).

2. LOGON

The first step in using ORLOOK is to establish contact with the IBM 360 model 75 computer. This step is accomplished merely by dialing the appropriate computer telephone number and establishing terminal-to-computer telephone line connection through an acoustic-coupler device. The user then logs onto the system using standard TSO LOGON procedures.[1]

The ORNL version of TSO accepts the command ORLOOK as a valid command. A TSO user may enter ORLOOK at any time merely by giving the "ORLOOK" command.

3. File selection

After the user has established contact with the ORLOOK program, ORLOOK queries

DATA BASE PUBLIC/PRIVATE/OTHER/STOP?

to which the user should answer PUBLIC if he wishes to search one of the DSRS data bases. No PRIVATE data bases are now used with DSRS. A reply of "STOP" will end ORLOOK execution and return the user to TSO. Use of "OTHER" data bases will be described below.

If the user requests a PUBLIC data base, he can receive a listing of all public files, including a reference number and corresponding line of descriptive text. This listing may be aborted if so desired. ORLOOK will next ask the user which file he wishes to access. After receiving an answer the program will then locate the appropriate file and reply ORLOOK READY. The user may then initiate data search and retrieval.

4. The LOOK command

The principal ORLOOK command used for file searching is the LOOK command, which tells ORLOOK to "look" for all tests fitting the description given. The description is given by specifying the identifier to be searched within brackets and then giving the value of the identifier to be searched for. Values of text fields may be specified using "=" followed by the value desired in single quotes. Numerical fields may be searched by specifying FORTRAN-like relational operators such as, .EQ. (equal to); .GE. (greater than or equal to); .LE. (less than or equal to), .GT. (greater than); or .LT. (less than). Examples follow; note that entry of the work "LOOK" is optional in the examples of this section. Underlined characters are ORLOOK-supplied prompts and are not typed by the user:

```
(1).LOOK <TY> = 'CREEP'
   .END
(2).<HT> = 'ANN'
   .END
(3).LOOK <Y2> .GE.'30000.'
   .END
(4).<US> .LT. '100000.'
   .END
```

(An entry of "END" denotes end of the LOOK specification; see below.)

Searches of text fields initiate a search for any test containing the given string of textual characters anywhere in the given field. For example, item 2 above would return tests containing heat treatments such as 'ANN' (annealed), 'ISO ANN' (isothermally annealed), 'SOLUTION ANN' (solution annealed), etc. For this reason, one must use extra caution, since he may cause ORLOOK to return more tests than those he actually seeks. Also, one must be precise in his specifications. For instance, a request for <MA> = '304 SS' will not locate tests on type 304 stainless steel, since these tests are stored as "304SS."

Numbers specified for search in numerical fields should be entered in the correct format; that is, integers should be entered simply as integers, but real numbers should be entered either with a decimal point in the proper place or in "E" format. If one wishes to search for an approximate value of a real number, say <TE> about equal to 540°C, he may specify a tolerance. For instance,

```
.ERR = 10.0
.<TE> .EQ. '540.'
.END
```

specified a search for all tests containing a temperature within 10° of 540°C.

In fact, it is generally a good idea to specify a tolerance whenever searching fields containing floating-point (real) numbers, since these numbers cannot always be represented exactly in computer storage. Once set, a tolerance remains during a given session unless reset. This tolerance applies only to real numbers, not to integers.

One may specify a search for tests meeting all or any of several criteria using "AND logic" or "OR logic."[1] Entering two or more search specifications on one line specifies a search for tests meeting all of the specified criteria. Up to four specifications may be entered on a line. Entering LOOK commands on consecutive lines specifies a search for tests meeting the criteria given on any one of the individual lines. Up to ten consecutive lines of LOOK commands may be entered. Entry of "NOT" before a LOOK command specifies search for all tests *not* meeting the given requirements. All LOOK commands containing NOT are processed separately from those without NOT. Then, tests which meet both of these groups of specifications are given in the result. The search specifications using NOT are grouped for processing according to their implied AND-OR logic. One may specify up to ten lines of LOOK commands using NOT in addition to the ten allowed without NOT. One NOT negates the entire line, and NOT may be used only at the beginning of a line of search specifications. Thus

```
.NOT <MA> = '304SS' <TY> = 'TENSILE'
```

returns all tests which are not tensile tests on type 304 stainless steel. For LOOK commands specifying NOT, the same rules of AND-OR logic apply as in normal LOOK commands. However, since NOT has been specified, the results are negated, and any test that would normally have been selected is now rejected. Thus the specification

```
.LOOK <TY> = 'TENSILE'
.LOOK <TY> = 'CREEP'
.END
```

locates all tensile or creep tests. On the other hand,

```
.LOOK NOT <TY> = 'TENSILE'

.LOOK NOT <TY> = 'CREEP'
```

locates all tests which are neither tensile nor creep tests.

```
.<MA> = '304SS' <TE> .LE. '600.'

.<MA> = '316SS' <TE> .LE. '800.'

.NOT <TY> = 'CREEP'

.NOT <HT> = 'ANN'

.END
```

specifies a search for all noncreep tests on nonannealed material which are either for type 304 stainless steel below 600°C or for type 316 stainless steel below 800°C.

Finally, an individual specification can be negated by placing an "N:" before the specified value. Thus

```
.<MA> = '21/4CR1MO' <TY> = 'N:TENSILE'

.END
```

searches for all nontensile data for 2 1/4 Cr-1 Mo steel.

Again, all LOOK commands or combinations of LOOK commands are completed by entering "END" on the line after the last LOOK command.

Use of AND and OR logic enables great flexibility in data search. For instance, "bracketing commands" are quite often useful. Thus,

```
.ERR = 100.

.<TY> = 'CREEP' <MA> = '304SS' <ST> .GT. '10000.' <ST> .LT.'20000
```

specifies a search for creep tests on type 304 stainless steel with a nominal creep stress between 10,000 and 20,000 psi. Setting of error bands, as shown, is generally good practice when using bracketing commands, because of the formats in which numbers are stored on the computer. (Also, if one is interested in a 20,000-psi test, he is also likely to be interested in a 20,100-psi test.)

Variations in AND and OR logic have been the subject of whole texts in logic and set theory. Generally, however, proper search strategy requires only practice and adequate utilization of common sense.

Entry of the "CANCEL" command erases the last line of LOOK commands entered. Entry of successive CANCEL commands cancels all current LOOK commands one by one from last to first entered in the current search scheme (the current series of LOOK commands since the last END command). Entry of CANCEL ALL erases all current LOOK commands.

Successful completion of a search will be acknowledged by ORLOOK's returning the subset number of the located subset and the number of tests in the subset.

5. Subsets

When one begins search of an ORLOOK file, the entire file is denoted by ORLOOK as SUBSET 0. Subsequent searches for tests meeting specified requirements will generate new subsets numbered consecutively. Thus, the first search locates a set of tests which it denotes as SUBSET 1, the next search creates SUBSET 2, etc. The user may return to any subset previously located in a given session by entry of the SUBSET command. For instance, a user who has just located SUBSET 8 may return to SUBSET 2 simply by entering

.SUB 2

The SUBSET command is useful in its own right, but also can be useful in search strategy. For instance, if one wishes to separately isolate creep and fatigue tests on Inconel alloy 718, one might first locate tests on Inconel alloy 718 by

.<MA> = 'INC718'
.END

as, say, SUBSET 1. Then the creep tests might be found by

.<TY> = 'CREEP'
.END

This command, however, transfers the current ORLOOK pointer to the creep tests in SUBSET 2. Thus, the fatigue tests might be located by

.SUB 1
.<TY> = 'FATIGUE'
.END

Note that the current ORLOOK pointer is always on the last subset located unless otherwise specified by the SUBSET command. Subsequent commands such as output commands will be performed on the subset at which the pointer currently resides, unless otherwise specified by the user.

Two subsets may be combined into a third subset, using the COMBINE command, which has the form

AND
COMBINE – first subset number OR second subset number
NOT

COMBINE AND forms a third subset from all tests contained in both of the two original subsets; COMBINE OR forms a subset containing all tests in either of the two original subsets; and COMBINE NOT forms a subset containing all tests in the first subset which are not also in the second subset.

Once a given ORLOOK session is ended, all subsets except the original SUBSET 0 will be destroyed; thus, in a subsequent ORLOOK session one must begin again with SUBSET 0 and proceed to isolate other subsets as before. If one wishes to save a given subset for future use with ORLOOK, or for access by ADPLOT or ADTABLE, the COPY command is used. COPY stores a given subset separately from the master file for future use. The form of this command is

COPY (subset number)

Copied subsets are classified as "OTHER" data bases in the original ORLOOK LOGON. Thus, to access a COPIED data set with ORLOOK, the user answers

DATA BASE PUBLIC/PRIVATE/OTHER/STOP?

by OTHER. ORLOOK will then request the data set name, at which the user must supply the entire data set name as cataloged, that is, user-ID.ORLOOK. SUBSET. (name given by user). Finally, the user must supply the unit number and volume name on which the data set resides. Having completed all of these steps successfully, ORLOOK will acknowledge its readiness, and the user may begin searching the COPIED subset (which is now SUBSET 0).

6. ORLOOK output

Data searched and selected by ORLOOK may be output at the terminal by giving the LIST command, or at the line printer in the Computing Center at ORNL, by giving the PRINT command. Other commands also obtain various output information and will be described here. The form of the LIST and PRINT commands is

$$\begin{Bmatrix} \text{LIST} \\ \text{PRINT} \end{Bmatrix} \quad \text{(test number)} \quad \text{(list of identifiers)}$$

Omission of the test number parameter causes output of the tests in the subset at which the pointer currently resides, while omission of the list of identifiers whose information is desired for output causes output of all information on the specified test(s). Figures 16 and 17 illustrate output of the LIST and PRINT commands.

The entire ORLOOK session (commands, queries, lists, etc.) can be printed at the line printer by specifying "HARDCOPY ON." Otherwise, only output specified by the PRINT command will be printed on the line printer.

HARDCOPY ON may be turned off either by entry of the HARDCOPY OFF command or the RELEASE command. The printer data set is automatically allocated when either the HARDCOPY ON or PRINT command is given.

ORNL-DWG 76-8259

```
### 3521 ###
<DISCTEST>
<IP         >TIMKEN;DS652;03/00/71;G.V.SMITH;UNK
<TE         >       5.3800E 02
<EN         >AIR
<MA         >21/4CR1MO
<HN         >2.125IN.X.428IN.
<AB         >FE
<HT         >ANN/899
<CM         >%C=.08
<RA         >       8.0000E 01
<TY         >CREEP
<NO         >M-34
<AA         >T-25
<ET         >       6.4000E 01
<CREEP      >
<ST         >       2.8000E 04


*** END LIST
```

Fig. 16. Example ORLOOK OUTPUT From List Command.

ORNL-DWG 76-8260

```
### 3142 ###
<DISCTEST>
<IP         >MARTEST;ORNL CONTRACT;07/12/75;JBCONWAY;COS;
<TE         >       4.8200E 02
<EN         >AIR
<MA         >21/4CR1MO
<HN         >3P5601
<AB         >FE
<HT         >AU/1.0/927/FC28CPERHRTO704/2.0/FC5CPERMINTORT (ISO ANN)
<SD         >HOURGLASS MIN. D=.25IN
<SR         >       4.0000E-01
<TY         >FATIGUE
<NO         >MIL-30
<ET         >       0.0000E 00
<ED         >       1.0000E 00
<SE         >       1.0000E 00   4.0000E 00   1.0000E 02   3.8400E 02   5.6700E 02
  7.1700E 02        9.0000E 02   1.0510E 03   1.3780E 03   1.5320E 03
<ST         >       6.6611E 04
<RT         >       8.1890E 02
<EL         >       2.1000E-01
<EP         >       7.9000E-01
<LM         >STRAIN
<NS         >       4.0000E 00
<AS         >       7.4442E 04
<TI         >       5.0000E-01
<SS         >       6.7425E 04   7.4442E 04   7.1391E 04   7.0171E 04   6.9560E 04
  6.9255E 04        6.8543E 04   6.8238E 04   6.6611E 04   6.3459E 04
<FATIGUE >
<WF         >RAMP
<HM         >TENSION
<FQ         >       5.5400E-04
<MS         >       3.0000E 04
<MN         >       1.9322E 04
<SH         >       2.1763E 04
<CF         >       1.6330E 03
<TS         >       3.0000E 04
<MC         >       3.6611E 04
```

Fig. 17. Example ORLOOK OUTPUT From Print Command.

The RELEASE command then releases this data set from ORLOOK, while subsequent PRINT or HARDCOPY ON commands will allocate a new printer data set. Thus, portions of a session which need to be printed at the line printer, but which are logically separate, may be printed separately by entering successive RELEASE and HARDCOPY ON commands between them. Also, since ORLOOK allows only limited space for the allocation of printer data sets, it is often good practice to separate successive PRINT commands by entry of the RELEASE command.

7. Miscellaneous ORLOOK commands

ORLOOK also allows certain other miscellaneous commands which might be useful from time to time. For a full description of these commands, the reader is referred to ref. 1. Some of the commands and their descriptions are given here.

(a) Entry of the BASES command results in a list of the referenced public or private data-base files being output at the terminal. This list contains the file reference numbers and their corresponding descriptions:

("Mechanical Properties," etc.)

(b) The NEWBASE command allows the user to switch from one data base to another. After entry of the NEWBASE command, ORLOOK asks

DATA BASE PUBLIC/PRIVATE/OTHER/STOP?

and the user then proceeds as in Sect. IV-A-3.

(c) The REQUEST command results in output of a summary listing of logical operations on the current file, including the numbers of the subsets searched, the numbers of the result sets, commands given in searching and/or combining subsets, etc.

(d) The STOP command signals that the user is ready to terminate an ORLOOK session. Entry of the STOP command automatically scratches all subsets used in the session (except SUBSET 0 and COPIED data sets). Contact with ORLOOK is terminated and control is returned to the TSO monitor level. TSO signals its readiness by typing READY at the user's terminals, after which the user may enter any acceptable TSO command. To complete the session, the user enters LOGOFF, after which the user has only to turn off his terminal and hang up his phone. Appendix I shows the commands and responses of a typical ORLOOK session.

8. Terminal interface commands

While in ORLOOK, the user also has the option of direct communication with the terminal to ORLOOK interface program. Various terminal-interface commands are described in ref. 1. Only the SHOW command will be mentioned here, since this command is the most valuable to DSRS.

Use of the SHOW command is described in detail in ref. 1. Basically, it allows the user to list (at the Teletype) various facts about stored (COPIED) data sets, or to SCRATCH (erase) stored data sets.

B. Auxiliary Output Programs

In addition to regular ORLOOK output, DSRS data can be accessed and output by a variety of auxiliary output programs, allowing a choice of several different forms of data display. These programs include ADSORT,[13] ADPLOT,[3] ADTABLE,[2] APEND,[14] ASEND,[14] and ADSEP.[8] Use of these auxiliary programs is generally confined to auxiliary COPIED subsets in order to output only data meeting certain restrictions, although the master files can also be accessed. The programs themselves are stored on disks on the ORNL IBM 360 computers. They are invoked through card decks containing job control statements and specific program commands.

ADSORT is not an output program as such, but is often used in conjunction with output programs (especially ADTABLE). ADSORT accesses a given data base, sorts it according to the values contained under specified identifiers, and temporarily stores the sorted file separately. Subsequent access of this sorted file by ADTABLE, for instance, results in output of a sorted table. Sorts may be specified for several identifiers at once, such as a primary sort by heat number <HN>; a sort within <HN> by temperature <TE>; a sort within <TE> by strain rate <SR>; etc.

ADTABLE allows output of data in tabular format and therefore is particularly well-suited for use with ADSORT. ADTABLE allows the user to specify which identifiers will be tabulated and the order in which the columns of the table fall. Input consists of a text description of the table to be printed on a cover page, the table title, column headings, and the identifiers to be tabulated in each column. If the data in one identifier are missing, the user can specify an alternate entry in the table (such as a text message, the data from another identifier, etc.). Figure 18 shows a sample table produced by the ADTABLE program. A full description of ADTABLE commands and options is given in ref. 2.

Numerical test data such as that contained in DSRS lend themselves well to graphical display. Plots of data give, at a glance, considerable information about the data. Therefore, the ADPLOT program was developed to allow graphical output of data from DSRS. The contents of any numerical field, including linear, log-log, and semilog plots, may be plotted. Different data sets can be plotted on the same graph in different symbols. Corresponding pairs of points from structured fields such as <SE> and <SS> for fatigue tests or <SE> and <SN> for tensile tests can be plotted to form stress-strain curves, etc. Figure 19 displays a graph produced by ADPLOT. (Note that graphs may also be produced on gridded paper to facilitate analysis.) Reference 3 describes the use of ADPLOT in more detail.

The ADSEP program itself also has capabilities which allow output similar to that obtained with the ORLOOK PRINT command. As with PRINT, the contents of specified identifiers will be output in the order specified by the user, although in this case there is no default option to

ORNL-HARTEST FATIGUE DATA FOR 2 1/4CR-1.0MO STEEL
(CONTINUED)

ORNL-DWG 75-7360

SPECIMEN NUMBER	HEAT NUMBER	SERIES LABEL	TEMPERATURE (DEG C)	STRAIN RATE (%/SEC)	STRAIN RANGE (%)	TENSILE STRESS AMPLITUDE AT NF/2 (PSI)	COMPRESSIVE STRESS AMPLITUDE AT NF/2 (PSI)	ELASTIC STRAIN RANGE AT NF/2 (%)	PLASTIC STRAIN RANGE AT NF/2 (%)	CYCLES TO 5% DECREASE IN STRESS RANGE	CYCLES TO FAILURE	TIME TO FAILURE (HRS)
2PTT	20017	20017ISC	538.	0.4000	3.000	48892.	50522.	0.3800	2.6200	425.	444.	2.
1MTL	20017	20017ISC	538.	0.4000	2.000	42800.	45400.	0.3400	1.6600	776.	796.	2.
2MTL	20017	20017ISC	538.	0.4000	1.500	42700.	40900.	0.3500	1.1500	1215.	1373.	3.
1PTT	20017	20017ISO	538.	0.4000	1.000	40340.	40751.	0.3100	0.6900	2132.	2437.	3.
3MTL	20017	20017ISO	538.	0.4000	1.000	38400.	35700.	0.3000	0.7000	2464.	2566.	4.
4PTL	20017	20017ISO	538.	0.4000	0.700	39400.	40300.	0.3100	0.3900	5227.	5543.	5.
5PTL	20017	20017ISO	538.	0.4000	0.560	35700.	36500.	0.2900	0.2800	7859.	6524.	7.
MIL-10	3P56C1		538.	0.4000	0.500	27800.	28900.	0.2200	0.2800	13951.	16036.	11.
6PTL	20017	20017ISO	538.	0.4000	0.500	34300.	34700.	0.2700	0.2300	17280.	16292.	13.
7MTL	20017	20017ISO	538.	0.4000	0.460	33400.	36400.	0.2700	0.1900	25200.	26418.	17.
14MTL	20017	20017ISC	538.	0.4000	0.420	33600.	33600.	0.2600	0.1600	34350.	37626.	22.
13PTL	20017	20017ISO	538.	0.4000	0.440	36300.	36500.	0.2800	0.1600	42600.	44540.	27.
16MTL	20017	20017ISO	538.	0.4000	0.390	32400.	34400.	0.2600	0.1300	63238.	63620.	34.
27PTL	20017	20017ISO	538.	0.4000	0.280	28890.	29895.	0.2300	0.0500	476055.	479174.	[illegible]

Strain controlled data

Fig. 18. Example ADTABLE Output.

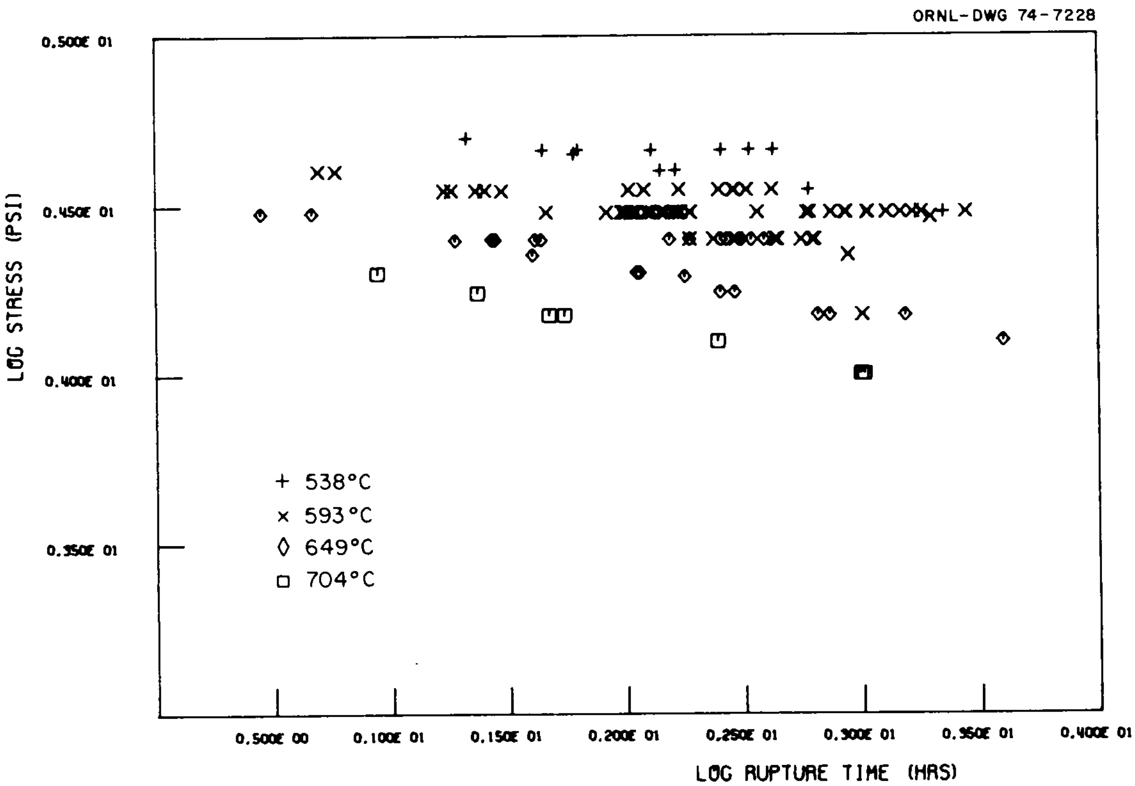

Fig. 19. Example Plot from ADPLOT.

output all of the data stored for a given test. However, ADSEP also contains an option for printing out the data for a certain range of test numbers, for instance, test number 14000 through test number 14500. The main advantage of using ADSEP for output occurs in the processing of large data sets. The limited space available for printer data sets in ORLOOK makes the PRINT command ill-suited for the output of very large data sets. [In fact, an attempt to PRINT the data from an extremely large data set may result in insufficient space for the printer data set, giving an ORLOOK ABEND (abnormal termination). In this case, the user will receive a minidump of the computer storage area in which the ABEND occurred and an error message. ORLOOK ABEND results in return of control to the TSO monitor level.] ADSEP, on the other hand, is not bound by such restrictions.

V. DATA ANALYSIS

Direct analysis of on-line data is accomplished through APEND and ASEND. These are general analytical programs which go beyond simple graphical output. Not only can these programs produce various forms of graphical output from DSRS copied data sets, but they also perform linear least-squares regressions and give statistical analyses of the data. Data-set concatenation, curve fitting, statistical analysis, alteration of the *X* and *Y* axes lengths, and upper and lower values for *X* and *Y* scales are optional in both programs. APEND is designed to handle simple analytical and/or plotting tasks, using only two fields from each test in the copied data set (one *X* field, one *Y* field). ASEND is more versatile, allowing greater flexibility in analysis and plotting. Analysis is provided for up to five fields with optional user-supplied subroutines to calculate the *X* and *Y* array, for the plotting, and to specify regression models. The user may specify (1) a plot of data points only; (2) a plot of the function (determined by a least-squares fit to the data) only; (3) a plot of the points and function; (4) a plot of the points, function, and statistical limits; and (5) a legend for a plot. Both programs have the capability to plot several data sets on one graph in different symbols with a legend for clarity. In ASEND, the user may also specify what type of plot (log-log, semilog, linear, etc.) and what type of graph paper should be used.

Applications of these programs are endless. While APEND is ideal for a quick simple analysis [example: temperature-ultimate tensile strength curve fits and plots for a given material (Fig. 20)], ASEND is better suited to more complicated tasks, such as parametric analysis of stress-rupture data (Fig. 21). Thus, DSRS serves not merely as a passive depository for data, but as a dynamic active system for data handling and analysis.

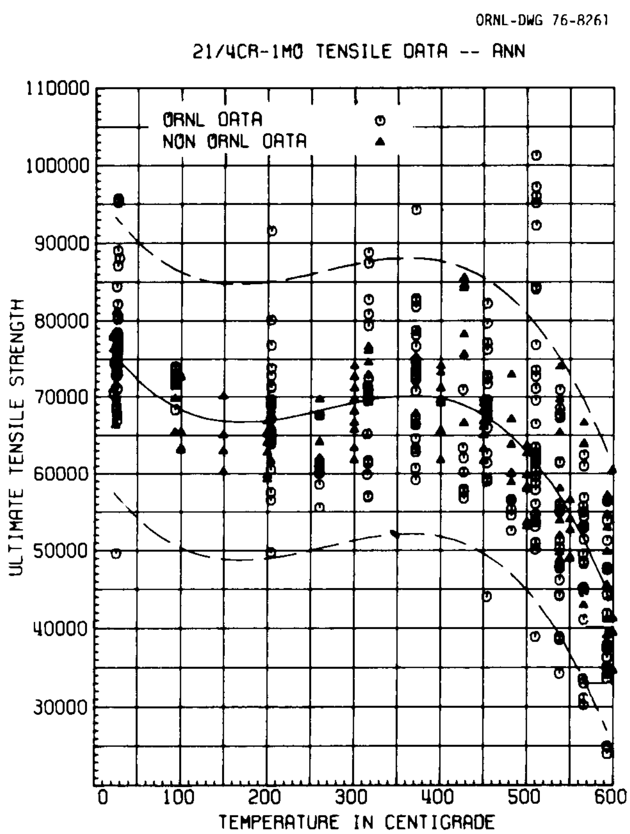

Fig. 20. Example Plot of Ultimate Tensile Strength vs Temperature for 2 1/4 Cr-1 Mo Steel with Least-Squares Curve Fit and ±2 Standard Error Bounds From APEND.

ORNL-DWG 76-8158

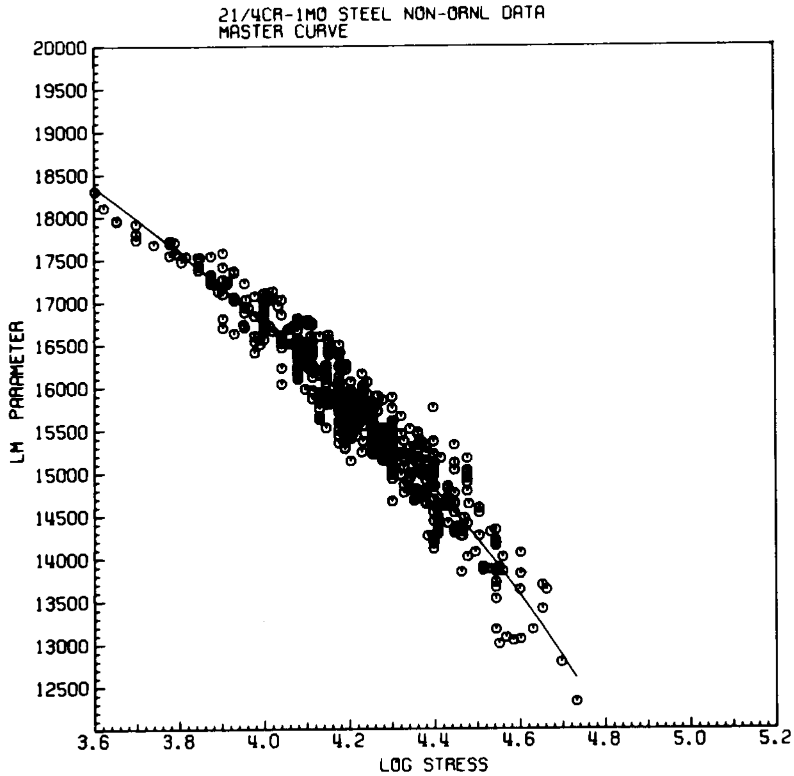

Fig. 21. Example Larson-Miller Master Curve for 2 1/4 Cr-1 Mo Steel from ASEND.

VI. SUMMARY

The ORNL Mechanical Properties Data Storage and Retrieval System is a computerized system for the storage, search, manipulation, retrieval, and analysis of data from mechanical properties tests on structural materials. The system contains data from several types of tests for a variety of materials. This report describes procedures for processing and input of the data, searching the data files, and outputting the desired data. Data to be input to the system are punched onto cards, either by keypunching from standard input forms or through computer programs designed to convert raw test output into salient test characteristics. These cards are read, checked, and their contents stored first on magnetic tape and finally in a permanent on-line disk file. This file is accessed directly by Teletype through the ORLOOK computer program, which allows the user to locate and isolate data meeting any description that might be entered. Data may be output in a variety of printed and graphical forms, including numerical and statistical analysis of data. Thus, the system provides a computerized mechanism for handling the massive amounts of mechanical properties data needed for the design of modern high-temperature nuclear reactor systems.

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APPENDIX

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WIL LOGON IN PROGRESS AT 11:06:20 ON APRIL 8, 1976
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READY
OBLOOK


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++ 3-3-76 ++++ NEW VERSION ORLOOK NOW EFFECTIVE.
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