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AN INTELLIGENT KNOWLEDGE SYSTEM FOR SELECTION OF MATERIALS FOR CRITICAL AEROSPACE APPLICATIONS (IKSMAT) PHASE II

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This is the Phase II SBIR USAF Contract Program for the detailed design, production and demonstration of a prototype intelligent knowledge system for the selection of materials for critical aerospace components (IKSMAT). IKSMAT was shown to be technically and economically feasible in a Phase I SBIR program, and the development of the prototype was based upon the specification defined in that effort.
The IKSMAT system provides multiple-path access to a knowledge base of information vital to the assessment of the suitability of materials for key components, with a software package capable of evaluating and ranking the performance of those materials based upon specific properties and/or design-related parameters such as critical flaw size index. Users of the system are able to search for candidate materials for specific aerospace components (a) utilizing the basic materials and selection processes programmed into the system, (b) adding new properties for the existing materials, (c) adding information for additional materials, and/or (d) altering the criteria and functional priorities used in rating the materials.
The knowledge base for the prototype IKSMAT system was developed to support material selection for seven aerospace components: winspar, upper wing skin, lower wing skin, pivot/swivel pin, bulkhead, landing gear and fuselage. The Master IKSMAT Database for the prototype was based primarily upon MIL-HDBK-5F, with supplementary data for several sources.

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FINAL TECHNICAL REPORT
AN INTELLIGENT KNOWLEDGE SYSTEM FOR SELECTION OF MATERIALS FOR CRITICAL AEROSPACE APPLICATIONS (IKSMAT)

1.0 ABSTRACT

This is the Final Technical Report on a Phase II SBIR USAF Contract Program for the detailed design, production and demonstration of a prototype intelligent knowledge system for the selection of materials for critical aerospace components (IKSMAT). IKSMAT was shown to be technically and economically feasible in a Phase I SBIR program, and the development of the prototype was based upon the specification defined in that effort.

The IKSMAT system was targeted to provide multiple-path access to a knowledge base of information vital to the assessment of the suitability of materials for key components, with a software package capable of evaluating and ranking the performance of those materials based upon specific properties and/or design-related parameters such as critical flaw size index. Users of the system are to be able to search for candidate materials for specific aerospace components (a) utilizing the basic materials and selection processes programmed into the system, (b) adding new properties for the existing materials, (c) adding information for additional materials, and/or (d) altering the criteria and functional priorities used in rating the materials.

The knowledge base for the prototype IKSMAT system was developed to support material selection for seven aerospace components: wingspar, upper wing skin, lower wing skin, pivot/swivel pin, bulkhead, landing gear and fuselage. The Master IKSMAT Database for the prototype was based primarily upon MIL-HDBK-5F, with supplementary data from several sources.

A fully operational prototype IKSMAT for several key aerospace components was developed and evaluated as part of this program. The resultant prototype met many of the objectives, but highlighted three serious problems that limit its utility.

The first problem is the lack of a complete master electronic version of MIL-HDBK-5 in a form that can be readily updated for search and retrieval. The second is the large number of missing data for many of the candidate materials for critical aerospace applications, making proper functioning with the appropriate knowledge base incomplete and inefficient. The solution to these two problems is the development of an electronic master database for MIL-HDBK-5 that forces a consistency of data requirements for all materials and an automating updating capability.

The third problem was the large quantity of data potentially responsive to the IKSMAT queries that must be transported over public telecommunications before being analyzed by the IKSMAT software. In any future exploration or implementation of the IKSMAT system, it is recommended that the IKSMAT Master Database be maintained locally with the IKSMAT software and knowledge base. An online communication system link should be maintained but only for purposes of updating the Master IKSMAT Database.

A Phase III implementation of the IKSMAT system is not recommended until a fully electronic version of MIL-HDBK-5 is available in a master electronic database form facilitating updating and addressing the need for more consistent treatment of fatigue and fracture toughness data.

2.0 INTRODUCTION AND BACKGROUND

A key requirement for the successful implementation of the unified life cycle engineering concept (ULCE) to aerospace structures (1) is the availability of a well-developed intelligent knowledge system for the selection of materials for specific components. There are two reasons for this: 1) the increasing complexity of the requirements for material performance for many components, and 2) the wide range of candidate materials, particularly the newer and more sophisticated "advanced" materials classes.

With regard to requirements for material performance, the increasing severity and sophistication of demands on the performance of many critical components require that many properties and characteristics of each candidate material be considered. In addition to the conventional design properties provided by MIL-HDBK-5 (2), careful consideration must be given to the fracture toughness, fatigue crack initiation and propagation resistance, and corrosion resistance, often under a variety of time-temperature-environment conditions. In addition, there are less quantifiable, but equally important characteristics which must be considered such as availability, workability, weldability and finishing requirements. A computerized diagnostic program to assure that all of the important properties and characteristics of all logical candidate materials are considered and that they are analyzed with appropriate priorities would be of great value for reliable material selection.

With regard to material options, the proliferation of new structural materials, including polymers, ceramics and a wide range of composites, as well as advanced versions of conventional alloys, greatly increases the task of assuring that all realistic options have been considered (3). There are two complicating aspects to this part of the problem: first, the newer high performance polymers, ceramics and composites are difficult to identify and compare because of the lack of standard nomenclatures and test procedures; and second, data are becoming available so rapidly on so many materials that the task of keeping a database current is enormous. Again, the potential of a computerized system includes the capability of handling a number of sophisticated descriptors for the materials and the test procedures, and of rapidly incorporating new data in standard formats and additional performance indices in the supporting knowledge base.

A Phase I study (4) demonstrated the technical and economic feasibility of developing a computerized intelligent knowledge system (IKSMAT) to aid materials specialists and designers in the screening and selection of a wide range of materials for critical aerospace applications. Further it was demonstrated that the IKSMAT system has the potential to provide great flexibility in query, search and analysis options, would be very easy for engineers and scientists to use, and would be easily and economically expanded to include many additional applications.

The program herein covers the production and evaluation of a prototype IKSMAT system providing material-search capabilities for a wide variety of aircraft components. This was intended to be a system capable of becoming the first stage of an extensive and valuable element of the ULCE concept of design and manufacturing.

3.0 TECHNICAL PROGRAM OBJECTIVES

The Phase II technical objectives are best defined in the context of the original three-phase program, as described in the following sections:

3.1 - Overall goal of the entire three-phase program and the relationships among the effort during the three phases,

3.2 - Specific technical objectives of Phase II.

3.1 Overall Goal of Three-Phase Project: The goal of this three-phase program was to build an intelligent knowledge system for the selection of materials for critical aerospace applications (IKSMAT). IKSMAT was intended to provide guidance in the selection of alloys to meet sophisticated design requirements for spar applications, and also to form the basis of a system that can be expanded to encompass a broad range of materials (polymers, ceramics composites), components (engines, empennage, etc.), and applications (helicopters, missiles, etc.).

Phase I of the program (4) established the feasibility of the system. The scope of the material options, performance criteria and system options to be incorporated in IKSMAT were defined, using one component (wingspar) as the model).

Phase II, as described herein, covered the building of a complete prototype system based upon the specifications defined in Phase I, plus the expansion of the conceptual model to cover a variety of aircraft components.

Phase III was to cover the implementation of the system on a broad scale, including its application to a variety of aerospace applications and to other similar non-aerospace structural components, and the development of increased interface to the design process by increasing the sophistication of the analytical elements included.

3.2 Specific Phase II Technical Objectives: The goal of the program was to perform the detailed design for, build and evaluate the prototype IKSMAT system, including the following specific technical objectives:

1. Knowledge base development, data qualification, and interface refinement: define the knowledge base logic, required data files and data presentation formats for the materials and properties required for the IKSMAT knowledge base and databases to assure effective demonstration of prototype capability for the following specific components and applications:

    wingspar
    bulkhead
    upper wingskin
    lower wingskin
    fuselage
    landing gear
    pivot/swivel fitting

2. System design and assembly: refine the IKSMAT system design, including the individual components and the nature of their interface and interaction; and develop the basic units for the user-resident portions of the system.

3. Programming: extend and refine the system logic and program the query rules and response options. Program the interface of the knowledge base and controller to internal and external databases.

4. Electronic data acquisition: Obtain required data and support information in machine-readable form; digitize those portions of the original data sources such as MIL-HDBK-5F and the military specifications which are not in machine-readable form, and verify the correctness of the digitized information.

5. File design and loading: refine the data formats, create the file design, and carry out the file loading for the information to be in the "master" databases, i.e., MIL-HDBK-5F and the related basic sources, on MPD Network.

6. Evaluation and debugging: conduct pilot debugging trials and conduct demonstrations and alpha tests; add capabilities as necessary to achieve the desired capability and performance.

7. Demonstrations and reports: conduct public demonstrations of prototype system; prepare reports and technical papers documenting operations, including detailed plans for Phase III commercialization of systems.

4.0 OVERALL DESCRIPTION AND SPECIFICATIONS FOR PROTOTYPE IKSMAT

In order to fully define the capabilities of I''SMAT, its functionality is described at three levels:

4.1 Conceptual Model of An Intelligent Knowledge System

4.2 ''KSMAT System Architecture and Operations

4.3 Specifications for the prototype IKSMAT from the Phase I study, and elements of effort required to expand its applicability:
- Materials
- Criteria
- Properties
- Metadata system
- Logic, for search path and material screening

4.1 Conceptual Model Of An Intelligent Knowledge System: One generalized model of an intelligent knowledge system (IKS) applicable to the material selection problem defined above is illustrated in Figure 1 (4).

In this model, the KNOWLEDGE BASE is the catalog of design and performance criteria for specific structures and the relative importance of the individual criteria in the performance of those structures, which interfaces with the material properties database covering the range of materials and properties of interest. This knowledge base is interfaced with programs permitting users to compile (KNOWLEDGE ACQUISITION) and utilize (INFERENCE ENGINE) knowledge and data solve problems. The system may be used independently to aid in the tracking and selection of materials for specific applications or interfaced directly with the early stages of the design process to illustrate the impact of utilization of advanced materials on component/vehicle performance.

It is important to note that while the knowledge base itself is the foundation of the system, and it is essential to have a well developed database of reliable well-documented information on which the inference engine can operate. No matter how sophisticated the the logic incorporated into the system, it has little value unless users can have a high level of confidence in the completeness and quality of the underlying data sources (5,6,7,8).

4.2 IKSMAT System Architecture and Operations Capabilities: The specific system architecture required for the prototype is illustrated in Figure 2. It is composed of two groups of components, one in the user's facility and the other in a "master database facility." The USER INTERFACE, CONTROLLER, KNOWLEDGE BASE, and the supporting databases are to be maintained with their own database management system at the user's site. The "master" database facility is to consist of the evaluated data prescribed by Air Force and Aerospace Industry materials specialists through activities such as the MIL-HDBK-5 Coordination Committee and maintained in MIL-HDBK-5 itself (2), plus other "external" sources of data such as those made accessible by the National Materials Property Data Network (MPD NETWORK) and the scientific and technical information network (STN International) (6).

The USER INTERFACE is to handle interactions with the user and provide the display screen control. The CONTROLLER, the inference engine in the conceptual model discussed above, is to carry out the expert system functions, most of which will be broadly applicable to other components and other applications. The rules for material selection and design of specific components constitute the KNOWLEDGE BASE in this model; extension of the system to handle additional components and applications involves adding to the logic in this KNOWLEDGE BASE. Based upon information in the KNOWLEDGE BASE, the CONTROLLER passes information to the USER INTERFACE to determine what actions are required, and then interprets the user input to generate queries in the SEARCH QUERY GENERATOR.

The local database management system (DBMS) deals with the information in "temporary" data files supplied by the user in a manner completely compatible with the permanent databases, and the responses to the user are completely transparent in this respect (i.e., the user will not see the operation as two separate systems interacting), yet the integrity of the permanent databases is maintained. Two user files are to be maintained: the PERSONAL DATABASE contains user specific information, while the UPDATE DATABASE contains those data agreed upon by the entire user group as "pre standard," perhaps candidate material for the permanent databases at the appropriate time.

As noted above, the original plan was for the permanent databases containing evaluated data, such as that based upon MIL-HDBK-5, and the search software that would supply the data for IKSMAT software analysis to reside at a remote location (e.g., the MPD Network on STN-Columbus, in this case), and all additions and deletions to these databases would be carefully controlled by the appropriate agencies (like the MIL-HDBK-5 Coordination Committee).

The system is to operate by applying rules based upon application or component performance requirements in the comparison and ranking of individual materials in prescribed sequences, gradually eliminating candidate materials based upon their inability to meet stated criteria and the presentation in priority order of surviving candidates. The system is to be flexible and dynamic in the sense that new material options could be incorporated at any time and the rules may be altered as necessary to reflect changing vehicular or structural performance requirements.

To be more specific, user approaches to IKSMAT may be of several general types of varying sophistication, including but not necessarily limited to the following:

a. User works within existing database and predefined material selection/design criteria and logic to identify optimum candidate materials for specific application;

b. User adds new materials to database, and then performs analyses based upon preset material selection/design criteria and logic to select optimum candidate materials;

c. User adds new properties for materials in the knowledge base, and then performs analyses based upon existing or new criteria involving those new properties to identify candidate materials;

d. User redefines priorities associated with existing properties and criteria for material selection, and performs new analyses to determine the effect of the changes on the preferred candidate materials;

e. User inputs new criteria (specific properties or design related parameters) and defines their priorities, and then carries out analyses to determine candidate materials; or

f. User conducts general unstructured search with self-generated queries based upon material/property/parameter criteria.

Functionally, there are several additional features beyond those within the internal IKSMAT logic base and knowledge base that are considered important to a valuable materials information retrieval and analysis system. These are:

a. Extreme ease of understanding for the occasional user who is not an information professional trained in the language and command structure of traditional online search systems,

b. Great flexibility with regard to the use of materials nomenclature and property terminology, permitting the user to use any technically correct names or terms (aliases) and still be able to locate the desired information; in addition, the user should have the ability to easily query the system about the meanings of the terms or abbreviations encountered in the process of searching, and

c. Easy access to many other sources of materials property data, beyond those upon which the programmed materials selection process is based, so that newly generated, corroborative or contrasting data may be located, retrieved and analyzed quickly and efficiently.

4.3 Preliminary Specifications for Prototype IKSMAT: In Phase I of this program, a combination of discussions with materials specialists and designers and reference to specific aerospace reports, handbooks and specifications (references 9 thorough 15) led to a compilation of materials, properties, criteria and logic for the selection of materials for wingspar applications. The specifications for the prototype IKSMAT resulting from consideration of those inputs are documented in Reference 4 and the preliminary user requirements are in Appendix A.

4.3.1 Materials included in IKSMAT: The materials included in the prototype IKSMAT included all steels, aluminum alloys, magnesium alloys, and high temperature alloys included in MIL-HDBK-5F.

4.3.2 Key criteria and their priorities for the selection of materials for wingspar applications: The selection of a wingspar for the prototype application of the IKSMAT in Phase I of the program provided an interesting challenge, because by its nature in spanning between the upper and lower wingskins, the key design parameters for the upper and lower surfaces of the wingspar differ.

In Phase I, a specific set of candidate criteria for searching for wingspar materials was proposed, as follows:

1. Critical crack size index - square of ratio of plane strain fracture toughness to yield strength, or (KIc/Fty.LT)**2, an index of the critical crack size at the yield strength.

2. Stress-corrosion cracking (SCC) susceptibility - ratio of maximum tensile stress for SCC resistance to tensile yield strength, or Fsccth/Fty; as an alternative, the ratio of stress intensity threshold for SCC to plane strain fracture toughness, or KIscc/KIc, might be used.

3. Stiffness efficiency - ratio of modulus of elasticity to density, E/d or E/dens.

4. Tensile or yield strength efficiency - ratio of ultimate tensile or tensile yield strength to density, Ftu/d or Fty/d.

5. Fatigue crack initiation resistance fatigue strength at one million cycles of life, with stress ratio, R = 0.0, with smooth (Kt=1.0) and notched (Kt=3.0) specimens.

6. Rate of fatigue crack propagation - fatigue crack growth rate at a an applied stress intensity (R=0.0) of 10 ksi*in**0.5. (prefer based upon spectrum loading, but no consistent standard exists).

7. Fabricability/cost index - this factor was the most difficult to define based upon the information available, but seemed to be best characterized as the cost per pound of the finished part. It was recognized that such information would not be readily available, and so an alternative approach of a fabricability factor would be a useful alternative. With this approach, each material is rated with a summary numeric rating from 1 to 10 with the higher numbers selecting a favorable combination of production-oriented factors including initial cost per pound, special fabrication requirements like finishing or joining, and/or multiple sources. Materials with high production costs or time lines would have low index numbers. (See Paragraph 5.1.3 below, and Appendix B which illustrates typical numbers for the classes of materials involved in the IKSMAT program).

In this Phase II study, discussions and reviews with various aerospace companies, most notably General Dynamics/Ft. Worth, led to a more detailed and specific set of design-related criteria, as defined in Appendix C. for six additional aerospace components: bulkheads, upper and lower wingskins, fuselages, landing gears and pivot/swivel fittings.

4.3.3 Properties considered for IKSMAT: Based upon the list of important criteria for material selection and preliminary design of wingspars, and from related considerations of logical extensions of the system, the following list of properties were identified for potential inclusion in the prototype IKSMAT knowledge base:

>From MIL-HDBK-5:

All design properties from MIL-HDBK-5 design tables

Plane-strain fracture toughness values

Ratings and maximum tensile stresses for stress-corrosion resistance

Axial fatigue strength, 10**6 cycles, R=0.0, Kt=1.0, 3.0 and/or 5.0

Fatigue crack propagation rate, KIf = 10 ksi*in**0.5

>From specifications:

Key requirements of MIL-STD-1587(USAF)(Ref 13), e.g.:

Materials excluded from use (e.g., 5.1.2.2 of MIL-STD)
Heat treatment requirements, limitations (e.g., 5.1.2.3)
Straightening, forming limitations (e.g., 5.1.2.4)
Thickness, cross-section limitations (Table I of MIL-STD)

Key requirements of MIL-STD-1568(USAF)(Ref 14), e.g.:

Materials excluded from use (e.g., 5.4.3.1.2)
Thickness, cross-section limitations

For castings, load reduction factors in MIL-A-008860A (Ref 15)

>From other sources:

Fabricability Index, reflecting:
Cost, $/lb
Special purchasing requirements (e.g., limited suppliers)
Special fabricating problems
Special finishing problems

Detailed formats for inputting and storing information on the materials, including their designations, specifications, compositions, and fabrication histories were established as part of the file design task. In general, information from specifications such as those referenced above were treated in the same manner as footnotes: in any situation where information on any materials whose use is limited or excluded in any way, that information would appear as footnotes to any tabular data presented, so that the limitations are called automatically to the attention of the user.

4.3.4 Metadata System: The metadata support system for IKSMAT was to be fully equivalent to that in the MPD Network pilot system (4,6) based upon the MIST (Materials Information for Science and Technology) technology developed in the joint NBS/DOE/MPD/Stanford program (7,16). This system makes it possible for users to specify any technically acceptable nomenclature and terminology and still obtain the appropriate results, even though the data may not be stored under those same names/terms. Access to an active thesaurus was intended at appropriate points in the system. If the IKSMAT system can interface with the MPD THESAURUS on STN International, all of the materials, properties and related terminology represented in IKSMAT would be covered by the metadata system, such that the user may:

a. Use any technically acceptable name or abbreviation for a material in conducting a search, and

b. By using a simple command such as "? NAME" or " ? TERM", receive a detailed listing of the information in the metadata system for whatever name, term or abbreviation is used after the "?" help-search command.

The technical challenges of providing complete access to the MPD Network system and thesaurus proved greater than expected, and the prototype system was unable to achieve this anticipated capability.

4.3.5 Logic of the Material Selection Process: Given the factors identified for the selection of materials for specific components, their priorities, and the properties needed to conduct the evaluation and selection process, specific steps of logic were identified for incorporation into the prototype system dependent upon the option selected by the user. In Phase I, a specific set of rules were established for wingspars (4), and in Phase II new sets were defined for the other components as well (see Appendix C).

5.0 PHASE II DEVELOPMENT PROGRAM

The major components of work on the Phase II IKSMAT project leading to the prototype development are described below, utilizing the breakdown laid out in the program scope above.

5.1 Knowledge Base/Database Content Development

5.1.1 Criteria for search based upon design criteria for all components were developed based upon discussions with several aerospace companies, notably general Dynamics/Ft. Worth, and from various published papers and presentations. Candidate criteria had been defined for wingspars during the Phase I program, and these were expanded and critiqued, then frozen for the Phase II IKSMAT prototype as defined in Appendix C of this report.

5.1.2 Key data required from references other than MIL-HDBK-5F were sought from the Aerospace Structural Materials Handbook (ASMH) and from the applicable specifications. The search of relevant data from ASMH was very disappointing, and few comparable data from alloy to alloy suitable for such specific searching was located. After several attempts to locate more complete data, such sources were abandoned and MIL-HDBK-5F became the sole major source for numeric data. The requirements of the applicable specifications were retained.

5.1.3 Definition of the "fabricability factor" was explored, based upon the the major "ilities"....e.g., formability, weldability, etc. After considering several specific measures of each factor, and of cost, it was concluded that a summary "fabricability factor" combining a relative measure of all of these factors would be the most useful approach. This approach was supported in discussions with General Dynamics/Ft. Worth experts, who indicated that these factors were seldom more than 5-15 % of the decision, and so a more precise, separate approach for any of the factors was not considered further.

As applied, the fabricability factor is a quantitative ranking factor made up by summing the relative individual factors for five individual characteristics, listed below, which make a material relatively easy or difficult to work with. By this process, each material in each product form has been rated and given points from zero (0, lowest possible) to ten (10, highest or best) depending upon their characteristics or problem areas. The sum for the five areas is the "fabricability factor," which is included in the Master IKSMAT Database, but at the local level. The factors are:

a) Cost - The base price of the material, not to the penny, but in a comparative sense. For example, titanium alloys may be in the range of $10/lb, the most expensive (cost factor = 0), and certain steels and aluminum alloys in the order of $1/lb, the lowest (cost factor = 10). Note that the relative cost of fabricating the materials is not included here, but in the factors below.

b) Workability - A general index of relative workability, with titanium alloys rated lowest (most difficult to work), and aluminum alloys highest (best, easiest to work).

c) Machining Characteristics - A general index of relative machining difficulty, with specialty steels rated lowest and aluminum alloys highest.

d) Finishing Characteristics - An index permitting recognition of special finishing requirements for certain materials (example: lower rating for aluminum alloys requiring anodizing).

e) Product Factor - An index of the relative ease of production of the respective product from (sheet, plate, forging, extrusion) into the specific component. Example: Sheet and plate are good fits for a wingskin application; (product factor = 10) but producing a wingspar from plate requires complex machining and results in complex exposed grain configurations requiring consideration of stress corrosion cracking, and this rates very low in product factor (0).

The final version of the Fabricability Factors utilized for the Prototype IKSMAT system is shown in Appendix B. This approach has the advantage that it is quite easy to add or delete factors, and easy to revise values for individual components of the overall factor. It may not be as "precise" as might be desired, but this is compatible with the lower weighting given such factors in material selection.

5.1.4 A determination was made on how to handle design-related search criteria that are combinations of two or more properties, such as critical crack size factor (KIc/Fty)**0.5. Such values may be calculated "on the fly" during the search or may be "posted" (i.e., already present on the search file for all possible combinations. Some such combinations were determined to be best posted rather than calculated to improve the speed ard efficiency of the search.

5.1.5 An algorithm was developed to allow the knowledge base to contain user-specified criteria in addition to the standard criteria. A user may choose to use their own criteria in addition to, or in place of, the standard criteria. The user requirements are included in Appendix A.

5.1.6 Some elements of the knowledge base were incorporated into the user interface so that there is a single source for a set of information when possible. For example, the same list of components which are searchable by IKSMAT (wingspar, upper wingskin, etc.) is used in the knowledge base and in the list of components presented to the user.

5.2 IKSMAT System Design

5.2.1 The initial functional decomposition of the IKSMAT system was completed (identifying the major modules of the program and how they interact, including the data, parameters, and commands that are passed between modules). Data flow and control diagrams were created to illustrate the actions in the programs in response to user input. A working document covering the IKSMAT knowledge base management system design, Version 1, is included in Appendix D.

5.2.2 The program was designed to parse data received as the result of a search. This permits the individual property values for a material to be used as input to the logic evaluation program.

5.2.3 Components of the system were developed on Sun 386i workstations and then installed on the IKSMAT computer, which has the following specifications:

Zenith ZW-248-40 Advance System
& FTM Monitor Bundle
Epson Dot Matrix Near Letter Quality Printer
(24 Pin)
2400 Baud Modem (Hayes)
Mouse
External Tape Drive

Software packages installed included:

Microsoft Windows
Crosstalk

5.3 Programming

5.3.1 Programming was completed for two-way communication between the IKSMAT PC application and the MPDN mainframe online search job. The system is able to send multiple line messages between those two processes and use the "pass-through" feature of IKSMAT to conduct user defined searches and display of results.

5.3.2 Programming was completed for the scrolling of IKSMAT Master Database information being displayed at the PC. This will allow the user to easily view search results when the information to be displayed is wider than the terminal screen.

5.3.3 An efficient means was implemented to store the text that makes up the screens and help messages of the IKSMAT PC application. Messages are loaded into memory only when they are needed and deleted after they are output. The application was organized to optimize the way that the program changes from one screen to the next and hence make it easier to add new screens.

5.3.4 A prototype program was written to generate search queries from the design-related search criteria. The search criteria were implemented as a spread-sheet like datafile; the search queries are generated by combining the criteria for a component together. The query generated includes all standard and user specified criteria. It allows for missing and alternate criteria.

5.3.5 A prototype program was written to perform logic evaluation for an IKSMAT search. Candidate materials from the Master IKSMAT Database (those that passed the search query) are first combined with materials in the local database. The materials are then evaluated to make sure they satisfy all nonposted criteria. Items from the local database are also checked to make sure they pass the search query. Materials that pass logic evaluation will become input for the ranking logic.

5.3.6 A "local database management system," i.e., present in the local application, was programmed to carry out all functions at the local materials database (Display, Update, Add and Delete).

5.3.7 A HELP function was created that describes the options available to the user on each IKSMAT screen.

5.4 Electronic Data Acquisition

5.4.1 Originally, arrangements were made to obtain a complete electronic version of the tables and figures from MIL-HDBK-5 being generated on a NIST project, as major input to IKSMAT Master Database. This was being carried out by Sci-Tech Knowledge Systems (Jack Westbrook and Walter Grattidge), employing unique new table/graphics capture technology. This technology was used in producing a preliminary version of the MIL-HDBK-5E tables online on STN International, but the input did not prove efficient and timely enough to be used for the entire Master IKSMAT Database, and so after long delays in an attempt to accommodate the Sci-Tech schedule, that approach was abandoned.

5.4.2 PDA Engineering also produces an electronic version of MIL-HDBK-5, and has its content verified by Battelle-Columbus. A suitable working arrangement was made to incorporate that version into IKSMAT. This version, too, proved to be incomplete, and additional delays were caused before a working prototype could be supported with reliable electronic material from MIL-HDBK-5F. Establishment of all of the complex links among the various displays in MIL-HDBK-5E in electronic format proved to be much more difficult that anticipated, and contributed to delays in getting the fully digitized material.

5.4.3 One major decision resulting from the problems and delays was to develop two versions of the Master Database. Version 1 was made available online late in 1990, including all of the tables from MIL-HDBK-5E; development of the planned publically available version of MIL-HDBK-5F online will not be complete when this project is completed, as originally planned. It is now expected that it will take approximately one (1) year longer to complete, and this is planned to be done with public funds.

5.5 File Design and Loading

5.5.1 As noted above, because of the lateness of the Sci-Tech data records, a decision was made to develop the IKSMAT Master Database in two segments, and this decision was implemented. Version 1 was the complete design tables from Chapters 2 though 7 of MIL-HDBK-5E, and will reflect the initial release of the design tables for user testing in the Fourth Quarter of 1990. Version 2 was to include the most up-to-date MIL-HDBK-5F database available from PDA Engineering at the time of completion of the contract.

5.5.2 A problem in the design and implementation of the file was how to evaluate the temperature-dependent properties at a user-specified design temperature. This was solved by using the ORACLE database management system to load and search the file. Values for temperature-dependent properties are determined by interpolating point pairs captured from the appropriate figure.

5.5 3 The key elements of the substantial task to create a suitable electronic version version of the Master IKSMAT Database file from the PDA Engineering input data that will permit proper search and retrieval of the individual elements of data from the tables and figures, while maintaining the appropriate limiting conditions and supporting data, included the following:

a. assemble and sort workunits

b. manipulate data and assign data elements into a format suitable for input using ORACLE.

c. create display field definition table

d. create search field definition table

e. anticipate and respond to problems of "field available/data not available" searching

Other peripheral capabilities programmed include:

f. units conversion at display time

g. enhanced table display

h. query related display

i. range searching

5.5.4 The complete file design for the Master IKSMAT Database is included in Appendix E.

5.6 Prototype IKSMAT Testing and Evaluation

5.6.1 The fully assembled IKSMAT system was tested and evaluated for conformance with user requirements and specifications. The advantages and limitations of the prototype system were noted, and where appropriate recommendations for improvements were noted.

5.6.2 A User Manual was developed for IKSMAT and is available as a separate volume.

6.0 EVALUATION OF THE PROTOTYPE IKSMAT SYSTEM

6.1 A complete IKSMAT prototype was built and evaluated before delivery to the US Air Force Materials Laboratory. The strengths and weaknesses or limitations of the system are described in the next two paragraphs.

6.2 Capabilities/advantages

6.2.1 IKSMAT performs according to specifications in identifying the correct design criteria from the Master IKSMAT Database and the local database, locating the available data to respond to the search criteria, screening the appropriate materials and presenting the top five candidates (or less if five do not meet the design requirements).

6.2.2 In situations where a complete cross-section of the data required to be responsive to the design criteria are available for all or most materials in the MPD Network version of MIL-HDBK-5, IKSMAT provides reliable recommendations for the top candidate materials for specific applications.

6.2.3 The IKSMAT interface readily allows searchers to adapt the design-based search criteria in either priority or technical content, and if the appropriate data are available, to conduct a useful search.

6.2.4 IKSMAT permits "free" searches, allowing searchers to develop their own search queries, and locate materials and/or properties responsive to those queries.

6.3 Disadvantages/Limitations

6.3.1 If materials data responsive to the design-based search criteria are not in the Master or local IKSMAT databases, the system does not do well in dealing with missing data, especially when two or more data needs are missing. The judgement process involved in such cases is among the most difficult to program.

6.3.2 Because of the inconsistency of design-related data in MIL-HDBK-5 and related databases such as ASMH, there are relatively few materials for which the rather sophisticated searches required by IKSMAT can be successfully answered; the result is frequent unsuccessful searches. This is a serious problem most often with the types of data needed for damage-tolerant design, e.g., plane-strain fracture toughness and fatigue crack propagation rates.

6.3.3 An added limitation is the frequent lack of up-to-date information from MIL-HDBK-5 in the electronic version of that database. This is because the master MIL-HDBK-5 data is maintained in hardcopy form and must be converted to digitized form before it can be available in the electronic version.

6.3.4 Response times for searches of the master database are relatively long because of the large numbers of candidate materials selected from the Master IKSMAT Database for screening. Hundreds of first level candidates may be involved, requiring up to 15 or 20 minutes to upload to the local software for analysis. Once the first level candidates are available, the remaining screening process is quite rapid (a few seconds). This is an area for further development; further restriction of the search parameters was tried without much success.

6.4 These observations make it clear that a significant amount of additional effort is needed if the IKSMAT system is to be an effective aide to the identification of strong candidate materials for critical aerospace components. Specifically, the following areas would need attention:

6.4.1. More flexibility is needed in users' ability to modify the search conditions, notably for service temperature.

6.4.2. A greater capability for calculating answers "on the fly" is needed to optimize the value of IKSMAT. The limitation to largely posted (i.e., precalculated) ratios of properties is a major limitation.

6.4.3. The desire to ensure that no possible answers are missed led to making the search queries very broad. A search may result in many candidate materials, which can result in a significant amount of time to upload to the IKSMAT system.

6.4.4 An alternative is needed for the massive transmission of data for analysis by the IKSMAT system across telecommunication lines such as from the MPD Network host to the local IKSMAT computer. It appears more reasonable to have the "Master IKSMAT Database" local to the IKSMAT system, and use the connection to the MPD Network host only for occasional updates of the Master IKSMAT Database.

6.5 The observations about the performance of the IKSMAT prototype also have implications to the means of maintaining and updating MIL-HDBK-5.

6.5.1. One major limitation of the IKSMAT system is the limited availability of data responsive to many of the criteria related to fatigue and fracture toughness. Reliable data for these properties are available for only a few alloys in the context of the whole alloy spectrum, and that limits the completeness and, hence, the value of the analysis. The MIL-HDBK-5 Coordination Committee would provide a major service to its Aerospace Industry associates if it would insist on more complete and consistent data for all potential aircraft materials, especially in the areas related to damage-tolerant design.

6.5.2 Another major limitation related to MIL-HDBK-5 is the very long time and effort required to obtain electronic updates of the data. This could be completely eliminated by the maintenance of MIL-HDBK-5 as an electronic database (as contrasted to being published from machine-readable information). The MIL-HDBK-5 Coordination Committee would also assist its own Aerospace Industry sponsors by providing instant electronic updates followed by the traditional hardcopy.

7.0 FUTURE PROGRAM FOR IKSMAT

The concept of having a local IKSMAT software package deal on a continuous basis with an external Master Database that must be queried vis telecommunications on a regular basis has not proven effective. A more efficient system would appear to be to have the IKSMAT software and the Master IKSMAT Database reside on the same host system. It is recommended that if and when future work on an IKSMAT system is undertaken, it be based upon the premise of a local Master Database, one that is capable of accessing and updating its own records from external sources such as MPD Network, but does not require that contact to perform each search.

Further, dealing with the production and incorporation of an up-to-date electronic version of the very complex MIL-HDBK-5 into IKSMAT from hardcopy was an extremely difficult and costly process. This was primarily because the hardcopy version of the handbook contains so many varied presentations and formats and many inconsistencies in format that have grown up over the years of additions. These difference are not so important when MIL_HDBK-5 is used as an occasional reference manual for designers, but for an IKSMAT-style searchable electronic database the variability of MIL-HDBK-5 data presentation is delimiting.

No further work is recommended on the incorporation of MIL-HDBK-5 into an IKSMAT system until the entire master version of MIL-HDBK-5 is an electronic database, and more consistency is achieved in including design data of the types required for damage-tolerant design. Since it appears that considerable time will be required to develop that version of MIL-HDBK-5, no Phase III program for IKSMAT for aerospace applications is proposed at this time.

8.0 CONCLUSIONS AND RECOMMENDATIONS

The detailed design and production of a prototype intelligent knowledge system for the selection of materials for critical aerospace components (IKSMAT) has been completed. IKSMAT was shown to be technically and economically feasible in a Phase I SBIR program, and the development of the prototype was based upon the specification defined in that effort.

The IKSMAT system provides multiple-path access to a knowledge base of information vital to the assessment of the suitability of materials for key components, with a software package capable of evaluating and ranking the performance of those materials based upon specific properties and/or design-related parameters such as critical flaw size index. Users of the system are able to search for candidate materials for specific aerospace components (a) utilizing the basic materials and selection processes programmed into the system, (b) adding new properties for the existing materials, (c) adding information for additional materials, and/or (d) altering the criteria and functional priorities used in rating the materials.

The knowledge base for the prototype IKSMAT system was developed to support material selection for seven aerospace components: wingspar, upper wing skin, lower wing skin, pivot/swivel pin, bulkhead, landing gear and fuselage. The Master IKSMAT Database for the prototype was based primarily upon MIL-HDBK-5F.

A fully operational prototype IKSMAT for several key aerospace components was developed and evaluated as part of this program.

Some specific conclusions and recommendations follow:

1. When a good cross-section of the required data, including fracture mechanics data for damage-tolerant design, are present in the IKSMAT Master Database or in the associated local databases, the IKSMAT system performs according to specification. The top five candidates for specific aircraft components are correctly reported. When two or more pieces of data are not present, which occurs often, or when massive amounts of data for many candidate materials must be transferred over telecommunications line, performance is not adequate and the IKSMAT system does not provide useful recommendations.

2. The concept of having a Master IKSMAT Database remote from the IKSMAT knowledgebase and analysis software did not prove practical because of the large quantity of data that must be moved over telecommunications. It is recommended that an future work on an IKSMAT system incorporate a local Master Database, with a capability for updating from external sources, but not involving them in every search.

3. Dealing with the production and incorporation of and electronic version of the very complex MIL-HDBK-5 into IKSMAT was an extremely difficult and expensive process. This was primarily because the hardcopy version of the handbook contains so many varied presentations and formats, and contains many inconsistencies in format that have grown up over the years of additions. Since IKSMAT is solidly dependent upon a electronic master version of MIL-HDBK-5, capable of handling at least bi-annual updates in a timely manner, no Phase III program for IKSMAT is proposed at this time.

4. There are opportunities for application of the basic IKSMAT software to other fields, such as pressure vessels and ship structures. These will be explored independent of the current contract program.

5. Experience in this program clearly leads to the recommendation that MIL-HDBK-5 be converted to an electronic master database that can be quickly and efficiently updated. Further, it is recommended that a standard format be developed for damage-tolerant data in MIL-HDBK-5 as well as for the design strengths, and that the MIL-HDBK-5 Coordination Committee encourage the compilation of data for all materials used in critical aerospace components in that format as soon as possible.

9.0 LIST OF REFERENCES

1. Harris M. Burte and Clayton L. Harmsworth, "Data Base R&D for Unified Life Cycle Engineering," Computerization and Networking of Materials Data Bases, Glazman and Rumble, Editors, ASTM Special Technical Publication 1017, April, 1989, pp 197-199.

2. "Military Standardization Handbook: Metallic Materials and Elements for Aerospace Vehicle Structures," MIL-HDBK-5E, Department of Defense, May 1, 1986.

3. R. Renard, "Computerized Materials Data - The SDI View," Proceedings of the Workshop Proceedings of the Workshop "Computerized Aerospace Materials Data," J. H. Westbrook and L. R. McCreight, Editors, AIAA, New York, January, 1987.

4. "An Intelligent Knowledge System for Selection of Materials For Critical Aerospace Applications (IKSMAT)," Final Technical Report, USAF Contract F33615-87-C-5305, J. G. Kaufman, MPD, Inc.; Columbus, Ohio, March 31, 1988.

5. Ernest Ambler, Engineering Property Data-A National Priority," ASTM Standardization News, August, 1985, pp 46-50.

6. J. G. Kaufman, "The National Materials Property Data Network, Inc.- The Technical Challenges and the Status," MPD-Vol 1, Material Property Data: Applications and Access, ASME, New York, 1986, pp 159-166.

7. J. H. Westbrook, "Some Considerations in the Design of Properties Files for a Computerized Materials Information System," Proceedings of the International CODATA Conference, Jerusalem, 1984.

8. J. G. Kaufman, "Standardization for Materials Property Databases and Networking," ASTM Standardization News, February, 1986, pp 28-33.

9. "The Aerospace Structural Materials Handbook," Battelle Memorial Institute for the Department of Defense.

10. Personal visits and telephone conferences of J. G. Kaufman with General Dynamics/Fort Worth materials specialists and designers.

11. R. V. Turley, "USAF C-17 Material Selection," McDonnell-Douglas, Long Beach CA., Presentation to MIL-HDBK-5 Coordination Meeting, October 17, 1987.

12. "Prototype Advanced Materials Data Base User's Guide" Report No PDA-TR-5167-10-01, PDA Engineering, Costa Mesa, CA, September, 1987

13. MIL-STD-1587 (USAF), Materials and Processes Requirements for Air Force Systems, Department of Defense.

14. MIL-STD-1568 (USAF), Materials and Processes for Corrosion Prevention and Control in Aerospace Systems, Department of Defense.

15. MIL-A-008860A, Structural Reduction Factors for Castings, Department of Defense.

INTELLIGENT KNOWLEDGE SYSTEM

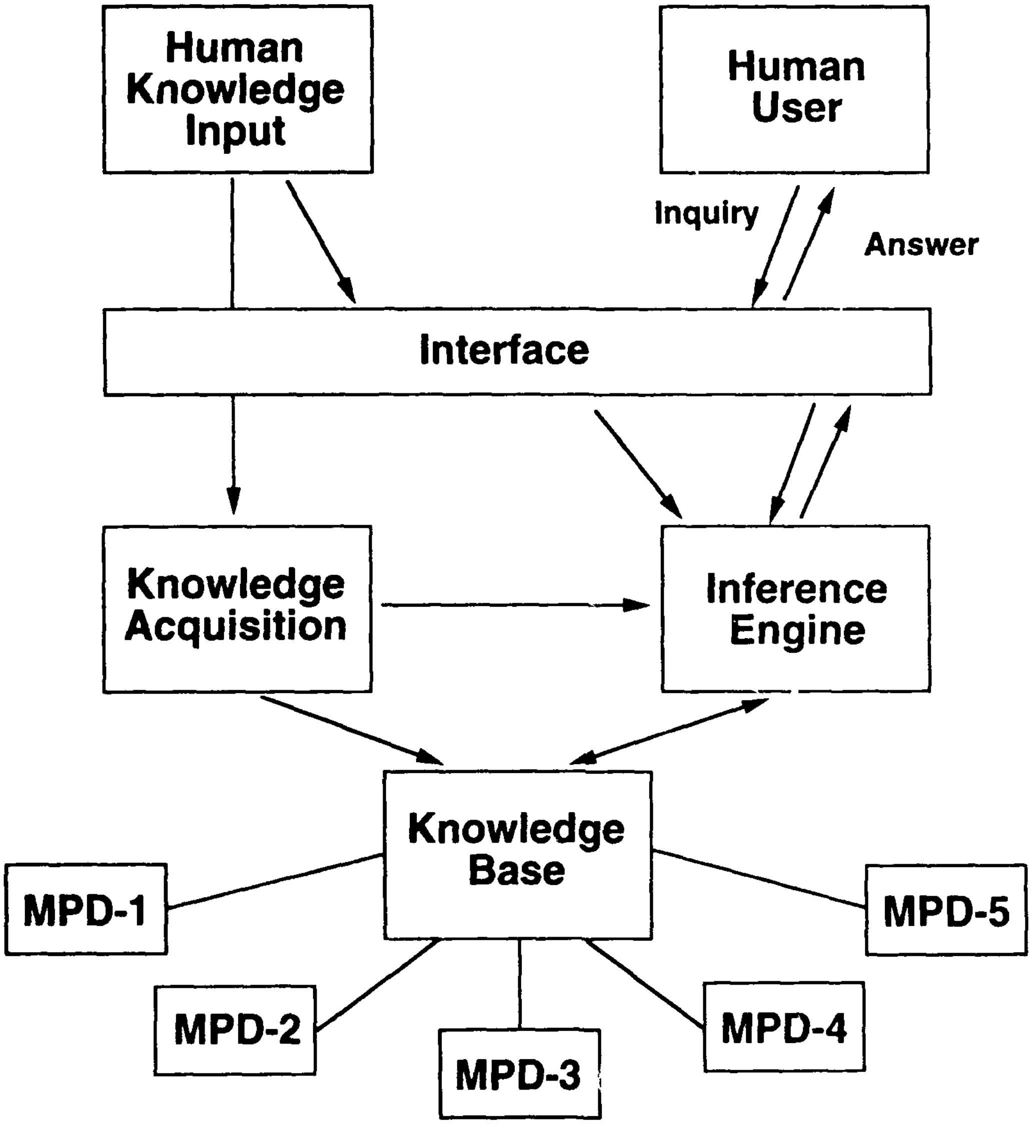
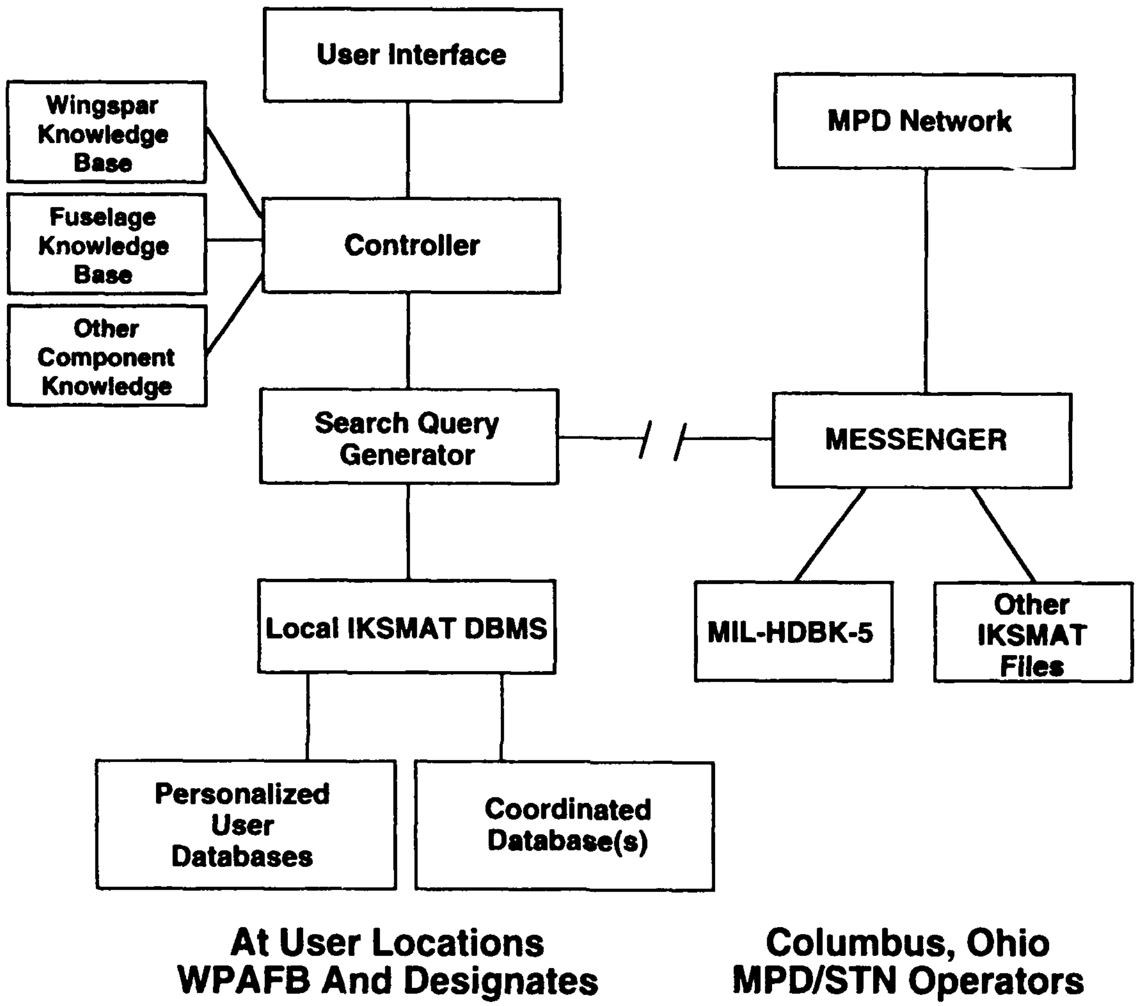


Figure 1
Sc!ematic of Intelligent Knowledge System

Figure 1



IKSMAT FUNCTIONAL SCHEMATIC

Figure 2

APPENDIX A

PRELIMINARY USER REQUIREMENTS FOR IKSMAT

JANUARY 15, 1990

IKSMAT PHASE II- AN INTELLIGENT KNOWLEDGE SYSTEM FOR SELECTION OF MATERIALS FOR CRITICAL AEROSPACE APPLICATIONS

User Requirements

PREPARED BY: Materials Property Databases, Inc.
DRAFT DATE : January 20, 1990

INTRODUCTION

This document delineates the user requirements for a prototype intelligent knowledge system for the selection of materials for critical aerospace components (IKSMAT). This is the second phase of a three phase program being conducted by MPD, Inc. (MPD, Inc. is a wholly owned subsidiary of the MPD Network.) MPD, Inc. determined the feasibility and developed a conceptual model of the IKSMAT system in Phase I of this program. The second phase builds upon the conceptual model to provide a working prototype. This prototype will be developed in a joint effort by MPD, Inc., MPD Network, and CAS. It is a thirty month project with work commencing July 15, 1989.

BACKGROUND

The IKSMAT system is a knowledge based software package used to assess the suitability of materials for key aircraft components. The system uses commercially available personal computer software to control sequencing of information, to provide database management and to allow communications to the MPD Network files on STN International. In addition, custom software is used to evaluate and rank the performance of those materials based upon specific properties and/or design-related parameters such a critical crack size index. Users of the system apply the basic materials and selection processes programmed into the knowledge base, add new properties for the existing materials, add information for additional materials, and/or alter the criteria and priorities used in rating the materials.

To maximize the ease of use of the system for occasional users, a very logical and easily understood series of windows is incorporated into the personal computer software. Further, users can directly access the MPD Network and STN International through this personal computer package. A prototype of the Windows interaction developed in a Microsoft Windows environment demonstrates this interaction and is considered a part of these User Requirements.

Phase II encompasses building and demonstrating the complete prototype system defined in Phase I, plus the expansion of the conceptual model to cover a variety of aircraft components. Work also includes the file design and building of a "master database" containing the major numeric materials property information underlying IKSMAT, consisting primarily of MIL-HDBK-5 and related publications (herein called the Master File).

USER REQUIREMENTS

1. MAJOR FUNCTIONS

1.1 CAPABILITIES OF SYSTEM

The IKSMAT system will provide the following capabilities:

a. The user works within existing database and predefined material selection/design criteria and logic to identify optimum candidate materials for specific application;

b. The user changes priorities associated with existing criteria for material selection, and performs new analyses to determine the effect of the changes on the preferred candidate materials;

c. The user adds new materials to a database local to the pc, and then performs analyses based upon preset material selection/design criteria and logic to select optimum candidate materials;

d. The user adds new properties for materials in a database local to the pc, and then performs analyses based upon existing or new criteria involving those new properties to identify candidate materials;

e. The user selects new criteria (from a predefined list of criteria) and defines their priorities, and then carries out analyses to determine candidate materials; or

f. User conducts general searches that do not use the knowledge base capabilities to access data in any of the MPD Network files. The MPD Network menu interface will be used.

1.2 FEATURES/ASSUMPTIONS OF SYSTEM

The IKSMAT system will be designed to provide the following objectives:

a. Extreme ease of understanding for the occasional user who is not an information professional trained in the language and command structure of traditional online search systems like Messenger,

b. Great flexibility with regard to the use of materials nomenclature and property terminology, permitting the user to use any technically correct names or terms (aliases) and still be able to locate the desired information; in addition, the user should have the ability to easily query the system about the meanings of the terms or abbreviations encountered in the process of searching, and

c. Easy access to many other sources of materials property data, beyond those upon which the programmed materials selection process is based, so that newly generated, corroborative or contrasting data may be located, retrieved and analyzed quickly and efficiently.

Several features should be available to users of the IKSMAT system:

a. Windows features such as caption bar, fonts, dialog box

b. Error messages appear as window overlaid on current client area

c. alternate input- use of mouse

d. capture transcript

e. scrolling regions

f. scroll bar

g. status bar indicating if online or not

h. Options menu (set color, password, access method)

i. Help messages appear as window overlaid on current client area

j. headers on displays-- Tabular displays must be able to repeat the column headers when the screen is cleared, so that each full screen includes labels for each column.

k. The application will contain a parameter file for the user which contains information such as the MPDN/STN loginid and password, the name of their local database and any other "customized" features in IKSMAT. This will allow a user to access IKSMAT several times without having to reenter this information each time.

l. automatic log on and log off at appropriate times so that users does not waste a lot of online time viewing data during an online session, but allowing sufficient system speed

m. single access method to STN- This can either be direct dial or via Telenet.

n. Pass through mode to allow general searches in MPD Network files

o. downloading - using Messenger download command and KERMIT

p. Print Report at Local PC using a special report format

While graphics capability is not required for the Phase II implementation, the systems should be designed so that it can be easily added in at some future date.

Another basic assumption, necessary for memory management, is that the IKSMAT application is the only application utilizing the resources of the personal computer where the application is running.

1.3 SYSTEM RESPONSE TIME

The crucial measurement of response time is the time from when the user hits the carriage return to initiate a selection of materials until the first character of the results appears. The response time will depend upon the nature of the request and the size of the answer set resulting from the query. In view of this, satisfactory response time shall be defined as follows: for a request which processes 50 answers or less, 75% of the resulting displays should appear within 30 seconds, with 90% initiating within 60 seconds.

1.4 MAJOR SYSTEM COMPONENTS

To meet the functionality requirements, the system will consist of two major components: a personal computer based component and the Master file. These components are shown schematically in Figure 2 of the main report.

2. PC BASED COMPONENT

2.1 OVERVIEW

The personal computer component will be designed to work on a Zenith Z-248 Advanced System & FTM Monitor Bundle with a 2400 Baud Modem, Mouse, and Epson Lq-510 Printer. It will operate in a Microsoft Windows environment and use Microsoft Excel as the local database manager and Crosstalk for Windows as the communications interface.

The personal computer will reside at the Wright Patterson Air Force Base.

2.2 COMMAND GENERATION

The personal computer software will interpret users inquiries into Messenger commands. Multiple commands may be saved as appropriate and issued together to the Master file. Equivalent commands will also be generated for use with the local databases created in Microsoft Excel.

2.3 COMMUNICATION

This portion of the PC component provides the ability to send those commands to Messenger and receive results. Crosstalk for Windows will be used as software to conduct this functionality. The use of this software should be as transparent to the user as practical.

2.4 KNOWLEDGE BASE

The knowledge base is the catalog of design and performance criteria for specific structures and the relative importance of the individual criteria in the performance of those structures. The knowledge base interfaces with the material properties database covering the range of materials and properties of interest. This knowledge base is interfaced with programs permitting users to compile (knowledge acquisition) and utilize (inference engine) knowledge and data to solve problems. The system may be used independently to aid in the tracking and selection of materials for specific applications or interfaced directly with the early stages of the design process to illustrate the utilization of advanced materials on component/vehicle performance.

These criteria may be a property value, a non-numeric data field value, or any combination of property values and/or other data field values. A listing of the design criteria is being developed as a separate document.

Users will have the opportunity to choose the default criteria, select from a predefined set of additional criteria, or to add criteria that are constraints to the ranking algorithm. Combinations of raw data values that have not been predetermined (and hence not loaded in the file) cannot be used as new criteria. New criteria may not be saved from session to session.

2.5 QUERY GENERATION

The query generation portion of the PC component will interpret the knowledge base rules and algorithms into Messenger queries. This portion works together with the command generation portion and the communications portion to provide the full Messenger interaction with the Master file.

2.6 RANKING LOGIC

The ranking logic portion of the PC component uses weighting factors to determine which selected materials are "optimal" for the given application. Ranking logic uses the results of the Messenger interaction to make this determination.

2.7 USER INTERFACE-- WINDOWS

The user interface handles interactions with the user and provides the display screen control.

Microsoft Windows will be used as a basis to provide easy-to-understand access to the system. Windows will give the user the opportunity to select from a list of capabilities and guide the user to a successful result. A listing of functions to be performed by the user interface is shown in Appendix A1.

2.8 LOCAL DATABASE MANAGEMENT

The local database management system must allow the user to add, delete, update and display materials from the local database. It is assumed that a standard set of properties will be used for all materials in the local database.

The local database management system will allow the addition of up to 256 additional materials to be evaluated. When addition additional materials the user will be able to copy data from an existing material to use as a start for a new material.

A single user cannot have more than one local database.

2.9 PASS THROUGH TO MPD NETWORK ON STN

The system will provide direct access to the MPD Network menu interface on STN International. The pass through mode of the program will aid the user in logging on to MPDN/STN and then permit him to use any files and commands that he is entitled to use. No help is given by IKSMAT in formulating queries or executing any commands on MPDN/STN.

2.10 INTEGRATION OF COMPONENTS

The above listed components shall be integrated so that the functionality of the system can perform as desired, with interaction between the components being transparent to the user.

3. MASTER FILE

As part of the IKSMAT project a comprehensive version of the Military Standardization Handbook, MIL-HDBK-5 will be made available on STN. This database will include all footnotes, cautionary provisions, limitations on materials applications, special requirements and the like, all displayed in such a way that the user of the knowledge base will not miss important elements of information which may not be obvious from looking at the numeric data themselves. In addition, some data values will be added to this file from other sources, such as from the Aerospace Structural Materials Handbook (ASMH).

In addition to data values derived directly from MIL-HDBK-5, some data values will need to be calculated. These values will be delineated in the user requirements for the file.

3.1 MINIMUM FILE REQUIRED FOR SEPTEMBER 1990

The following sections of the Master file will be completed by September, 1990.

Design Tables
Elongation Tables
Physical Properties Graphs
Thesaurus

3.2 FULL FILE REQUIRED FOR CONTRACT FULFILLMENT

In addition to data derived from Mil-Handbook-5, some additional data fields will be added to the MIL-HDBK-5 file to be used as part of the IKSMAT system only. These fields will not be shown to general users of the Mil-Handbook-5 database on STN International. These additional data item may include, but is not limited to:

>From specifications:

Key requirements of MIL-STD-1587(USAF)(Ref 13), notably

Materials excluded from use (e.g., 5.1.2.2 of MIL-STD)
Heat treatment requirements, limitations (e.g., 5.1.2.3)
Straightening, forming limitations (e.g., 5.1.2.4)
Thickness, cross-section limitations (Table I of MIL-STD)

Key requirements of MIL-STD-1568(USAF)(Ref 14), notably

Materials excluded from use (e.g., 5.4.3.1.2)
Thickness, cross-section limitations

For castings, load reduction factors in MIL-A-008860A (Ref 15)

>From other sources (e.g., ASMH and publications/papers)

Exfoliation corrosion resistance

Cost, $/lb

Special purchasing requirements (e.g., minimum size orders, limited suppliers, other extras)

Relative processibility

Finishing requirements

Exceptional life cycle costs

For a complete description of the Master file, please refer to the file design.

3.3 INTEGRATION OF FILE WITH MPD NETWORK

The file will be loaded as a standard STN file that is fully accessible to users via any of the following methods: STN Messenger command language, MPD Network menu interface, and the IKSMAT system. The file will be reloaded when new versions of Mil-Handbook-5 are released, since the majority of the data in the file is from Mil-Handbook-5.

APPENDIX A1

USER INTERFACE FUNCTIONALITY

APPENDIX A1
USER INTERFACE FUNCTIONALITY

GENERAL FUNCTIONS

Several commands may be used at almost any point within IKSMAT. These are referred to as basic commands. The user may execute these commands from anywhere in the Windows environment with only limited exceptions. These exceptions will be clearly identified to the user. These Basic Commands are described below:

Help (?)

At any point, the user shall have the option to request help messages specific to the current location in the system. The help messages will describe the options available to the user at the current display. This includes listing all of the available basic commands. For instance, if the user types '?' at the Menu Option Window, the help message will contain one to two line descriptions of each menu option and the basic commands. These messages are designed to assist the user in navigating through the system.

Definitions (? TERM)

At any point, the user may request the meaning of a name, term, or abbreviation with the command '? TERM, where 'TERM' is the name, term or abbreviation being questioned. For example, '? ELONGATION' would display information about the term elongation.

In response to such a query about a material name, property term or variable term or any abbreviation, the user will receive a display showing:

standard name/term
definition of material/property/variable
type of name/term
appropriate broader name/term
acceptable aliases (synonyms/"used for"s)
narrower terms (if appropriate)
standard units (if appropriate)
notes (including specs and test standards)

This data will come from the MPD Network Thesaurus. The display format of the data is defined by the MPD Network Thesaurus file design.

Main Menu (M)

The user shall be able to return to the Main Menu at any prompt in the interface with the command 'M'. This command is useful for a user who is unsure of where s/he is in the interface and would like to "start over". If the user is in the middle of setting up a search when s/he choose to execute the this command, the current search criteria will be lost and the user will be required to rebuild the search.

Previous Window (P)

The user shall be able to return to the previous screen at any prompt in the interface with the by clicking on an appropriate icon. A user may want to go to a previous screen to verify an earlier decision and then return to the current screen.

SPECIFIC SCREEN FUNCTIONS

The following are the specific screen functions for IKSMAT:

1. Work within existing database (materials and properties)

    11. Use standard criteria, priorities to determine the optimum materials for an application

    12. Change priorities of standard criteria to determine the optimum materials for an application

2. Add new materials to database

    21. Specify standard property values

    22. Add new properties and specify values

    23. Change priorities of standard criteria

    24. Add new properties, criteria

3. Add new properties to database for existing materials

    31. Specify standard property values

    32. Add new properties and specify values

    33. Add new criteria, priorities

4. Add new criteria

    41. Work with existing materials

    42. Add new materials to database

5. Conduct general search

6. Options Menu

DISPLAY OF RESULTS

When the evaluation of search results has completed, information about the top candidate materials will automatically be displayed to the user. This display will have these characteristics:

a. The top five candidate materials will be displayed in order from top to bottom of the display, with the best material being at the top.

b. If fewer than five materials were found then those materials meeting the criteria will be displayed, followed by a message "No other materials met the specified criteria".

c. If no materials were found which met the criteria then the display screen will contain only the message "No materials met the specified criteria".

d. There will be a standard default display format for each component which IKSMAT can be used to search for. This format will contain the properties and criteria which are important for that component. At a minimum, it will contain all of the default standard criteria for that component.

e. If a user has specified any additional criteria to be used in material evaluation for a component, they will be displayed in addition to the standard default display format.

f. The user will not be able to request which formats are displayed or the units that are used.

g. The first column in the display will be the material name as specified in the database where the material originated. This column will have a format similar to that described below for the display format. The heading for this column will be "Mat'l".

h. The second column will contain the source of the material. The heading for this column will be "Source". Values in this column will be "MIL-5", "local", or "ASMH".

   (Alternatively, this information could be identified by color coding on the screen. For instance, data from a local database could be highlighted in a different color.)

i. The remaining columns of the display will be the display formats for criteria and properties. Each display format will be output as a column consisting of:

   - the descriptor for the property or criteria (centered over the column)

   - units for the property or criteria (centered). If there are no meaningful units for the column then that will be indicated by a "-". If the materials being displayed have come from more than one source (e.g. MIL-5 and local database) and there is a conflict between units used for a field then the MIL-5 untis will be used.

   - a line of dashes of an appropriate length for the column

   the display value (aligned on decimal point). If a property or criteria is not defined for a material then that will be indicated by a "-". All display values will be converted to the standard unit (if necessary) and will be output in a standard numeric format for that property or criteria (precision, use of scientific notation, etc.)

- if the item is a criteria used for evaluating the material then the display value will be followed immediately (no separating character) by its rank enclosed within parenthesis. The rank indicates how this material compares for that criteria among all materials that passed the original search. In case of ties between more than one material, each will be given the same rank, with the next best material given a rank incremented by the number of tied materials.

j. Whenever possible, all display data will be output on one screen. If this is not possible, the additional criteria and display columns will be accessible via a scrolled region to the right of the current screen.

APPENDIX B

FABRICABILITY FACTOR

FABRICABILITY FACTOR (CUMULATIVE POINTS)

	TOTAL	COST	WORKABILITY	MACHINABILITY	FINISHING	PRODUCT
ALUMINUM						
Sheet/Wingskins	45	10	10	10	5	10
Plate/Wingskins	45	10	10	10	5	10
Sheet/All Others	38	10	10	10	8	0
Forging/All	48	10	10	10	8	10
Extrusions/All	40	10	10	10	5	5
STEEL						
Sheet/Wingskins	40	8	8	7	7	10
Plate/Wingskins	39	8	7	7	7	10
Plate/All Others	25	8	5	5	7	0
Forging/All	38	8	5	8	7	10
Extrusions/All	31	8	4	7	7	5
TITANIUM						
Sheet/Wingskins	28	0	5	5	8	10
Plate/Wingskins	28	0	5	5	8	10
Plate/All Others	18	0	5	5	8	0
Forging/All	28	0	5	5	8	10
Extrusions/All	22	0	4	5	8	5
HIGH TEMP METALS						
Sheet/Wingskins	35	4	7	6	8	10
Plate/Wingskins	35	4	7	6	8	10
Plate/All Others	24	4	6	6	8	0
Forging/All	34	4	6	6	8	10
Extrusions/All	27	4	4	6	8	5

NOTE: See paragraph 5.1.3 of the main report for the background and development of the Fabricability Factors.

APPENDIX C

SEARCH CRITERIA FOR IKSMAT

JULY 30, 1990

APPENDIX C

BASED UPON DESIGN CRITERIA FOR AEROSPACE COMPONENTS

July 30, 1990

Weight
From 1.00 - 0

Upper Wingskin (Sheet or thin plate)

1. Corrosion (exfoliation, gauged by relative stress corrosion resistance, LT direction) Fsccth.LT/Fty.LT=> 0.75 — 1.00

   where:
   Fsccth.LT= LT threshold stress for stress-corrosion cracking e.g., from Table 3.2.1.3.1(a); ksi
   Fty.LT= LT tensile yield strength; ksi

   or by corrosion rating A-best; D-worst

2. Compressive buckling/stiffness at temp Fcy.LT*%RTcy/Ec*%RTEc — 0.60

   where: Fcy.LT*%RTcy= LT compressive yield strength at at designated temperature
   Fcy.LT= LT compressive yield strength at room temperature; ksi
   %RTcy= percent of room temperature Fcy at designated temperature
   Ec*%RTEc= compressive modulus at designated temperature
   Ec= compressive modulus of elasticity at room temp; 10e3ksi
   %RTEc= percent of room temperature Ec at designated temperature

   Default temperature = 300degF

3. Fracture toughness, critical crack size index — 0.15

   If data available, (Kapp/Fty.LT)e2

   where: Kapp= apparent critical stress intensity factor from residual strength tests, e.g., Fig. 3.7.4.1.10(f)
   Fty.LT= LT tensile yield strength

   For wingskins, if Kapp not available, and all other components (KIc.LT/Fty.LT)e2
   where: KIc.LT= LT plane-strain fracture toughness; ksi*ine0.5

4. Fatigue expressed as either: 0.20

Fatigue crack growth rate, da/dN, at a stress-intensity range, dK of 10 ksi*ine0.5; in/cycle

where: da= increment in crack length, in., per
dN= increment in number of cycles

Or, if da/dN not available, axial-stress fatigue strength at at 10e6 cycles (EL.A0.0), measured with notched specimens having notch sharpness at Kt=5; ksi
where Kt= Neuber coefficient

5. Bearing ultimate strength, Fbru (ksi) at temperature 0.05

Fbru**RTFbru; ksi

where: Fbru= bearing ultimate strength; ksi
%RTFbru= percent of room temperature bearing ultimate strength

6. Bearing yield strength, Fbry (ksi) at temperature 0.05

Fbry*%RTFbry

where: Fbry= bearing yield strength; ksi
%RTFbry= percent of room temperature bearing yield strength

7. Weight (density); lb/ine3 0.05

8. Manufacturing considerations 0.05

Numeric rating from 1 (best, combining low cost and standard fabricating practices) to 10 (representing worst combination of high cost and difficult, non-standard fabricating practices)

Factors included:
- cost (original material; $/lb)
- forming difficulties?
- machining difficulties?
- finishing characteristics
- product fit to part

<u>Lower wingskins</u> (Sheet or thin plate)

1. Corrosion (see upper wingskin) 1.00

2. Fracture toughness (see upper wingskin) 0.375

3. Fatigue, da/dN, dK=10 ksi*ine0.5 (see upper wingskin) 0.375
   or axial stress, 10e6 cycles, Kt=5

4. Strength efficiency, Ftu.LT/density 0.15

where: Ftu.LT= LT tensile ultimate strength; ksi

5. Manufacturing considerations (see upper wingskin) 0.10

<u>Fuselage bulkhead, with wing carry-through</u> (Plate or forging)

1. Stress corrosion, (KIsccth.ST/KIc.ST)e2
   or Fsccth.ST/Fty.ST => 0.75 1.00

   where: KIsccth.ST= ST threshold stress intensity factor for stress corrosion cracking; ksi*ine0.5

   KIC.ST= ST plane strain fracture toughness (if not available, use LT value); ksi*ine0.5

   Fsccth.ST= ST threshold stress for stress corrosion cracking; ksi

   Fty.ST= ST tensile yield strength; ksi

2. Fracture toughness, critical crack size index (KIc.LT/Fty.LT)e2 0.375

   where: KIC.LT= LT plane strain fracture toughness; ksi*ine0.5

   Fty.LT= LT tensile yield strength; ksi

3. Fatigue, expressed as either: 0.375

   Fatigue crack growth rate, da/dN, at a stress-intensity range, dK of 10 ksi*ine0.5; in/cycle

   where:
   da= increment in crack length, in., per
   dN= increment in number of cycles

   Or, if da/dN not available: axial-stress fatigue strength at at 10e6 cycles (EL.A0.0), measured with notched specimens having notch sharpness at Kt=3-5; ksi
   where Kt= Neuber coefficient

4. Strength efficiency, Ftu.ST/density (LT if ST not available) 0.15

5. Manufacturing considerations (see upper wingskins) 0.10

<u>Fuselage/skin sheet, with fuel tanks</u> (Sheet or thin plate)

1. Exfoliation corrosion (see upper wingskin) 1.00

2. LT tensile strength at temperature, Ftu.LT*%RTFtu; ksi 0.30

3. LT tensile yield strength at temperature, Fty.LT*%RTFty; ksi 0.30

4. Stiffness: tensile modulus at temperature, E*%RTE; 10e3 ksi 0.15

5.	Fracture toughness: critical crack size index (see upper wingskin)	0.10
6.	Fatigue (see upper wingskin)	0.10
7.	Manufacturing considerations (see upper wingskin)	0.05

Default temperature = 300 degF

Pivot Pin (Forging, extruded shape, or plate)

1.	Stress corrosion (see bulkhead)	1.00
2.	ST tensile strength at temperature,Ftu.ST*%RTFtu; ksi (use 0.8LTFtu.LT if Ftu.ST not available)	0.35
3.	Fatigue (see bulkhead)	0.35
4.	Manufacturing considerations (see upper wingskin)	0.30

Default temperature = 300 degF

Landing Gear (Forging, extruded shape, or plate)

1.	Stress corrosion (see bulkhead)	1.00
2.	LT tensile strength efficiency at temperature, Ftu.LT8%RTFtu/density; in.	0.25
3.	Fatigue (see bulkhead)	0.25
4.	Wear resistance - microin/hr	0.25
5.	Fracture toughness: critical crack size index (see bulkhead)	0.15
6.	Manufacturing considerations (see upper wingskin)	0.10

Default temperature = 300 degF

Wingspar (Forging, extruded shape, or plate)

1.	Stress corrosion (see bulkhead)	1.00
2.	Fracture toughness: critical crack size index (see bulkhead)	0.375
3.	Fatigue (see bulkhead)	0.375
4.	ST tensile ultimate strength efficiency, Ftu.ST/density; in.	0.15
5.	ST tensile yield strength efficiency, Fty.ST/density; in.	0.10
6.	Manufacturing considerations	0.80

APPENDIX D

IKSMAT KNOWLEDGEBASE MANAGEMENT SYSTEM DESIGN

VERSION 3.2

IKSMAT Knowledgebase Management System Design

Version 3.2

February 15, 1993

Kevin P. Cross
Roger B. Long

I. Introduction

The purpose of this document is to present the final state of the IKSMAT knowledge base and associated functionality by examining its design and elucidating the assumptions that the design is based upon. The ramifications of these assumptions will identify the limits of IKSMAT functionality and may be used to review the stated IKSMAT user requirements. The design and implementation of the IKSMAT Knowledgebase Management System is complete and is included as part of the IKSMAT phase II prototype program.

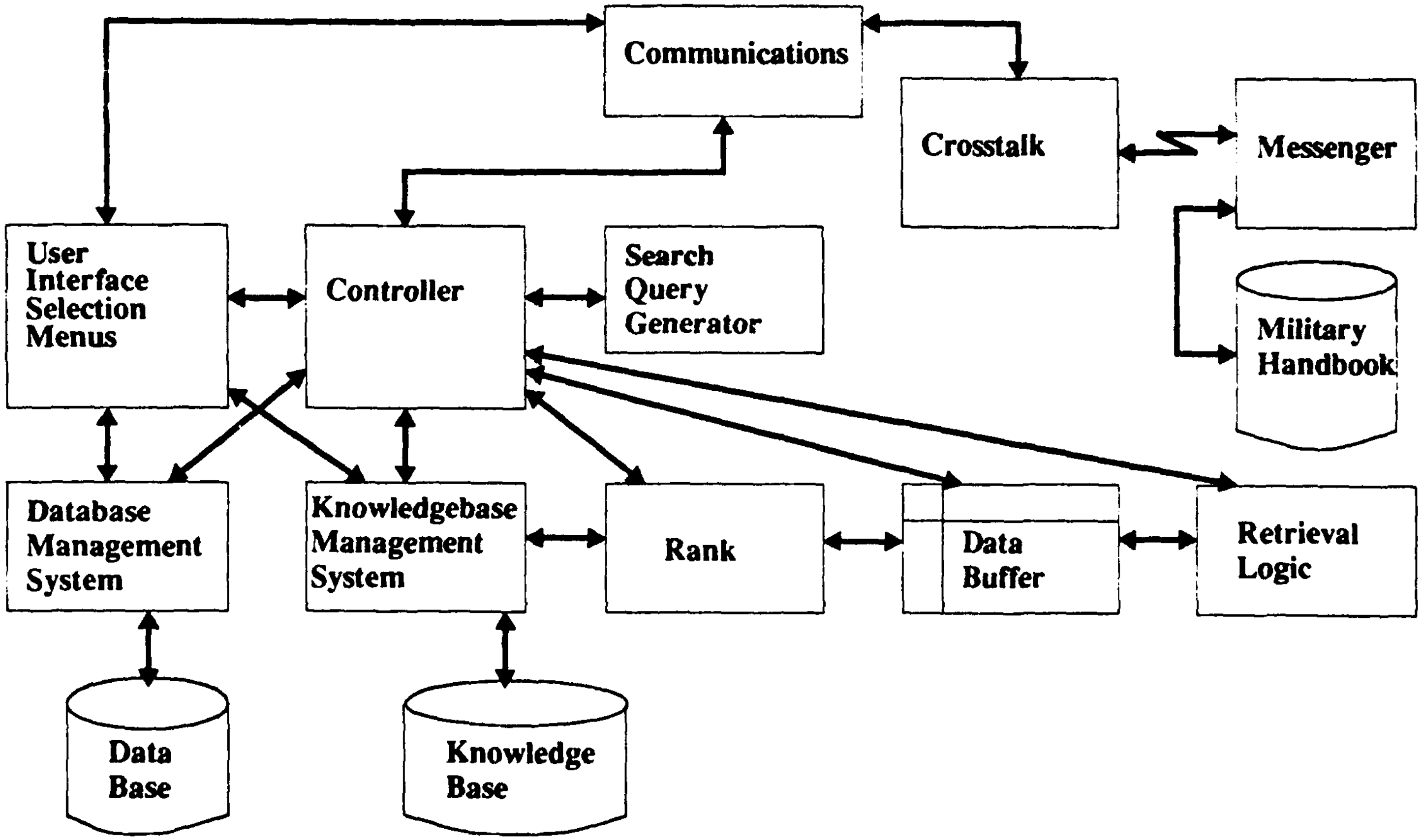
II. IKSMAT Architecture

The architecture of the IKSMAT system is displayed in the IKSMAT Functional Decomposition diagram (see figure 1). This description identifies the major modules of the system according to their functionality. The double-headed arrows indicate that there is two-way communication between the modules.

The user interacts with the User Interface module to control operation of the system. In pass-through mode, the user accesses the Communications module and Crosstalk to communicate directly with remote MESSENGER software and STN files. The user may directly access a Database Management System to add, delete, update, and display material property data stored in the local database. The user may directly access the Knowledge Base Mangement System to add, delete, update, and display material design criteria for aircraft components.

In search-mode, the Controller independently accesses the various modules. Information from the knowledge base is used by the Search Query Generator to create a MESSENGER query for searching the Military Handbook. This query is sent to MESSENGER via the Communications module and Crosstalk. A display query is subsequently sent to retrieve data from MESSENGER. Retrieved materials are stored in a Data Buffer and are combined with materials from the local database, if selected.

The Retrieval Logic post-processes the retrieved data, calculating criteria values as necessary. Materials containing design criteria outside of acceptable boundaries are eliminated from the buffer. Lastly, the Ranker uses criteria priorities and weighting factors defined in the Knowledgebase to rank the remaining materials in the Data Buffer so that the most-acceptable materials appear at the beginning of the list.



IKSMAT Functional Decomposition

Figure 1.

III. Knowledgebase Architecture

Knowledge used in IKSMAT consists of design criteria for the construction of specific aircraft components. Currently these components include: the fuselage bulkhead, fuselage skin, landing gear, lower wingskin, wing pivot pin, upper wingskin, and wingspar. The design criteria were compiled from aerospace design experts at General Dynamics and from materials experts at MPD, Inc.

The primary purpose of design criteria in IKSMAT is to support three functions: 1) generation of queries to search numeric property data and display materials data located in STN files and/or the local database, 2) post-processing query results by removing materials that do not meet design criteria specifications, and 3) ranking the answer set of materials by the relative priorities of the design criteria. Algorithms for each of these functions will be discussed in detail in later sections.

The knowledgebase management system was designed to contain component, criteria, and material property data, and to support the three primary IKSMAT functions. The knowledgebase is implemented in data files which can be accessed and manipulated by the IKSMAT software using spreadsheet like functions. The sheets are highly inter-related with cells in one sheet containing references to rows or columns in other sheets. The relationship between the sheets is part of the algorithm used for query generation, logic evaluation and ranking.

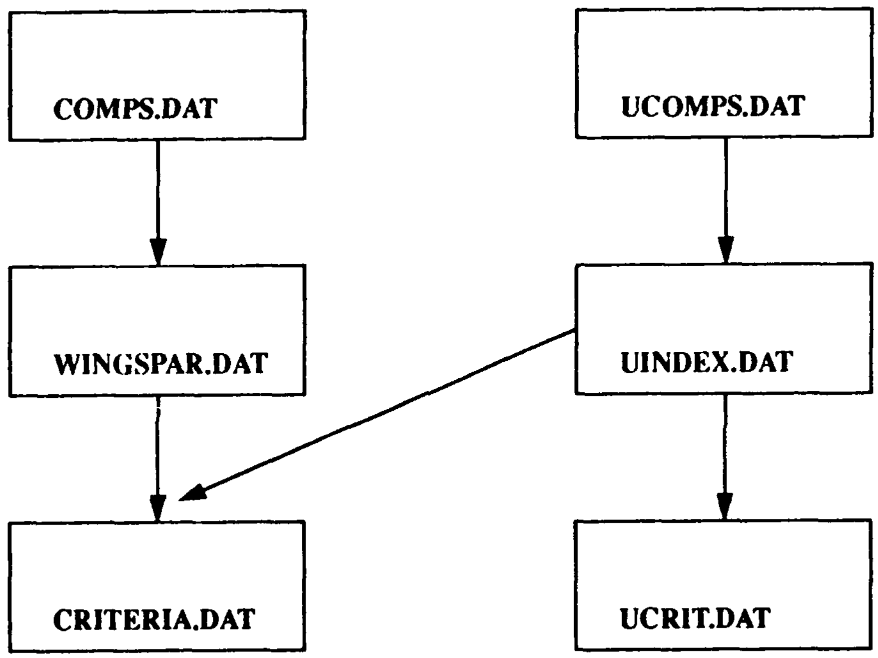
The IKSMAT knowledge base consists of several, separate spreadsheets that are linked together (see figure 2). The component sheet (COMPS.DAT) contains references to a set of design criteria for each component as well as other component design information. Separate sheets were constructed to hold the set of design criteria for each aircraft component. Each sheet describes design criteria for an independent component. New sheets describing design criteria for unrelated components (or for objects other than aircraft) may be easily created and added to the knowledgebase. In this sense each component sheet is an individual component knowledgebase inside the larger IKSMAT knowledgebase. The component knowledgebases for each component are: BULKHEAD.DAT (fuselage bulkhead), FUSELAGE.DAT (fuselage skin), GEAR.DAT (landing gear), LOWER.DAT (lower wingskin), PIN.DAT (pivot pin), UPPER.DAT (upper wingskin), and WINGSPAR.DAT (wingspar) respectively.

Since many of the design criteria for material specifications are identical for different aircraft components, a common sheet of all design criteria was created which is referenced by each component knowledgebase (CRITERIA.DAT). Component knowledgebases are also termed criteria indexes as they reference the Criteria sheet. Criteria may be defined as a single, numeric material property (posted criteria), as a mathematical combination of several material properties (calculated criteria) or as a property which varies by temperature and must be evaluated at the temperature specified by the user (interpolated criteria).

Each sheet will be discussed in detail in later sections. The basic sheet relationships are illustrated in figure 2. The relationships between the various sheets show the dependency of data in one sheet on the data in other sheets.

The right column of figure 2 lists sheets for user-defined knowledge. These relationships parallel those for system knowledge (in the left column). The User sheet determines whether the component currently being designed was defined by the system or the user. User-defined components are identified in the UCOMPS.DAT sheet. The set of design criteria for a user-defined component is defined in the UINDEX.DAT sheet. There may be multiple instance of this sheet. A UINDEX.DAT sheet may reference criteria defined in system (CRITERIA.DAT) or user (UCRIT.DAT) Criteria sheets.

The following sections describe the sheets and IKSMAT functions that constitute the knowledgebases and the knowledgebase management system.



Knowledge Base Architecture

Figure 2.

IV. User Interface Accessibility

The IKSMAT knowledgebase is read by the IKSMAT user interface application as sheets are needed. They are removed from memory when they are no longer needed. For permanent updates, IKSMAT will write the sheet back to disk. Access to the knowledgebase is initiated by the IKSMAT user interface prompting the user for the component to be evaluated, the database source, the design temperature and the minimum criteria weight. This determines which other knowledgebase sheets will be accessed.

The database source value determines which databases that will be searched. A user may choose to search the remote database (IKSMAT master database), the local database, or both. If the database is "REMOTE", a MESSENGER search query will be generated and the results post-processed. If the database is "LOCAL", no MESSENGER search query will be generated and no MIL-HNDBK-5 data will be retrieved. If the database is "BOTH", both the local and STN databases will be searched. The user may choose to evaluate the pre-defined components using standard criteria or select a component or criteria definition which they have defined in the user sheets.

The minimum criteria weight value identifies the minimum criteria weight necessary to generate a search query statement for a criterion. If a criterion has a weight below this value, no search of this criterion will be included in the search query. Instead, this criterion will be added to the display query so that its values may still be used in ranking retrieved materials.

V. Component Design Parameters

The component sheet (COMPS.DAT) contains references to a set of design criteria for each component (see figure 3). The user-defined component sheet (UCOMPS.DAT) has the same format as COMPS.DAT.

The available components containing design criteria are listed in the "Component" field. The "Criteria Reference" field contains the name of the criteria index sheet for a given component. The "Default Design Temp" field contains the default design temperature (Fahrenheit) for each component. Different components may have different design temperatures. The "Lower Thickness" and "Upper Thickness" fields determine the thickness range (in inches) for a component. Different components may have different design thicknesses.

Data in fields for "Preferred Thickness", "Preferred Form", "1st Alternate Form", "2nd Alternate Form", and "Preferred Base" are used to determine which form and thickness of a material is to be displayed when several sets of measurements for the same material (ALLOY/TREATMENT/FORM) are encountered during logic evaluation and ranking. These fields are not included in the material selection criteria. Only one instance of a material will appear in the final display.

COMPS.DAT

	A	B	C	D	E	F
1	**Component**	**Criteria Reference**	***Default Design Temp***	***Preferred Thickness***	**Lower Thickness**	**Upper Thickness**
2	Fuselage Bulkhead	BULKHEAD.DAT	300	1	0.5	6
3	Fuselage Skin	FUSELAGE.DAT	300	0.125	0.025	0.625
4	Landing Gear	GEAR.DAT	300	2	1	4
5	Lower Wingskin	LOWER.DAT	300	0.125	0.05	0.75
6	Pivot Pin	PIN.DAT	300	2	1	4
7	Upper Wingskin	UPPER.DAT	300	0.125	0.05	1
8	Wingspar	WINGSPAR.DAT	300	2	1	4

	G	H	I	J
1	**Preferred Form**	**1st Alternate Form**	**2nd Alternate Form**	**Preferred Alloy Base**
2	forging	plate		
3	sheet	plate		Aluminum
4	forging	plate	extrusion	
5	sheet	plate		Aluminum
6	forging	extrusion	plate	
7	sheet	plate		Aluminum
8	forging	extrusion	plate	

IKSMAT Knowledgebase Components

Figure 3.

VI. Component Knowledgebases

Component knowledgebases (also called criteria indexes) contain the set of design criteria evaluated in IKSMAT (see figures 4a and 4b). The component knowledgebases for each component are: BULKHEAD.DAT (fuselage bulkhead), FUSELAGE.DAT (fuselage skin), GEAR.DAT (landing gear), LOWER.DAT (lower wingskin), PIN.DAT (pivot pin), UPPER.DAT (upper wingskin), and WINGSPAR.DAT (wingspar) respectively.

The first field in each knowledgebase contains the names of the criteria. These cell formulas reference the criteria names in the CRITERIA.DAT sheet. The "Priority" and "Weight" fields contain the relative priority and weight of each criterion relative to the other criteria. The criteria priority is a user-changeable value of the relative importance of a criterion. The criteria weight is an internal value used to determine whether this criterion will be used in the search query as well as the importance of this criterion in ranking. For phase II of the IKSMAT prototype the user is not able to specify the weight value for a criterion. The weight value is determined by the priority of the criterion, with the highest weights being given to the criteria with the highest priority.

The user-defined criteria index sheet (UINDEX.DAT) may be created to contain user definitions of a new component, or a redefinition of the design criteria for an existing component. It has the same format as all other criteria indexes except that it may reference user-defined criteria contained in UCRIT.DAT as well as system-defined criteria contained in CRITERIA.DAT (see figure 2).

BULKHEAD.DAT

	A	B	C
1	Criteria	Priority	Weight
2	Stress Corrosion ST	1	1
3	Plane Strain Fracture Toughness	2	0.375
4	Fatigue Crack Growth Rate	3	0.375
5	Tensile Strength Efficiency ST	4	0.15
6	Manufacturing Considerations	5	0.1

GEAR.DAT

	A	B	C
1	Criteria	Priority	Weight
2	Stress Corrosion ST	1	1
3	Tensile Strength Efficiency LT	2	0.25
4	Fatigue Crack Growth Rate	3	0.25
5	Wear Resistance	4	0.15
6	Plane Strain Fracture Toughness	5	0.15
7	Manufacturing Considerations	6	0.1

FUSELAGE.DAT

	A	B	C
1	Criteria	Priority	Weight
2	Stress Corrosion LT	1	1
3	Tensile Strength LT	2	0.3
4	Tensile Yield Strength LT	3	0.3
5	Stiffness	4	0.15
6	Fracture Toughness	5	0.1
7	Fatigue Crack Growth Rate	6	0.1
8	Manufacturing Considerations	7	0.05

LOWER.DAT

	A	B	C
1	Criteria	Priority	Weight
2	Stress Corrosion LT	1	1
3	Fracture Toughness	2	0.375
4	Fatigue Crack Growth Rate	3	0.375
5	Tensile Strength Efficiency LT - Temp Ind	4	0.15
6	Manufacturing Considerations	5	0.1

IKSMAT Component Criteria Definitions

Figure 4a.

	A	B	C
1	Criteria	Priority	Weight
2	Stress Corrosion ST	1	1
3	Tensile Strength ST	2	0.35
4	Fatigue Crack Growth Rate	3	0.35
5	Manufacturing Considerations	4	0.3

PIN.DAT

	A	B	C
1	Criteria	Priority	Weight
2	Stress Corrosion LT	1	1
3	Compressive Buckling	2	0.6
4	Fatigue Crack Growth Rate	3	0.2
5	Fracture Toughness	4	0.15
6	Bearing Ultimate Strength	5	0.05
7	Bearing Yield Strength	6	0.05
8	Density	7	0.05
9	Manufacturing Considerations	8	0.05

UPPER.DAT

	A	B	C
1	Criteria	Priority	Weight
2	Stress Corrosion ST	1	1
3	Plane Strain Fracture Toughness	2	0.375
4	Fatigue Crack Growth Rate	3	0.375
5	Tensile Strength Efficiency ST	4	0.15
6	Tensile Yield Strength Efficiency ST	5	0.1
7	Manufacturing Considerations	6	0.1

WINGSPAR.DAT

IKSMAT Component Criteria Definitions (continued)

Figure 4b.

VII. Criteria Definitions

Every system design criterion is defined in the CRITERIA.DAT sheet (see figures 5a and 5b). The criteria names are defined in the first field while the "Definition" field contains a readable comment defining the criterion. Criteria may be defined as a single numeric material property, as a mathematical combination of several material properties or as a property which varies by temperature which must be evaluated at the temperature specified by the user. Criteria defined as mathematical combinations of basic material properties may be pre-calculated on the search file or calculated during the search. Commonly-accessed criteria, such as those dealing with stress corrosion, are calculated and stored on the STN search file during file building. For temperature-dependent criteria pre-calculation was not possible since the user may specify any arbitrary temperature at search time. These criteria are computed by the search software by interpolating the measurements at the two temperatures closest to the search temperature.

The "Property Reference" field specifies whether the criterion is posted on the STN file or needs to be calculated or interpolated at search time. A criterion that is pre-calculated, or is a single property is considered "posted". For a posted criterion, the "Field Code" field lists the search field code of the criterion on the STN file. This field code is used to construct a query for that component using the "Minimum" and "Maximum" values as the endpoints of the search range.

For a calculated criterion, the "Field Code" value references another criterion definition in the CRITERIA.DAT sheet; this is the first operand of the calculation. The "Secondary Field" value references the criterion definition for the second operand. The "Operator" field gives the operation which is to be performed with the two operands. Supported operations are:

* = multiplication

/ = division

+ = addition

- = subtraction

The criteria definitions referenced for the operands may be of any type: posted, calculated or interpolated. Each operand will be resolved recursively until a value can be found for the operand or it is determined that it is undefined. Each criterion must be able to be eventually resolved as a posted or interpolated value. It is not permitted to refer to a calculated criterion in the definition for a criterion which depends on the same criterion; this would create an unresolved loop of definitions. One operand of a calculated criterion may be a constant value. These are stored in the CRITERIA.DAT sheet as other criterion and are indicated by a "Property Reference" = 'calculated', "Field Code" = no value and "Minimum" = constant value. The posted or interpolated criteria which resolve a calculated criterion will be included in the search query for the STN file just as other criteria of those types are. The values needed to resolve each criterion will be retrieved from the display file for all candidate answers and the criterion value calculated. Candidate answers which have calculated criteria values which fall outside of the "Maximum" and "Minimum" values will be eliminated during the Logic Evaluation phase of the search.

Resolving interpolated fields on the IKSMAT master file requires two operations: interpolating a temperature dependent property at the specified search temperature to get the percent of room temperature for that value and then multiplying that percent by the room temperature value and dividing by 100 to get the actual property value at the specified temperature. In the criteria definitions for interpolated criteria the "Field Code" identifies the room temperature measurement on the search file. The "Secondary Field" identified the percent of room temperature value which must be interpolated at the specified search temperature. The "Minimum" and "Maximum" fields give the search range endpoints which the result of the calculation must fall between. The interpolation, calculation and checking of endpoints is included in the search query for the STN file as a single operation which is done by the search software at the search engines.

The "Optimal" field is used after the search has completed, during the ranking of materials. Each criteria value is scored on how well it matches the "best" value for the criterion. An optimal value may be 'high', 'low', or 'close' to the desired value for a criterion.

Each criterion may specify an alternative criterion for retrieval if the primary criterion is: 1) unavailable for a given material or 2) cannot be calculated or interpolated because one of the basic properties is unavailable. In these cases, the value in the "Alternative Criteria" field will be used as an alternative specification. The logic for this type of retrieval is included inside the generated search query. Additionally, each alternative criterion may specify another alternative criterion. The total number of alternative criteria is unrestricted and is open-ended. An alternate criterion may be posted, calculated or interpolated.

The "Heading" value is used in the final display of search answers to identify the criterion value. The "Score Rank Heading" appears in the search display over the column which gives the score and rank for that criterion value as compared to other values for the same criterion. See the section on Postprocessing Queries for an explanation of scoring and ranking.

The "Display Field' value is used for posted and interpolated criteria to identify the field which should be retrieved from the display file for this criterion. This is the value for the criterion.

The user-defined criteria sheet (UCRIT.DAT) contains user definitions of new criteria for a new or existing component. It has the same format as CRITERIA.DAT and may reference other criteria definitions in CRITERIA.DAT or UCRIT.DAT. Each criterion definition in CRITERIA.DAT and UCRIT.DAT must have a unique name. Criteria in each sheet are ordered by their ASCII sorting sequence to allow for efficient lookup.

CRITERIA.DAT

	A	B	C	D
1	Criteria	Definition	Property Reference	Field Code
2	Alternative Stress Corrosion ST	Fsccth.ST/Fty.ST	Posted	ALTACST
3	Alternative Tensile Strength ST	0.8*Ftu.LT*%RTFtu	Calculated	Tensile Strength LT
4	Axial Stress Fatigue Strength	EL.A0.0	Posted	ASFS
5	Bearing Ultimate Strength	Fbru*%RTFbru	Interpolated	US20B
6	Bearing Yield Strength	Fbry*%RTFbry	Interpolated	YS20B
7	Compressive Buckling	Fcy.LT*%RTFcy/EC*%RTEC	Calculated	Compressive Yield Strength LT
8	Compressive Elastic Modulus L	EC*%RTEC	Interpolated	E11C
9	Compressive Yield Strength LT	Fcy*%RTFcy	Interpolated	YS11C
10	Density	DEN	Posted	DENS
11	Fatigue Crack Growth Rate	da/dN(P)10/dk	Posted	FCGR
12	Fracture Toughness	(Kapp/Fty.LT)^2	Posted	FRT
13	Manufacturing Considerations	MFG	IKSMAT	MFG
14	Plane Strain Fracture Toughness	(K1c.LT/Fty.LT)^2	Posted	PSFRT
15	Stiffness	E*%RTE	Posted	E11T
16	Stress Corrosion LT	Fsccth.LT/(0.8*Fty.LT)	Posted	SCLT
17	Stress Corrosion ST	Fsccth.ST/Fty.ST	Posted	SCST
18	Stress Corrosion Threshold ST	Fsccth.ST	Posted	SCTST
19	Tensile Strength Efficiency LT	Ftu.LT*%RTFtu/DEN	Calculated	Tensile Strength ST
20	Tensile Strength Efficiency LT -Temp Ind	Ftu.L/DEN	Posted	TSETI
21	Tensile Strength Efficiency ST	Ftu.ST/DEN	Posted	TSEST
22	Tensile Strength LT	Ftu.LT*%RTFtu	Interpolated	US22T
23	Tensile Strength ST	Ftu.ST*%RTFtu	Interpolated	US33T
24	Tensile Yield Strength Efficiency ST	Fty.ST/DEN	Posted	TYSEST
25	Tensile Yield Strength LT	Fty.LT*%RTFty	Interpolated	YS22T
26	Wear Resistance	??	IKSMAT	WEAR

IKSMAT Criteria Definitions

Figure 5a.

CRITERIA.DAT

	E	F	G	H	I	J	K
1	**Secondary Field**	**Operation**	**Display Field**	**Minimum**	**Maximum**	**Optimal**	**Alternative Criteria**
2			ALTSCST	0.75	1	High	
3	0.8	*		15	300	High	
4			ASFS	10	70	High	
5	US_B		US20B	50	400	High	
6	YS_B		YS20B	50	400	High	
7	Compressive Elastic Modulus L	/		0.002	0.01	High	
8	E11C		E11C				
9	YS11C		YS11C				
10			DENS	0.05	0.3	High	
11			FCGR	0.000001	0.00001	High	Axial Stress Fatigue Strength
12			FRT	0.02	1	High	Plane Strain Fracture Toughness
13				1	10	High	
14			PSFRT	0.02	1	High	
15	E11T		E11T	*1000000*	*40000000*	*High*	
16			SCLT	0.75	1	High	
17			SCST	0.75	1	High	Alternative Stress Corrosion ST
18			SCTST				
19	Density	/		15	6000	High	
20			TSETI	50	6000	High	
21			TSEST	50	6000	High	Tensile Strength Efficiency LT -Temp Ind
22	US11T		US22T	15	300	High	
23	US11T		US33T	15	300	High	Alternative Tensile Strength ST
24			TYSEST	50	6000	High	
25	YS11T		YS22T	15	300	High	
26				??	??	High	

IKSMAT Criteria Definitions (continued)

Figure 5b.

VIII. Search Query Generation

Search query generation is done at search time by the IKSMAT user interface application only if the user has chosen to search the IKSMAT master database. A portion of the query is generated for each criterion defined in the knowledgebase for the component being evaluated. This set of queries is combined together with the material thickness range defined in the component sheet to form the complete query. The purpose of the search query is to eliminate from consideration materials on the IKSMAT master database whose properties do not meet the criteria for the component being evaluated at the search temperature specified by the user.

Queries for the criteria for a component are generated from the criteria definition (CRITERIA.DAT) sheet. If a criterion is posted, the query for that criterion consists of the minimum to maximum criterion values searched within the Field Code. For interpolated criteria the query consists of logic to locate the property percent of room temperature values for the two temperatures closest to the search temperature, a calculation to interpolate the sets of property/temperature points at the search temperature, a calculation to multiply that percent of room temperature value by the room temperature measurement for that property, and a comparison to make sure that the result falls within the range of the minimum and maximum values for that criterion. For calculated criteria a query will be generated for any component of the calculation which is for a posted or interpolated criterion for which a minimum and maximum range has been defined. It is possible that no search query will be generated for a calculated criterion if no minimum and maximum ranges have been defined for the components of the calculation.

If a criterion, posted or not, has an Alterative Criteria then it is constructed and added to the query so that it will be evaluated for each candidate material only if the primary criterion value is not available for that material. The queries for all criteria contain a final check to see if none of the primary or alternate criteria values are defined for the candidate material. If that is true then the material is allowed to pass for that criterion to make sure that potential hits are not rejected just because a particular property has not been measured for a material.

As mentioned earlier, a Minimum Criteria Weight can be used to restrict query generation for a criterion. If a criterion has a weight below the minimum, no statement searching this criterion will be included in the search query. Instead, this criterion field code will be added to the display query so that its values may still be used in ranking retrieved materials. Query statements restricting material thickness are always included in the complete search query.

The maximum line length in MESSENGER is 255 characters. Consequently, if the search query is longer than that, it must be broken up into several query statements to form a multiple-line query.

IX. Display Query Generation

Display query generation is done at the same time as search query generation, also only if the user has chosen to search the IKSMAT master database. The display query contains the field names for items where values are needed to complete the evaluation of answers, for ranking and for the display of search results. The nature of processing at the search engines requires that it also contain the calculations needed to resolve all interpolated fields. The display query will also contain any fields needed to resolve calculated criteria.

X. Postprocessing Queries

If the remote file is being searched the search query and display queries are sent to the STN system and the IKSMAT master database is searched. Material properties are retrieved by sending display requests and the results placed in the RETRIEVE.DAT sheet. Each column contains one of the material criteria or property values generated by the display query. An additional "Source" field indicates the source of the data as local or remote. Each candidate answer becomes a row.

If a local database is searched by itself or with the remote file, data from the local database is added to the Retrieve sheet before post-processing is begun. Only local materials which meet the thickness limits for the component, defined in the Component sheet, are added as rows to the Retrieve sheet. Interpolation of temperature dependent criteria values at the designated search temperature is done as part of the processing to add local data to RETRIEVE.DAT.

Post-processing material property data is necessary to calculate design criteria values for a component from raw property data values. Post-processing is not necessary for criteria that are posted or interpolated on the remote file since the search query has already restricted the boundary limits for those values. All criteria on the local database must be checked as no prior search is performed on these data. It is assumed that criteria on the remote file have the same characteristics on the local file (posted, interpolated and calculated) and use the same units of measurement.

Post processing begins by an evaluation of each design criterion specified for the component against the materials in RETRIEVE.DAT. This is done for each candidate answer. The different cases are outlined below in the order that they are evaluated:

1) If a criterion is posted or interpolated and does not specify any alternative criteria, and only the remote file was searched, then no calculation or checking need be performed for that criterion.

2) If the local database was searched and the criterion is posted or interpolated, then the criterion values for all Source=local rows in the Retrieve sheet are checked for boundary limits. Any rows which do not meet the boundaries for a criterion are removed from RETRIEVE.DAT and will not be considered an answer.

3) If a criterion is calculated then the calculation will be performed and the value checked against its boundary limits. The first step in the calculation is checking to see that the operands of the calculation have been resolved. These criteria names are specified in the Field Code and Secondary Field columns in the criterion definition. If a value is not present in the RETRIEVE.DAT column for a criterion which is an operand, its definition is checked to see if it must be calculated or if there is an alternative criteria. If it can be calculated then it is; otherwise the alternative criteria is checked. This processing will continue through as many levels as necessary to get a value for an operand or determine that one is not available. If both operands of a calculation can be resolved then the operation contained in the Operation column of the criterion definition is performed and the result saved in the criterion column for the current row. Any results which fall outside of the boundaries for the criterion will have the material row removed from RETRIEVE.DAT.

4) If the primary criterion does not have a value defined or it can not be calculated and an alternative criterion is specified, it is also calculated and/or checked with the same rigor as the primary criterion. This continues through the chain of alternate criteria until a value is found or the chain is exhausted. In this manner, any number of alternatives for one criterion may be evaluated. If a value can not be determined for a criterion then it is assumed to be acceptable.

XI. Ranking Materials By Design Criteria

Materials which meet all of the search criteria are given a score for each criterion and for the material as a whole. The scores are compared to determine the relative rank for each material for each criterion and for the material as a whole. A material with a high score is better than a material with a low score. The material with the highest total score can be said to meet the criteria the best and would be given the rank of one. Materials with the next highest score would be given the rank of two and so on. Materials with the same score are given the same rank.

The score for a criterion is a decimal value of 0.000 or between 1.000 and 10.000. It is determined by normalizing the values for a criterion for all materials which met the search criteria. The material with the best value for a criterion is given the score of 10.000; the material with the worst value is given a score of 1.000. Materials with values in between the best and worst are given scores between 10.000 and 1.000 which reflect their relative difference from the best and worst. Materials which do not have a value for a criterion are given a score of 0.000. If all materials have the same value for a criterion then they will all be given a score of 10.000. The definition for the best criteria value can vary for each criterion. It can be the highest value, lowest value or the value closest to some optimal value.

The score for a material is determined by multiplying each criteria score by the weighting factor defined for that criterion in the sheet for the component being evaluated. The weighted criteria scores are summed to give the total score for the material.

This method for determining material scores has some known weaknesses. They are:

- a very high or low criteria value for a material can affect the scores for all other materials for that criterion since they are normalized to each other

- a material which doesn't have a value for a criterion is given a score of 0.000, ranking it below all other materials, even though its real performance is unknown

- a high score on a heavily weighted criterion will cause a material to rank highly even if it has poor scores for other criteria

APPENDIX E

FILE DESIGN FOR MASTER IKSMAT DATABASE

File: MH5
Status: Proposed for MH5.2
Database Design Summary

Section K2.227.1.1
Date: 92.04.17

STN INTERNATIONAL DATABASE DESIGN SUMMARY

Proposed STN filename: MH5

Database name: Military Standardization Handbook: Metallic Materials and Elements for Aerospace Vehicle Structures Database (MIL-HDBK-5F).

Database producer: US Department of Defense and Federal Aviation Administration.

Proposed implementation date: 04/93

Submission date to File Design STNIG: ________

Provisional approval date: ________ Final approval date: ________

Any corresponding hardcopy publication? Printed Handbook (MIL-HDBK-5F)

Type of file (bibliographic, numeric, full-text, etc.): Numeric

Subject matter: Standardized design values and related design information for metallic materials and structural elements used in aerospace structures.

Types of documents covered: N/A

Intended audience: Engineers and scientists interested in the selection of materials and elements for aerospace structures.

Language of file: English.

File: MH5
Status: Proposed for MH5.2
Database Design Summary

Section K2.227.1.1
Date: 92.04.17

File size: Approx. 1000 workunits with the key ALLOY-FORM-TREAT

Max. record size: unknown Avg. record size: unknown

Years covered: 1990 Edition

Update Size and Frequency: Reloaded semi-annually

Design submitted by: E. Scurr.

Remarks: A workunit in this file is a set of design data for one combination of material, form, and condition (CNAME_FORM_TREAT)

Commands available in this file:

ACTIVATE	YES	EXPAND	YES	PRINT	YES	SEARCH	YES
BATCH	NO	FILE	required	QUERY	YES	SELECT	YES
DELETE	YES	HELP	required	RUN	NO	SEND	NO
DISPLAY	YES	LOGOFF	required	SAVE	required	SET	YES
DOWNLOAD	NO	NEWS	YES	SCREEN	NO	STRUCTU	NO
EDIT	YES	ORDER	YES	SDI	NO	SORT	YES

File: MH5
Status: Proposed for MH5.2
Database Design Summary

Section K2.227.1.1
Date: 92.04.17

File Access Restrictions: None

Help File Names: Military Handbook MIL-HDBK-5F

Help File Names Message Availability: System-wide

SET RANGE Parameters: Accession Number

SET HIGHLIGHT default: ON

SELECT default field: Alloy Designation

BROWSE Index: not required

SUBSET Search required: not required

Numeric Rounding: Yes Use defaults: Yes

Numeric Display Parameters: See Display Fields.

Extracted Term (Type 1) Crossover: YES

Registry File Locator (LC) search field: MH5, CPD FILES

CAS Authority Database LCTABLE value: MH5

Structure Search Mode (SSS, EXA, FAM, CSS): not required

Special billing features: Count CAS RN search terms separately

CAN Other Sources (OS) search field (Yes/No): NO

SDI Frequency: No SDI

Thesaurus (name, field, language(s)): MPDN Thesaurus, /THI, English

Thesaurus (SET REL ON (YES/NO); ARC=): YES; ARC=PFT

MH5 Fields

Code	Name
Generated Fields	
AN	Accession Number
BI	Basic Index (1)
FA	Field Availability
FNA	Field Not Available (2)
MAI	Material Index
MATCL	Material Class
MATSUB	Material Subclass
MATTP	Material Type
MPDBRF	MPD Brief Display (3)
PPN	Preferred Property Name (Alias for FA field)
PRPFA	Property Field Available (4)
RN	CAS Registry Number
THI	Thesaurus Index

(1) The Basic Index contains single word terms from the Alloy (ALLOY), Unified Numbering System Number (UNS), CAS Registry Number (RN), Product Form (FRM), Condition (COND), Temper (TEMPR), and Specimen Orientation (SPEOR) fields.
(2) Dummy field - field specific edit required
(3) Special field introduced to provide a specific display via the MPDN menu interface. Available to Messenger users but not expected to be used by them. Will not be documented.
(4) Special fields introduced to provide a specific "dynamic list" capability via the MPDN menu interface. Available to Messenger users but not expected to be used by them. Will not be documented.

Code	Name
Material Level Fields	
ALLOY	Alloy Designation
UNS	Unified Numbering System Number

Code	Name
Specimen Level Fields	
COND	Condition
DEN	Density
FRM	Product Form
MATTH	Material Thickness
SPEC	Specification Number
SPECSRC	Specification Source
SPEOR	Specimen Orientation
SPHT	Specific Heat
TEMPR	Temper

Environment Level Fields

BXR	Biaxial Ratio*
CRPSTRA	Creep Strain
EXTEMP	Exposure Temperature
EXTIM	Exposure Time
MSTRE	Mean Stress*
MSTREL	Mean Stress Relaxation (MSE=display only)*
STRAR	Strain Ratio*
STRER	Stress Ratio*
TTEMP	Test Temperature

Source Level Fields

BAS	Design Basis
ROP	Ramberg-Osgood Parameter*

File: MH5
Status: Proposed for MH5.2
Database Design Summary

Section K2.227.1.1
Date: 92.04.17

Code	Name
Property Level Fields	
BRU	Bearing Ultimate Strength*
BRU%RT	Percent Room Temperature BRU*
BRY	Bearing Yield Strength*
BRY%RT	Percent Room Temperature BRY*
CUS	Compressive Ultimate Strength
CYS	Compressive Yield Strength
CYS%RT	Percent Room Temperature CYS*
E	Tensile Modulus of Elasticity
E%RT	Percent Room Temperature E*
EC	Compressive Modulus of Elasticity
EC%RT	Percent Room Temperature EC*
ECND	Electric Conductivity
EG	Shear Modulus of Elasticity
EG%RT	Percent Room Temperature EG*
ELON	Tensile Elongation
ELON%RT	Percent Room Temperature ELON*
EOD	Ratio of Edge Distance to Hole Diameter
FAT	Fatigue Strength
FATSTRA	Fatigue Strain Range*
FCGR	Fatigue Crack Propagation Rate
KC	Plane Stress Fracture Toughness*
KIC	Plane Strain Fracture Toughness
KIC%RT	Percent Room Temperature KIC*
KIC.CV	Plane Strain Fracture Toughness, Coefficient of Variation
LEC	Linear Expansion Coefficient
MAXDIA	Maximum Round Diameter*
MSTREL	Mean Stress Relaxation*
PRNU	Poisson's Ratio
PRNU%RT	Percent Room Temperature PRNU*
RA	Reduction in Area
RA%RT	Percent Room Temperature RA*
RESST	Residual Strength*
RHN	Rockwell Hardness
RHN.SC	Rockwell Hardness Scale
ROP	Ramberg-Osgood Parameter*
SCC	Stress Corrosion Rating
TCND	Thermal Conductivity
TST	Tensile Stress
TYS	Tensile Yield Strength
TYS%A	Axial Stress as Percent TYS*
TYS%RT	Percent Room Temperature TYS*
USS	Ultimate Shear Strength
USS%RT	Percent Room Temperature USS*
UTS	Tensile Ultimate Strength
UTS%RT	Percent Room Temperature UTS*

Code	Name
Variable Fields Generated for X-axis in Property Level	
CRIN	Initial Crack Length*
DELK	Stress Intensity Factor Range*
EXTEMP	Exposure Temperature
FATL	Fatigue Life
STRAIN	Strain Increment*
TSTRA	Tensile Strain*
TTEMP	Test Temperature
TYS%H	Hoop Stress as Percent TYS*

* New STN Field

Code	Name
Fields Not Present in PDA data (Identified for Sci-Tech data)	
BRU%RF	BRU Reduction Factor
BRY%RF	BRY Reduction Factor
CDANO	CDA Alloy Number
EXLIM	High Temperature Exposure Limit
EXSTRE	Exposure Stress
FC	Allowable Column Stress
FCC	Allowable Crushing Stress
GDEL	G Delta Ratio
LODIA	Length to Diameter Ratio (embedded in DIMS)
PNWDT	Panel Width (embedded in DIMS)
QNO	QQ-C-390 Alloy Number
RUP	Stress Rupture Strength
RUP.TIM	Stress Rupture Time
SLR	Slenderness Ratio
TEMPR.T	Tempering Temperature
WELD	Weldability
WELDTP	Weld Type

MH5 Search Fields

Field Code	Left-Trunc	Numeric Field	Max. Term Length (1)	R Value	Search Units	Implied Proximity Edit;Parse;Stopword	Field Edit
Generated Fields							
AN	-	-	-	-	-	-	-
BI	-	-	-	-	-	E080DH5;IPPL1;IPSW0	-
FA (2)	-	-	-	-	-	-	-
FNA	-	-	-	-	-	-	(3)
MAI	-	-	-	-	-	-	(4)
MATCL	-	-	-	-	-	-	-
MATSUB	-	-	-	-	-	-	-
MATTP	-	-	-	-	-	-	-
MPDBRF	-	-	-	-	-	-	-
PPN	-	-	-	-	-	-	-
PRPFA	-	-	-	-	-	-	-
RN	-	-	-	-	-	-	-
THI	-	200	-	-	-	-	-

(1) Unless otherwise specified in this column, the maximum term length is the system default (52 characters).
(2) Display HIT of the results of a search on a field qualifier in the /FA field will be the display format which contains that field, e.g., for => S LEC/FA, D HIT will provide the LEC display format for the first answer in the answer set.
(3) Convert user input TERM/FNA to (ALL/FA NOT TERM/FA)
(4) A field edit is required in the MAI field to convert user input of the type => S TERMA TERMB TERMC/MAI to => S TERMA/MAI (S) TERMB/MAI (S) TERMC/MAI

Field Code	Left-Trunc	Numeric Field	Max. Term Length (1)	R Value	Search Units	Implied Proximity Edit;Parse;Stopword	Field Edit
Material Level Fields							
ALLOY	-	200	-	-	-	-	-
UNS	-	-	-	-	-	-	-

Field Code	Left-Trunc	Numeric Field	Max. Term Length (1)	R Value	Search Units	Implied Proximity Edit;Parse;Stopword	Field Edit
Specimen Level Fields							
COND	-	-	-	-	-	-	-
DEN	-	X	-	(5)	lb/in**3	-	-
FRM	-	-	-	-	-	-	-
MATTH	-	X	-	(5)	in	-	-
SPEC	-	-	-	-	-	-	-
SPECSRC	-	-	-	-	-	-	-
SPEOR	-	-	-	-	-	-	-
SPHT	-	X	-	(5)	Btu/lb*F	-	-
TEMPR	-	-	-	-	-	-	-

Environment Level Fields

BXR	-	X	-	(5)	none	-	-
CRPSTRA	-	X	-	(5)	%	-	-
EXTEMP	-	X	-	(5)	F	-	-
EXTIM	-	X	-	(5)	h	-	-
MSTRE	-	X	-	(5)	ksi	-	-
MSTREL	-	X	-	(5)	none	-	-
STRAR	-	X	-	(5)	none	-	-
STRER	-	X	-	(5)	none	-	-
TTEMP	-	X	-	(5)	F	-	-

Source Level Fields

BAS	-	-	-	-	-	-	-
ROP	-	X	-	(5)	none	-	-

File: MH5
Status: Proposed for MH5.2
Database Design Summary

Section K2.227.1.1
Date: 92.04.17

Field Code	Left-Trunc	Numeric Field	Max. Term Length (1)	R Value	Search Units	Implied Proximity Edit;Parse;Stopword	Field Edit
Property Level Fields							
BRU	-	X	-	(5)	ksi	-	-
BRU%RT	-	X	-	(5)	%	-	-
BRY	-	X	-	(5)	ksi	-	-
BRY%RT	-	X	-	(5)	%	-	-
CUS	-	X	-	(5)	ksi	-	-
CYS	-	X	-	(5)	ksi	-	-
CYS%RT	-	X	-	(5)	%	-	-
E	-	X	-	(5)	Msi	-	-
E%RT	-	X	-	(5)	%	-	-
EC	-	X	-	(5)	Msi	-	-
EC%RT	-	X	-	(5)	%	-	-
ECND	-	X	-	(5)	%IACS	-	-
EG	-	X	-	(5)	Msi	-	-
EG%RT	-	X	-	(5)	%	-	-
ELON	-	X	-	(5)	%	-	-
ELON%RT	-	X	-	(5)	%	-	-
EOD	-	X	-	(5)	none	-	-
FAT	-	X	-	(5)	ksi	-	-
FATSTRA	-	X	-	(5)	none	-	-
FCGR	-	X	-	(5)	in/cycle	-	-
KC	-	X	-	(5)	ksi*in**0.5	-	-
KIC	-	X	-	(5)	ksi*in**0.5	-	-
KIC%RT	-	X	-	(5)	%	-	-
KIC.CV	-	X	-	(5)	%	-	-
LEC	-	X	-	(5)	uin/in*F	-	-
				(5)	uin/in		
MAXDIA	-	X	-	(5)	in	-	-
MSTREL	-	X	-	(5)	none	-	-
PRNU	-	X	-	(5)	none	-	-
PRNU%RT	-	X	-	(5)	%	-	-
RA	-	X	-	(5)	%	-	-
RA%RT	-	X	-	(5)	%	-	-
RESST	-	X	-	(5)	ksi	-	-
RHN	-	X	-	(5)	none	-	(7)
RHN.SC	-	-	-	-	-	-	(7)
ROP	-	X	-	(5)	none	-	-
SCC	-	-	-	-	-	-	-
TCND	-	X	-	(5)	Btu*ft/ft**2*h*F	-	-
TST	-	X	-	(5)	ksi	-	-
TYS	-	X	-	(5)	ksi	-	-
TYS%A	-	X	-	(5)	none	-	-
TYS%RT	-	X	-	(5)	%	-	-
USS	-	X	-	(5)	ksi	-	-
USS%RT	-	X	-	(5)	%	-	-
UTS	-	X	-	(5)	ksi	-	-
UTS%RT	-	X	-	(5)	%	-	-

File: MH5
Status: Proposed for MH5.2
Database Design Summary

Section K2.227.1.1
Date: 92.04.17

Field Code	Left-Trunc	Numeric Field	Max. Term Length (1)	R Value	Search Units	Implied Proximity Edit;Parse;Stopword	Field Edit
Variable Fields Generated for X-axis in Property Level							
CRIN	-	X	-	(5)	in	-	-
DELK	-	X	-	(5)	ksi*in**0.5	-	-
EXTEMP	-	X	-	(5)	F	-	-
FATL	-	X	-	(5)	cycles	-	-
STRAIN	-	X	-	(5)	%	-	-
TSTRA	-	X	-	(5)	uin/in	-	-
TTEMP	-	X	-	(5)	F	-	-
TYS%H	-	X	-	(5)	none	-	-

(5) Numeric ranges will be indexed for these fields and an R value must be selected for the query expansion that is part of the range search feature.
(7) RHN Field Edit required (only C scale valid for this file)

File: MH5
Status: Proposed for MH5.2
Database Design Summary

Section K2.227.1.1
Date: 92.04.17

MH5 Display Fields

Field Code	Custom Display	Answer SORT	High-light(6)	SELECT	SELECT CHEM	SELECT NAME	Original Units	Table SORT	SORTKEY
Generated Fields									
AN	X	-	-	-	-	-	-	-	-
FA	X	-	-	-	-	-	-	-	-
MATCL	X	X	X	X	-	-	-	-	A
MATSUB	X	X	X	X	-	-	-	-	A
MATTP	X	-	-	-	-	-	-	-	-
MPDBRF	-	-	-	-	-	-	-	-	-
PRPFA	X	-	-	X	-	-	-	-	-
RN	X	X	X	X	X	-	-	-	A
Material Level Fields									
ALLOY	X	X	X	X	X	X	-	-	A
UNS	X	X	X	X	X	X	-	-	A
Specimen Level Fields									
COND	X	X	X	X	-	-	-	-	A
DEN	-	X	-	-	-	-	lb/in**3	-	N
FRM	X	X	X	X	-	-	-	-	A
MATTH	X	X	-	-	-	-	in	-	N
SPEC	X	X	X	X	-	-	-	-	A
SPECSRC	-	X	-	X	-	-	-	-	A
SPEOR	-	-	-	-		-	-	-	-
SPHT	-	X		-			Btu/lb*deg F		N
TEMPR	X	X	X	X	-	-	-	-	A
Environment Level Fields									
BXR	-	-	-	-	-	-	none	-	
CRPSTRA	-	-	-	-	-	-	[illegible]	-	-
EXTEMP	-	-	-	-	-	-	deg F	-	
EXTIM	-	-	-	-	-	-	h	-	-
MSTRE	-	-	-	-	-	-	ksi	-	-
MSTREL	-	-	-	-	-	-	none	-	
STRAR	-	-	-	-	-	-	none		
STRER	-	-	-	-	-	-	none	-	-
TTEMP	-	-	-	-	-	-	deg F	-	

Field Code	Custom Display	Answer SORT	Highlight	SELECT	SELECT CHEM	SELECT NAME	Original Units	Table SORT	SORTKEY
Source Level Fields									
BAS	-	-	-	-	-	-	-	-	-
ROP	-	-	-	-	-	-	none	-	-

File: MH5
Status: Proposed for MH5.2
Database Design Summary

Section K2.227.1.1
Date: 92.04.17

Field Code	Custom Display	Answer SORT	High-light	SELECT	SELECT CHEM	SELECT NAME	Original Units	Table SORT	SORTKEY
Property Level Fields									
BRU	-	-	-	-	-	-	ksi	-	-
BRU%RT	-	-	-	-	-	-	%	-	-
BRY	-	-	-	-	-	-	ksi	-	-
BRY%RT	-	-	-	-	-	-	%	-	-
CUS	-	-	-	-	-	-	ksi	-	-
CYS	-	-	-	-	-	-	ksi	-	-
CYS%RT	-	-	-	-	-	-	%	-	-
E	-	-	-	-	-	-	Msi	-	-
E%RT	-	-	-	-	-	-	%	-	-
EC	-	-	-	-	-	-	Msi	-	-
EC%RT	-	-	-	-	-	-	%	-	-
ECND	-	-	-	-	-	-	%IACS	-	-
EG	-	-	-	-	-	-	Msi	-	-
EG%RT	-	-	-	-	-	-	%	-	-
ELON	-	-	-	-	-	-	%	-	-
ELON%RT	-	-	-	-	-	-	%	-	-
EOD	-	-	-	-	-	-	none	-	-
FAT	-	-	-	-	-	-	ksi	-	-
FATSTRA	-	-	-	-	-	-	none	-	-
FCGR	-	-	-	-	-	-	in/cycle	-	-
KC	-	-	-	-	-	-	ksi*in**0.5	-	-
KIC	-	-	-	-	-	-	ksi*in**0.5	-	-
KIC%RT	-	-	-	-	-	-	%	-	-
KIC.CV	-	-	-	-	-	-	%	-	-
LEC	-	-	-	-	-	-	uin/in*deg F	-	-
MAXDIA	-	-	-	-	-	-	in	-	-
MSTREL	-	-	-	-	-	-	none	-	-
PRNJ	-	-	-	-	-	-	none	-	-
PRNJ%RT	-	-	-	-	-	-	%	-	-
RA	-	-	-	-	-	-	%	-	-
RA%RT	-	-	-	-	-	-	%	-	-
RESST	-	-	-	-	-	-	ksi	-	-
RHN	-	-	-	-	-	-	none	-	
ROP	-	-	-	-	-	-	none	-	-
SCC	-	-	-	-	-	-	-	-	
TCND	-	-	-	-	-	-	Btu*ft/ft**2*h*deg F		
TST	-	-	-	-	-	-	ksi	-	
TYS	-	-	-	-	-	-	ksi		
TYS%A	-	-		-		-	none	-	
TYS%RT	-	-	-	-		-	%		
USS	-				-	-	ksi	-	
USS%RT	-	-	-	-	-	-	%	-	-
UTS	-	-	-	-	-	-	ksi	-	
UTS%RT	-	-	-	-	-	-	%	-	-

Field Code	Custom Display	Answer SORT	High-light	SELECT	SELECT CHEM	SELECT NAME	Original Units	Table SORT	SORTKEY
Variable Fields Generated for X-axis in Property Level									
CRIN	-	-	-	-	-	-	in	-	-
DELK	-	-	-	-	-	-	ksi*in**0.5	-	-
EXTEMP	-	-	-	-	-	-	deg F	-	-
FATL	-	-	-	-	-	-	cycles	-	-
STRAIN	-	-	-	-	-	-	%	-	-
TSTRA	-	-	-	-	-	-	uin/in	-	-
TTEMP	-	-	-	-	-	-	deg F	-	-
TYS%H	-	-	-	-	-	-	none	-	-

(6) Hit term highlighting with asterisks is turned on only for the fields in this table indicated by 'X'. Highlighting must be turned on for all fields, without the hit term asterisks feature, in order to capture the highlighting proximity information required for the QRD feature. Display fields required in the QRD format are defined in the section on predefined display formats in the detailed design.

Default format: QRD

Predefined Formats

ALL
BRF
IDE
ELON
MECH
PHYS
MOD
TCND
SPHT
LEC

Other Formats

QRD
HIT
KWIC
OCC

MH5 Fields - Numeric Display Parameters

Field Code	Pattern	Decimal Zeros	Exponential Digits	Leading Zero	Round (1)	Max. Number Trailing 0's (2)	Note
BRU							
BRU%RT							(3)
BRY							
BRY%RT							(3)
BXR							(4)
CRIN							
CRPSTRA							(3)
CUS							
CYS							
CYS%RT							(3)
DELK							
DEN							
E							
E%RT							(3)
EC							
EC%RT							(3)
ECND							
EG							
EG%RT							(3)
ELON							(3)
ELON%RT							(3)
EOD							(4)
EXTEMP							
EXTEMP							
EXTIM							
FAT							
FATL							
FATSTRA							(4)
FCGR							
KC							
KIC							
KIC%RT							(3)
KIC.CV							(3)
LEC							

File: MH5
Status: Proposed for MH5.2
Database Design Summary

Section K2.227.1.1
Date: 92.04.17

Field Code	Pattern	Decimal Zeros	Exponential Digits	Leading Zero	Round (1)	Max. Number Trailing 0's (2)	Note
MATTH							
MAXDIA							
MSTRE							
MSTREL							(4)
PRNU							(4)
PRNU%RT							(3)
RA							(3)
RA%RT							(3)
RESST							
RHN							(4)
ROP							(4)
SPHT							
STRAIN							(3)
STRAR							(4)
STRER							(4)
TCND							
TST							
TSTRA							
TTEMP							
TTEMP							
TYS							
TYS%A							(4)
TYS%H							
TYS%RT							(3)
USS							
USS%RT							(3)
UTS							
UTS%RT							(3)

(1) Y = round and use defaults; N = do not round; 1-8 = round and use this number for the number of significant digits.
(2) Applies to trailing decimal zeros of the values displayed in scientific notation only.
(3) Value is %, not converted
(4) No units, not converted

MH5 Property Dictionary

July 25, 1990 Version
(Units modified for PDA - 92.02.05 - E. Scurr)

PN: Preferred Property Name
FN: File Property Name (PN or synonym)
FQ: Property Field Qualifier
FA: Property Attribute Field Qualifier
FU: Property Unit (file-specific Default Search unit)
NOTE: Note
DEF: Property Definition

PN: compressive modulus of elasticity
FN: compressive modulus of elasticity
FQ: EC
FU: Msi
DEF: The ratio of compressive stress to compressive strain below the proportional limit. Theoretically equal to Young's modulus determined from tensile tests. For metals, it is measured according to ASTM E9.

PN: tensile elongation
FN: tensile elongation
FQ: ELON
FU: %
NOTE: Elongation is affected by specimen geometry (length, width, thickness of gage section and adjacent regions) and test procedure, such as alignment and speed of pulling.
DEF: The increase in distance between 2 gage marks that result from stressing the specimen in tension to fracture. Usually elongation is expressed as a percentage of the original gage length. For metals, it is measured after the fracture according to ASTM E8 or B557.

PN: linear expansion coefficient
FN: linear expansion coefficient
FQ: LEC
FU: uin/in*F
FU: uin/in
DEF: The change in specimen length resulting from a specified change in temperature per specimen length at a reference temperature per said change in temperature. For metals measured according to ASTM E289 or E228.

PN: tensile modulus of elasticity
FN: tensile modulus of elasticity
FQ: E
FU: ksi
DEF: The ratio of stress to corresponding strain below the proportional limit. Proportional limit is the greatest stress which a material is capable of sustaining without any deviation from proportionality of stress to strain. For metals, it is measured according to ASTM E8 or B557.

PN: reduction of area
FN: reduction in area
FQ: RA
FU: %
DEF: The difference between the original cross-sectional area of a tension test specimen and the area of its smallest cross section (measured at or after fracture as specified for a material under test). The reduction of area is usually expressed as a percentage of the original cross sectional area of the specimen. For metals, it is measured according to ASTM E8 or B557.

PN: specific heat capacity
FN: specific heat
FQ: SPHT
FU: Btu/lb*F
DEF: The quantity of heat per unit mass or volume per unit temperature rise, required to increase the temperature of a specimen without change of phase.

PN: shear modulus of elasticity
FN: shear modulus of elasticity
FQ: EG
FU: Msi
DEF: Ratio of the shearing stress to the shearing strain at low loads, or the initial slope of the stress-strain diagram for shear. For metals, it is determined according to ASTM B567.

PN: Poisson's ratio
FN: Poisson's ratio
FQ: PRNU
DEF: Absolute value of the ratio of transverse strain to the corresponding axial strain resulting from uniformly distributed axial stress below the proportional limit of the material. Determined according to ASTM E132.

PN: density
FN: density
FQ: DEN
FU: lb/in**3
DEF: The mass of any substance (gas, liquid or solid) per unit volume at defined temperature and pressure.

PN: electric conductivity
FN: electric conductivity
FQ: ECND
FU: %IACS
DEF: The conductance of a material at a specified temperature, between the opposite faces of a cube of the material having sides of unit length.

PN: thermal conductivity
FN: thermal conductivity
FQ: TCND
FU: Btu*ft/ft**2*h*F
DEF: The thermal conductivity is the time rate of transfer of heat by conduction across unit area of substance through unit thickness for unit difference in temperature.

Dictionary Entries needed for Property Fields for Version II

BRU	Bearing Ultimate Strength*
BRU%RT	Percent Room Temperature BRU*
BRY	Bearing Yield Strength*
BRY%RT	Percent Room Temperature BRY*
BXR	Biaxial Ratio*
CRPSTRA	Creep Strain
CUS	Compressive Ultimate Strength
CYS	Compressive Yield Strength
CYS%RT	Percent Room Temperature CYS*
E	Tensile Modulus of Elasticity
E%RT	Percent Room Temperature E*
EC	Compressive Modulus of Elasticity
EC%RT	Percent Room Temperature EC*
ECND	Electric Conductivity
EG	Shear Modulus of Elasticity
EG%RT	Percent Room Temperature EG*
ELON	Tensile Elongation
ELON%RT	Percent Room Temperature ELON*
EOD	Ratio of Edge Distance to Hole Diameter
FAT	Fatigue Strength
FATSTRA	Fatigue Strain Range*
FCGR	Fatigue Crack Propagation Rate
KC	Plane Stress Fracture Toughness
KIC	Plane Strain Fracture Toughness
KIC%RT	Percent Room Temperature KIC*
KIC.CV	Plane Strain Fracture Toughness, Coefficient of Variation
LEC	Linear Expansion Coefficient
MAXDIA	Maximum Round Diameter*
MSTRE	Mean Stress*
MSTREL	Mean Stress Relaxation*
PRNU	Poisson's Ratio
PRNU%RT	Percent Room Temperature PRNU*
RA	Reduction in Area
RA%RT	Percent Room Temperature RA*
RESST	Residual Strength*
RHN	Rockwell Hardness
RHN.SC	Rockwell Hardness Scale
ROP	Ramberg-Osgood Parameter*
SPHT	Specific Heat
STRAR	Strain Ratio*
STRER	Stress Ratio*
SCC	Stress Corrosion Rating
TCND	Thermal Conductivity
TST	Tensile Stress
TYS	Tensile Yield Strength
TYS%A	Axial Stress as Percent TYS*
TYS%RT	Percent Room Temperature TYS*
USS	Ultimate Shear Strength
USS%RT	Percent Room Temperature USS*

UTS	Tensile Ultimate Strength
UTS%RT	Percent Room Temperature UTS*

Variable Fields Generated for X-axis in Property Level

CRIN	Initial Crack Length*
DELK	Stress Intensity Factor Range*
EXTEMP	Exposure Temperature
FATL	Fatigue Life
STRAIN	Strain Increment*
TSTRA	Tensile Strain*
TTEMP	Test Temperature
TYS%H	Hoop Stress as Percent TYS*

* New STN Field

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
MATERIAL	Sequence no. of material in level		N			Not searched.					Not displayed.
	Display Accession Number	700- followed by a sequential <= 6 digit no. with no leading zeros. Generated during file loading.	N	AN	AN	For each unique combination of ALLOY-FORM-TREAT index an accession number in AN as generated.	1	1	1		Display in AN field. Not selected.
			A	FA FNA		For each AN in file (each workunit) index 'ALL' in FA. FNA is a dummy search field. Input terms are converted from TERM/FNA to (ALL/FA NOT TERM/FA) by a field edit.	590	590			FA is not selected.
	Material Type		A	MATTP THI BI	MATTP	For each workunit in the file, index the term 'metal' in the MATTP, THI and BI fields	8				Not displayed. Not selected.
CNAME	Common Name	Alphanumeric string	A			Not searched					Not displayed

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
ALLOY	Alloy Name	Alphanumeric string generated from CNAME	A	ALLOY THI	ALLOY	Index in ALLOY and as a bound phrase. Also index in MAI, see instructions under "Fields Generated"	2 2	1 1	1 1		Display, see layout. Select, no parsing
			A	BI		Parse at non-alpha-numerics and blanks and index single words in BI.	2	1	1	1-n	Not displayed. Not selected.
	Material Index		A	MAI		Parse at non-alpha-numerics and blanks and index single words in MAI	2	1	1	1-n	Not displayed. Not selected.
			A	FA	FA	Index 'ALLOY' and text in FA. See Appendix A.	2	1	1		Display code and text in FA. FA not selected
UNS	Unified Numbering System No.	Alphanumeric string	A A A	UNS THI BI	UNS	Index as input in UNS, THI and BI	4	1	1	1-n	Display, see layout Select, no parsing.
			A	FA	FA	index 'UNS' and text in FA. See Appendix A.	4	1	1		Display code and text in FA. FA not selected
MATCL	Material Class	Alphanumeric string generated from chapter	A A	MATCL THI	MATCL	Index as generated in MATCL and THI	3	1	1		Display, see layout Select, no parsing
			A	BI		Parse at non-alpha-numerics and blanks and index single words in BI.	3	1	1	1-n	Not displayed. Not selected.
			A	FA	FA	Index 'MATCL' and text in FA. See Appendix A.	3	1	1		Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	DIS	Index/Search	Proximity L	P	S	A/W	Display/Select
MATSUB	Material Subclass	Alphanumeric string generated from CNAME	A A	MATSUB THI	MATSUB	index as generated in MATSUB and THI	6	1	1		Display, see layout Select, no parsing
			A	BI		Parse at non-alpha-numerics and blanks and index single words in BI.	6	1	1	1-n	Not displayed. Not selected.
			A	FA	FA	Index 'MATSUB'and text in FA. See Appendix A.	6	1	1		Display code and text in FA. FA not selected
SPECIMEN	Specimen Level	Sequence no.				Not searched					Not displayed
FORM	Product Form	Alphanumeric string	A	FRM	FRM	Index as a bound phrase in FRM.	2	1	1		Display, see layout Select, no parsing
			A	BI		Parse at non-alpha-numerics and blanks and index single words in BI.	2	1	1	1-n	Not displayed. Not selected.
	Material Index		A	MAI		Parse at non-alpha-numerics and blanks and index single words in MAI	2	1	1	1-n	Not displayed. Not selected.
			A	FA	FA	Index 'FRM' and text in FA. See Appendix A.	2	1	1		Display code and text in FA. FA not selected

Input Field No.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
TREAT	Treatment	Alphanumeric string	A	COND	COND	Index as a bound phrase in COND	2	1	1		Display, see layout Select, no parsing
		Alphanumeric string	A	TEMPR	TEMPR	For values of TREAT in CH3 and CH4 only, also index in TEMPR.	2	1	1		Display and Select only as COND.
			A	BI		Parse at non-alphanumerics and blanks and index single words in BI.	2	1	1	1-n	Not displayed. Not selected.
	Material Index		A	MAI		Parse at non-alphanumerics and blanks and index single words in MAI	2	1	1	1-n	Not displayed. Not selected.
			A	FA	FA	Index 'COND' and text in FA. See Appendix A.	2	1	1		Display code and text in FA. FA not selected
DESIG	Specification	Alphanumeric string	A	SPEC	SPEC	Index in SPEC as a bound phrase	5	1	1		Display, see layout Select, no parsing
				FA	FA	Index 'SPEC' and text in FA. See Appendix A.	5	1	1		Display code and text in FA. FA not selected
	Specification Source	generated	A	SPECSRC	SPEC	Parse at non-alphanumerics and blanks. When the characters in the first parsed word = post to SPECSRC AISI AISI AMS AMS ASTM ASTM MIL Military QQ Federal WW Federal	5	1	2		
			A	FA	FA	Index 'SPECSRC' and text in FA. See Appendix A.	5	1	2		Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
DIMS	Specimen Dimension	Numeric value after preprocessing.	U	MATTH		Numeric value or range indexed in numeric field MATTH					Display, see layout Not selected.
			A	FA	FA	Index 'MATTH' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
		Alphanumeric value after preprocessing	A			Not searched					Display only, see layout.
DENS	Density	Numeric value	U	DEN		Numeric value indexed in numeric field DEN					Display, see layout Not selected.
			A	FA	FA	Index 'DEN' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for DEN in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'DEN.' in MPDBRF for each work-unit in which DEN values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Density' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Design Basis	Single letter 'A' 'B' or 'S' or text 'typical'	A A	BAS THI	BAS	For each occurence of DENS input field, index 'typical' in BAS and THI					Display: See Layouts Not selected.
			A	FA	FA	Index 'BAS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
CP	Specific Heat	Numeric Value	U	SPHT		Index in numeric field SPHT					Display, see layout Not selected
			A	FA	FA	Index 'SPHT' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for SPHT in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'Sp. Ht.' in MPDBRF for each work-unit in which SPHT values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Specific Heat' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Design Basis	Single letter 'A' 'B' or 'S' or text 'typical'	A A	BAS THI	BAS	For each occurence of CP input field, index 'typical' in BAS and THI					Display: See Layouts Not selected.
			A	FA	FA	Index 'BAS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
ELEC_COND	Electric Conduct'vity	Numeric value	U	ECND		Index in Numeric field ECND					Display: see layouts Not selected
			A	FA	FA	Index 'ECND' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for ECND in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'Electric Conductivity' in MPDBR for each workunit in which ECND values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Electric Conductivity' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Design Basis	Single letter 'A' 'B' or 'S' or text 'typical'	A A	BAS THI	BAS	For each occurence of ?? input field, index 'typical' in BAS and *THI*					Display: See Layouts Not selected.
			A	FA	FA	Index 'BAS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
CAREA	Cross Sectional Area	Alphanumeric string	A			Not searched					Display only
KT	Theoretical elastic stress concentration factor	Numeric value	N			Not searched					Display only
FANGLE	Flange Angle	Alphanumeric string	A			Not searched					Display only
GAGELNG	Gage length	Alphanumeric string	A			Not searched					Display only
GAGETHK	Gage thickness	Alphanumeric string	A			Not searched					Display only
GDIAM	Gross diameter of specimen	Alphanumeric string	A			Not searched					Display only

Input field no.	Content	Input Format	A N U	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
HOLEDIAM	Hole diameter (fatigue spec.)	Alphanumeric string	A			Not searched					Display only
MOD_ELAS	Modulus of Elast city	Alphanumeric string	A			Not searched					Display only
NDIAM	Net diameter of specimen	Alphanumeric string	A			Not searched					Display only .
NWIDTH	Net width of specimen	Alphanumeric string	A			Not searched					Display only
ORIENT	Specimen Orientation	Codes L-T, L-S, T-L, T-S, S-L, and S-T.	A A A	SPEOR THI BI	SPEOR	Index codes as input as bound phrases in SPEOR and THI and as parsed terms in BI. Also index, for: L-T = L L-S = L T-L = LT T-S = LT S-L = ST S-T = ST					Display codes as input. See layout. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected
RADIUS	Net section radius (fatigue specimen)	Alphanumeric string	A			Not searched					Display only
RNOTCH	Notch radius (fatigue spec.)	Alphanumeric string	A			Not searched					Display only
RRADIUS	Root radius (fatigue spec.)	Alphanumeric string	A			Not searched					Display only
SPCMDIA	Specimen diameter	Alphanumeric string	A			Not searched					Display only
SPTYPE	Specimen Type	Alphanumeric string	A			Not searched					Display only

Input field no.	Content	Input Format	ANU	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
SURFACE	Surface description	Alphanumeric string	A			Not searched					Display only
THICK	Thickness of specimen	Alphanumeric string	A			Not searched					Display only
TUS	Typical tensile ultimate strength	Alphanumeric string	A			Not searched					Display only
TYS	Typical tensile yield strength	Alphanumeric string	A			Not searched					Display only
SOURCE	Source Level	Sequence no.	N			Not searched					Not displayed
BOOK	Source Book	MIL-HDBK-5F	A			Not searched					Not displayed
FIGURE	Source Figure number	Alphanumeric string	A	FIGNO		Remove parentheses, close up, and post as a bound phrase					Display, see layout Used in D ACC FIGNO
TABLE	Source Table number	Alphanumeric string	A A	TABNO FIGNO		Remove parentheses, close up, and post as a bound phrase					Display, see layout Used in D ACC FIGNO
BASIS	Design Basis	Alphanumeric string	A A	BAS THI		Index in text field BAS and THI					Display, see layout Not selected
			A	FA	FA	Index 'BAS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
APPROVAL	Status of items approved by MIL5 coordination group	Alphanumeric string	A			Not searched					Not displayed
CH_NOTICE	Change notice number	Alphanumeric string	A			Not searched					Display only?

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
REF	Source Reference	Alphanumeric string	A			Not searched					Not displayed
WAVEFM	Wave form	Alphanumeric string	A			Not searched					Display only
DATE_EFF	Effect date of data release or approval by MIL5 coordination group	Alphanumeric string	A			Not searched					Display only?
RAM11C	Ramberg-Osgood Parameter	Numeric value	N	ROP		index in numeric field ROP					Display, see layout Not selected
			A	FA	FA	Index 'ROP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of RAM11C field, index 'L' in SPEOR, BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected
RAM11T	Ramberg-Osgood Parameter	Numeric value	N	ROP		index in numeric field ROP					Display, see layout Not selected
			A	FA	FA	Index 'ROP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of RAM11T field, index 'L' in SPEOR, BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
RAM22C	Ramberg-Osgood Parameter	Numeric value	N	ROP		index in numeric field ROP					Display, see layout Not selected
			A	FA	FA	Index 'ROP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of RAM22C field, index 'LT' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected
RAM22T	Ramberg-Osgood Parameter	Numeric value	N	ROP		index in numeric field ROP					Display, see layout Not selected
			A	FA	FA	Index 'ROP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of RAM22T field, index 'LT' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected
RAM33C	Ramberg-Osgood Parameter	Numeric value	N	ROP		index in numeric field ROP					Display, see layout Not selected
			A	FA	FA	Index 'ROP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of RAM33C field, index 'ST' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field SEA	DIS	Index/Search	Proximity L	P	S	A/W	Display/Select
RAM33T	Ramberg-Osgood Parameter	Numeric value	N	ROP		index in numeric field ROP					Display, see layout Not selected
			A	FA	FA	Index 'ROP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of RAM33T field, index 'ST' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected
ENVIRON	Environment Level	Sequence no.	A			Not searched					Not displaved
TEMP	Test Temperature	Numeric Value	U	TTEMP		Index all values in numeric field TTEMP When this field is not present at the ENVIRON Level, then index TEMP values at the FIGLINE level to TTEMP.					Display: see layout Not selected.
			A	FA	FA	Index 'TTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
BIAX_RATIO	Biaxial Ratio (L/T stress ratio)	Numeric value	N	BXR		Index in numeric fiel BXR.					Display, see layouts. Not selected.
			A	FA	FA	Index 'BXR' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
%CREEP	Percent Creep	Numeric value	N	CRPSTRA		Index in numeric fiel CRPSTRA					Display, see layou... Not selected.
			A	FA	FA	Index 'CRPSTRA' and text in FA. See appendix A.					Display code and text in FA. FA not selected
CREEPEQ	Creep equation	Alphanumeric string	A			Not searched					Display only

Input field no.	Co'	Input Format	A N U	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
EPS_RATIO	Strain Ratio	Numeric Value	N	STRAR		Index numeric value in STRAR.					Display, see layout Not selected
			A	FA	FA	Index 'STRAR' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
EXPOS	Exposure Time	Numeric Value	U	EXTIM		Index numeric value in EXTIM.					Display numeric value or 'RT', as in input.
			A	FA	FA	Index 'EXTIM' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
EXPTEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
FREQ	Loading frequency	Numeric value	N			Not searched					Display only
ENVIRON	Loading environment	Alphanumeric string	A			Not searched					Display only
LOADING	Loading description	Alphanumeric string	A			Not searched					Display only
LOTSNO	Number of heats/lots	Numeric value	A			Not searched					Display only
MSE	Mean stress relaxation	Alphanumeric string	A			Not searched					Display only

Input field no.	Content	Input Format	ANU	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
MSTRESS	Mean Stress	Numeric Value	N	MSTRE		Index numeric value in MSTRE.					Display, see layout Not selected
			A	FA	FA	Index 'MSTRE' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
N_SOURCES	Number of Sources	Numric Value	N			Not searched					Display only
RSQUARED	Square of reduced ratio	Alphanumeric string	A			Not searched					Display only
SSEQ_MONO	Stress-strain equation monotinic	Alphanumeric string	A			Not searched					Display only
SSEQ_CYC	Stress-strain equation cyclic	Alphanumeric string	A			Not searched					Display only
STRAINEQ	Equivalent strain equation	Alphanumeric string	A			Not searched					Display only
STRESSEQ	Equivalent stress equation	Alphanumeric string	A			Not searched					Display only
STERREST	Standard error of estimate	Alphanumeric string	A			Not searched					Display only
STDEVLIF	Standard deviation in life	Alphanumeric string	A			Not searched					Display only
SAMPSIZE	Sample size	Alphanumeric string	A			Not searched					Display only

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
SIG_RATIO	Stress Ratio	Numeric Value	N	STRER		Index in numeric field STRER					Display, see layout Not selected
			A	FA	FA	Index 'STRER' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
PROPERTY	Property Level	Sequence no.	A			Not searched					Not displayed
TABNAME	Table Name	Alphanumeric string	A			Not searched					Not displayed

Design Table Property Data (IKSMAT)

US11T	Tensile Ultimate Strength	Numeric value	U	UTS		Index in Numeric field UTS					Display: see layouts Not selected
			A	FA	FA	Index 'UTS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for UTS in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'UTS' in MPDBRF for each workunit in which US11T values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Tensile Ultimate Strength'as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of US11T field, index 'L' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
US12T	Tensile Ultimate Strength	Numeric value	U	UTS		Index in Numeric field UTS					Display: see layouts Not selected
			A	FA	FA	Index 'UTS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for UTS in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'UTS' in MPDBRF for each workunit in which US12T values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Tensile Ultimate Strength'as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of US12T field, index '45 deg' in SPEOR, BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
US22T	Tensile Ultimate Strength	Numeric value	U	UTS		Index in Numeric field UTS					Display: see layouts Not selected
			A	FA	FA	Index 'UTS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for UTS in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'UTS' in MPDBRF for each workunit in which US22T values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Tensile Ultimate Strength'as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of US22T field, index 'LT' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
US33T	Tensile Ultimate Strength	Numeric value	U	UTS		Index in Numeric field UTS					Display: see layouts Not selected
			A	FA	FA	Index 'UTS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for UTS in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'UTS' in MPDBRF for each workunit in which US33T values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Tensile Ultimate Strength'as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR .	For each occurence of US33T field, index 'ST' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
YS11T	Tensile Yield Strength	Numeric value	U	TYS		Index in Numeric field TYS					Display: see layouts Not selected
			A	FA	FA	Index 'TYS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for TYS in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'TYS' in MPDBRF for each workunit in which YS11T values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Tensile Yield Strength'as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of YS11T field, index 'L' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
YS12T	Tensile Yield Strength	Numeric value	U	TYS		Index in Numeric field TYS					Display: see layouts Not selected
			A	FA	FA	Index 'TYS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for TYS in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'TYS' in MPDBRF for each workunit in which YS12T values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Tensile Yeild Strength'as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of YS12T field, index '45 deg' in SPEOR, BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. *See Appendix A.*					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
YS22T	Tensile Yield Strength	Numeric value	U	TYS		Index in Numeric field TYS					Display: see layouts Not selected
			A	FA	FA	Index 'TYS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for TYS in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'TYS' in MPDBRF for each workunit in which YS22T values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Tensile Yield Strength'as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of YS22T field, index 'LT' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field SEA	DIS	Index/Search	Proximity L	P	S	A/W	Display/Select
YS33T	Tensile Ultimate Strength	Numeric value	U	TYS		Index in Numeric field TYS					Display: see layouts Not selected
			A	FA	FA	Index 'TYS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for TYS in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'TYS' in MPDBRF for each workunit in which YS33T values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Tensile Yield Strength'as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of YS33T field, index 'ST' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
US11C	Compressive Ultimate Strength	Numeric value	U	CUS		Index in Numeric field CUS					Display: see layouts Not selected
			A	FA	FA	Index 'CUS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for CUS in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'CUS' in MPDBRF for each workunit in which US11C values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Compressive Ultimate Strength'as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of US11C field, index 'L' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
US12C	Compressive Ultimate Strength	Numeric value	U	CUS		Index in Numeric field CUS					Display: see layouts Not selected
			A	FA	FA	Index 'CUS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for CUS in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'CUS' in MPDBRF for each workunit in which US12C values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Compressive Ultimate Strength'as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of US11C field, index '45 deg' in SPEOR, BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
US22C	Compressive Ultimate Strength	Numeric value	U	CUS		Index in Numeric field CUS					Display: see layouts Not selected
			A	FA	FA	Index 'CUS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for CUS in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'CUS' in MPDBRF for each workunit in which US22C values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Compressive Ultimate Strength'as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of US22C field, index 'LT' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
US33C	Compressive Ultimate Strength	Numeric value	U	CUS		Index in Numeric field CUS					Display: see layouts Not selected
			A	FA	FA	Index 'CUS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for CUS in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF *		Index 'CUS' in MPDBRF for each workunit in which US33C values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Compressive Ultimate Strength'as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of US33C field, index 'ST' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
YS11C	Compressive Yield Strength	Numeric value	U	CYS		Index in Numeric field CYS					Display: see layouts Not selected
			A	FA	FA	Index 'CYS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for CYS in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'CYS' in MPDBRF for each workunit in which YS11C values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Compressive Yield Strength'as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of YS11C field, index 'L' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
YS12C	Compressive Yield Strength	Numeric value	U	CYS		Index in Numeric field CYS					Display: see layouts Not selected
			A	FA	FA	Index 'CYS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for CYS in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'CYS' in MPDBRF for each workunit in which YS12C values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Compressive Yeild Strength'as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of YS12C field, index '45 deg' in SPEOR, BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
YS22C	Compressive Yield Strength	Numeric value	U	CYS		Index in Numeric field CYS					Display: see layouts Not selected
			A	FA	FA	Index 'CYS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for CYS in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'CYS' in MPDBRF for each workunit in which YS22C values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Compressive Yield Strength'as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of YS22C field, index 'LT' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
YS33C	Compressive Ultimate Strength	Numeric value	U	CYS		Index in Numeric field CYS					Display: see layouts Not selected
			A	FA	FA	Index 'CYS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for CYS in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'CYS' in MPDBRF for each workunit in which YS33C values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Compressive Yield Strength' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of YS33C field, index 'ST' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. *See Appendix A.*					Display code and text in FA. FA not selected
US12S	Ultimate Shear Stress	Numeric value	U	USS		Index in Numeric field USS					Display: see layouts Not selected
			A	FA	FA	Index 'USS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for USS in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'USS' in MPDBRF for each workunit in which US12S values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Ultimate Shear Stress' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing

Input field no.	Content	Input Format	ANU	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
US15B	Bearing Ultimate Strength	Numeric value	U	BRU		Index in Numeric field BRU					Display: see layouts Not selected
			A	FA	FA	Index 'BRU' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for BRU in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'BRU' in MPDBRF for each workunit in which US15B values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Bearing Ultimate Strength' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Ratio of Edge Distance to Hole Diameter	Numeric value	N	EOD	EOD	For each occurence of US15B input field index 1.5 in numeric field EOD.					Display, see layouts. Not selected.
			N	FA	FA	Index 'EOD' and tex in FA. See Appendix A.				-	Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
US20B	Bearing Ultimate Strength	Numeric value	U	BRU		Index in Numeric field BRU					Display: see layouts Not selected
			A	FA	FA	Index 'BRU' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for BRU in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'BRU' in MPDBRF for each workunit in which US20B values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Bearing Ultimate Strength' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Ratio of Edge Distance to Hole Diameter	Numeric value	N	EOD	EOD	For each occurence of US20B input field index 2.0 in numeric field EOD.					Display, see layouts. Not selected.
			N	FA	FA	*Index 'EOD' and tex* in FA. See Appendix A.				-	Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
YS15B	Bearing Yield Strength	Numeric value	U	BRY		Index in Numeric field BRY					Display: see layouts Not selected
			A	FA	FA	Index 'BRY' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for BRY in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'BRY' in MPDBRF for each workunit in which YS15B values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Bearing Yield Strength' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Ratio of Edge Distance to Hole Diameter	Numeric value	N	EOD	EOD	For each occurence of YS15B input field index 1.5 in numeric field EOD.					Display, see layouts. Not selected.
			N	FA	FA	Index 'EOD' and tex in FA. See Appendix A.				-	Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS.	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
US20B	Bearing Yield Strength	Numeric value	U	BRY		Index in Numeric field BRY					Display: see layouts Not selected
			A	FA	FA	Index 'BRY' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for BRY in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'BRY' in MPDBRF for each workunit in which YS20B values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Bearing Yield Strength' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Ratio of Edge Distance to Hole Diameter	Numeric value	N	EOD	EOD	For each occurence of YS20B input field index 2.0 in numeric field EOD.					Display, see layouts. Not selected.
			N	FA	FA	Index 'EOD' and tex in FA. See Appendix A.				-	Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
UE11T	Tensile Strain	Numeric value	U U	TSTRA ELON		Index in Numeric fields TSTRA and ELON					Display: see layouts Not selected
			A	FA	FA	Index 'TSTRA' and 'ELON' both with text in FA. See appendix A					Display code and text in FA. FA not selected
			A	THI		Index text for TSTRA and ELON in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'Elong.' and 'Tensile Strain' for each workunit in which UE11T values appear at the property level.	254	254			Display in BRF. See layout. Not selected
			A	PPPFA	PRPFA	Index both 'Tensile Strain' and 'Elongation' as bound phrases in PRPFA	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of UE11T field, index 'L' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
UE22T	Tensile Strain	Numeric value	U U	TSTRA ELON		Index in Numeric fields TSTRA and ELON					Display: see layouts Not selected
			A	FA	FA	Index 'TSTRA' and 'ELON' both with text in FA. See appendix A					Display code and text in FA. FA not selected
			A	THI		Index text for TSTRA and ELON in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'Elong.' and 'Tensile Strain' for each workunit in which UE22T values appear at the property level.	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index both 'Tensile Strain' and 'Elongation' as bound phrases in PRPFA	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of UE22T field, index 'LT' in SPEOR *BI, and THI*.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
UE33T	Tensile Strain	Numeric value	U U	TSTRA ELON		Index in Numeric fields TSTRA and ELON					Display: see layouts Not selected
			A	FA	FA	Index 'TSTRA' and 'ELON' both with text in FA. See appendix A					Display code and text in FA. FA not selected
			A	THI		Index text for TSTRA and ELON in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'Elong.' and 'Tensile Strain' for each workunit in which UE33T values appear at the property level.	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index both 'Tensile Strain' and 'Elongation' as bound phrases in PRPFA	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of UE33T field, index 'ST' in SPEOR BI, and THI.					*Display, see layouts.* Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
RA11	Reduction in Area	Numeric value	U	RA		Index in Numeric field RA					Display: see layouts Not selected
			A	FA	FA	Index 'RA' and text in FA. See appendix A					Display code and text in FA. FA not selected
			A	THI		Index text for RA in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'RA' in MPDBRF for each workunit in which RA11 values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Reduction in Area' as a bound phrase in PRPFA	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of RA11 field, index 'L' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
RA22	Reduction in Area	Numeric value	U	RA		Index in Numeric field RA					Display: see layouts Not selected
			A	FA	FA	Index 'RA' and text in FA. See appendix A					Display code and text in FA. FA not selected
			A	THI		Index text for RA in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'RA' in MPDBRF for each workunit in which RA11 values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Reduction in Area' as a bound phrase in PRPFA	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of RA22 field, index 'LT' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
RA33	Reduction in Area	Numeric value	U	RA		Index in Numeric field RA					Display: see layouts Not selected
			A	FA	FA	Index 'RA' and text in FA. See appendix A					Display code and text in FA. FA not selected
			A	THI		Index text for RA in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'RA' in MPDBRF for each workunit in which RA11 values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Reduction in Area' as a bound phrase in PRPFA	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of RA33 field, index 'ST' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
E11T	Tensile Modulus of Elasticity	Numeric value	U	E		Index in Numeric field E					Display: see layouts Not selected
			A	FA	FA	Index 'E' and text in FA. See appendix A					Display code and text in FA. FA not selected
			A	THI		Index text for E in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'E' in MPDBRF for each workunit in which E11T values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Tensile Modulus of Elasticity as a bound phrase in PRPFA	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of E11T field, index 'L' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
E12T	Tensile Modulus of Elasticity	Numeric value	U	E		Index in Numeric field E					Display: see layouts Not selected
			A	FA	FA	Index 'E' and text in FA. See appendix A					Display code and text in FA. FA not selected
			A	THI		Index text for E in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'E' in MPDBRF for each workunit in which E12T values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Tensile Modulus of Elasticity as a bound phrase in PRPFA	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of E12T field, index '45 deg' in SPEOR, BI and THI					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
E22T	Tensile Modulus o' Elasticity	Numeric value	U	E		Index in Numeric field E					Display: see layouts Not selected
			A	FA	FA	Index 'E' and text in FA. See appendix A					Display code and text in FA. FA not selectad
			A	THI		Index text for E in THI as a bound phrase.					Nct displayed Not selected
			A	MPDBRF		Index 'E' in MPDBRF for each workunit in which E22T values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Tensile Modulus of Elasticity as a bound phrase in PRPFA	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of E22T field, index 'LT' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
E11C	Compressive Modulus of Elasticity	Numeric value	U	EC		Index in Numeric field EC					Display: see layouts Not selected
			A	FA	FA	Index 'EC' and text in FA. See appendix A					Display code and text in FA. FA not selected
			A	THI		Index text for E in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'EC' in MPDBRF for each workunit in which E11C values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Compressive Modulus of Elasticity' as a bound phrase in PRPFA	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of E11C field, index 'L' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
E12C	Compressive Modulus of Elasticity	Numeric value	U	EC		Index in Numeric field EC					Display: see layouts Not selected
			A	FA	FA	Index 'EC'and text in FA. See appendix A					Display code and text in FA. FA not selected
			A	THI		Index text for E in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'EC'in MPDBRF for each workunit in which E12C values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Compressive Modulus of Elasticity' as a bound phrase in PRPFA	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of E12C field, index '45 deg' in SPEOR, BI and THI					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
E22C	Compressive Modulus of Elasticity	Numeric value	U	EC		Index in Numeric field EC					Display: see layouts Not selected
			A	FA	FA	Index 'EC'and text in FA. See appendix A					Display code and text in FA. FA not selected
			A	THI		Index text for E in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'EC'in MPDBRF for each workunit in which E22C values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Compressive Modulus of Elasticity' as a bound phrase in PRPFA	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A	SPEOR THI BI	SPEOR	For each occurence of E22C field, index 'LT' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
NU12	Poisson's Ratio	Numeric value	N	PRNU		Index in Numeric field PRNU					Display: see layouts Not selected
			A	FA	FA	Index 'PRNU' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for PRNU in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'Poisson's Ratio in MPDBRF for each workunit in which PRNU values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Poisson's Ratio as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Design Basis	Single letter 'A' 'B' or 'S' or text 'typical'	A A	BAS THI	BAS	For each occurence of NU12 input field, index 'typical' in BAS and THI					Display: See Layouts Not selected.
			A	FA	FA	Index 'BAS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
G12	Shear Modulus of Elasticity	Numeric value	U	EG		Index in Numeric field EG					Display: see layouts Not selected
			A	FA	FA	Index 'EG' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for EG in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'EG' in MPDBRF for each work-unit in which EG values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Shear Modulus of Elasticity' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Design Basis	Single letter 'A' 'B' or 'S' or text 'typical'	A A	BAS THI	BAS	For each occurence of G12 input field, index 'typical' in BAS and THI					Display: See Layouts Not selected.
			A	FA	FA	Index 'BAS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
CTE11	Linear Coefficient of Expansion	Numeric value	U	LEC		Index in Numeric field LEC					Display: see layouts Not selected
			A	FA	FA	Index 'LEC' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for LEC in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'Linear Exp.' in MPDBRF for each workunit in which LEC values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Linear Expansio Coefficient' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Design Basis	Single letter 'A' 'B' or 'S' or text 'typical'	A A	BAS THI	BAS	For each occurence of CTE11 input field index 'typical' in BAS and THI					Display: See Layouts Not selected.
			A	FA	FA	Index 'BAS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
CTC11	Thermal Conductivity	Numeric value	U	TCND		Index in Numeric field TCND					Display: see layouts Not selected
			A	FA	FA	Index 'TCND' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for TCND in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'Thermal Conductivity' in MPDBRF for each workunit in which TCND values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Thermal Conductivity' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Design Basis	Single letter 'A' 'B' or 'S' or text 'typical'	A A	BAS THI	BAS	[illegible] each occurence of [illegible]C11 input field index 'typical' in BAS and THI					Display: See Layouts Not selected.
				FA	FA	*Index 'BAS' and* text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
Room Temperature Plane Strain Fracture Toughness Table Data (IKSMAT)											
KIC_MAX	Plane Strain Fracture Toughness (Maximum)	Numeric value	U	KIC		Numeric value indexed in KIC					Display: see layout Not selected
			A	FA	FA	Index 'KIC' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for KIC in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'KIc' in MPDBRF for each workunit in which KIC_MAX values appear.	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Plane Strain Fracture Toughness' as bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Design Basis	Single letter 'A' 'B' or 'S' or text 'typical'	A A	BAS THI	BAS	For each occurence of KIC_MAX input field index 'maximum' in BAS and THI					Display: See Layouts Not selected.
			A	FA	FA	Index 'BAS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
KIC_MIN	Plane Strain Fracture Toughness (Minimum)	Numeric value	U	KIC		Numeric value indexed in KIC					Display: see layout Not selected
			A	FA	FA	Index 'KIC' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for KIC in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'KIc' in MPDBRF for each workunit in which KIC_MIN values appear.	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Plane Strain Fracture Toughness' as bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Design Basis	Single letter 'A' 'B' or 'S' or text 'typical'	A A	BAS THI	BAS	For each occurence of KIC_MIN input field index 'minimum' in BAS and THI					Display: See Layouts Not selected.
			A	FA	FA	Index 'BAS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field SEA	DIS	Index/Search	Proximity L	P	S	A/W	Display/Select
KIC_AVG	Plane Strain Fracture Toughness (Average)	Numeric value	U	KIC		Numeric value indexed in KIC					Display: see layout Not selected
			A	FA	FA	Index 'KIC' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for KIC in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'KIc' in MPDBRF for each workunit in which KIC_AVG values appear.	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Plane Strain Fracture Toughness'as bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Design Basis	Single letter 'A' 'B' or 'S' or text 'typical'	A A	BAS THI	BAS	For each occurence of KIC_AVG input field index 'average' in BAS and THI					Display: See Layouts Not selected.
			A	FA	FA	Index 'BAS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
KIC_CV	Plane Strain Fracture Toughness, Coefficient of Variation	Numeric value	U	KIC.CV		Numeric value indexed in KIC.CV					Display: see layout Not selected
			A	FA	FA	Index 'KIC.CV' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for KIC.CV in THI as a bound phrase.					Not displayed Not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
KIC_SPEC	Plane Strain Fracture Toughness (Minimum Specification Value)	Numeric value	U	KIC		Numeric value indexed in KIC					Display: see layout Not selcected
			A	FA	FA	Index 'KIC' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for KIC in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'KIc' in MPDBRF for each workunit in which KIC_SPEC values appear.	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Plane Strain Fracture Toughness'as bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Design Basis	Single letter 'A' 'B' or 'S' or text 'typical'	A A	BAS THI	BAS	For each occurence of KIC_AVG input field index 'minimum specification value' in BAS and THI					Display: See Layouts Not selected.
			A	FA	FA	Index 'BAS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Resistance to Stress Corrosion Ratings Table Data (IKSMAT)

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
RSCR11	Stress Corrosion Rating	1 character code	A A	SCC BI		Index code in SCC and BI					Display, see layout Not selected
				FA	FA	Index 'SCC' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of RSCR11 field, index 'L' in SPEOR BI, and THI.					Display, see layouts. Not selected.

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
RSCR22	Stress Corrosion Rating	1 character code	A A	SCC BI		Index code in SCC and BI					Display, see layout Not selected
				FA	FA	Index 'SCC' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of RSCR22 field, index 'LT' in SPEOR BI, and THI.					Display, see layouts. Not selected.
RSCR33	Stress Corrosion Rating	1 character code	A A	SCC BI		Index code in SCC and BI					Display, see layout Not selected
				FA	FA	Index 'SCC' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of RSCR33 field, index 'ST' in SPEOR BI, and THI.					Display, see layouts. Not selected.

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
Maximum Specfied Tension Stress Table Data (IKSMAT)											
SIG33T_MAX	Tensile Stress (Maximum)	Numeric value	U	TST		Index in Numeric field TST					Display: see layouts Not selected
			A	FA	FA	Index 'TST' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for 'TST' in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'Tensile Stress' in MPDBRF for each workunit in which SIG33T_MAX values appear.	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Tensile Stress' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of SIG33T_MAX field, index 'ST' in SPEOR *BI, and THI.*					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected
	Design Basis	Single letter 'A' 'B' or 'S' or text 'typical'	A A	BAS THI	BAS	For each occurence of SIG33T_MAX input field index 'maximum' in BAS and THI					Display: See Layouts Not selected.
	Test Temperature	Numeric Value	U	TTEMP		Index 68-75 F in TTEMP for each occurrence of TSCM in this table.					Display, see layout Not selected
			A	FA	FA	Index 'TTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
FIGLINE	Figure Level	Data elements for X and Y axes	A			Not searched					Not displayed

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
Residual Strength Behavior Curve Data (IKSMAT)											
Kapp=	Plane Stress Fracture Toughness	Numeric value (extracted from FOOTNOTE data)	U	KC		Index in Numeric field KC					Display: see layouts Not selected
			A	FA	FA	Index 'KC' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for KC in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Plane Stress Fracture Toughness' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
CL	Initial Crack Length	Numeric value	U	CRIN		Index numeric value in CRIN					Display, see layout Not selected.
			A	FA	FA	Index 'CRIN' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
US_R	Residual Strength	Numeric value	U	RESST		Index in Numeric field RESST					Display: see layouts Not selected
			A	FA	FA	Index 'RESST' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for RESST in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Residual Strength' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
Effect of Temperature on Physical Property Curve Data											
TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
CTE11	Linear Coefficient of Expansion	Numeric value	U	LEC		Index in Numeric field LEC					Display: see layouts Not selected
			A	FA	FA	Index 'LEC' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for LEC in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'Linear Exp.' in MPDBRF for each workunit in which LEC values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Linear Expansio Coefficient' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Design Basis	Single letter 'A' 'B' or 'S' or text 'typical'	A A	BAS THI	BAS	For each occurence of CTE11 input field index 'typical' in BAS and THI					Display: See Layouts Not selected.
			A	FA	FA	Index 'BAS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
CTC11	Thermal Conductivity	Numeric value	U	TCND		Index in Numeric field TCND					Display: see layouts Not selected
			A	FA	FA	Index 'TCND' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for TCND in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'Thermal Conductivity' in MPDBRF for each workunit in which TCND values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Thermal Conductivity' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Design Basis	Single letter 'A' 'B' or 'S' or text 'typical'	A A	BAS THI	BAS	For each occurence of CTC11 input field index 'typical' in BAS and THI					Display: See Layouts Not selected.
				FA	FA	Index 'BAS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
CP	Specific Heat	Numeric Value	U	SPHT		Index in numeric field SPHT					Display, see layout Not selected
			A	FA	FA	Index 'SPHT' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for SPHT in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'Sp. Ht.' in MPDBRF for each work-unit in which SPHT values appear	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Specific Heat' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Design Basis	Single letter 'A' 'B' or 'S' or text 'typical'	A A	BAS THI	BAS	For each occurence of CP input field, index 'typical' in BAS and THI					Display: See Layouts Not selected.
			A	FA	FA	Index 'BAS' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Percent Room Temperature Ftu-L Curve Data (IKSMAT)

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field SEA	DIS	Index/Search	Proximity L	P	S	A/W	Display/Select
%US11T	Percent Room Temperature Ultimate Strength	Numeric value	U	UTS%RT		Index in Numeric field UTS%RT					Display: see layouts Not selected
			A	FA	FA	Index 'UTS%RT' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for UTS%RT in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Percent Room Temperature UTS' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of %US11T field, index 'L' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected
UTS.300	Ftu value at 300 deg F	Calculate by value of UTS%RT @ 300 F* UTS value	N	UTS.300		Index in Numeric IKSMAT field.					Display: IKSMAT only Not selected

Percent Room Temperature Fty-L Curve Data (IKSMAT)

Input field no.	Content	Input Format	A N U	STN Field SEA	DIS	Index/Search	Proximity L	P	S	A/W	Display/Select
TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
%YS11T	Percent Room Temperature Yield Strength	Numeric value	U	TYS%RT		Index in Numeric field TYS%RT					Display: see layouts Not selected
			A	FA	FA	Index 'TYS%RT' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for TYS%RT in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Percent Room Temperature TYS' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of %YS11T field, index 'L' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected
TYS.300	Fty value at 300 deg F	Calculate by value of TYS%RT @ 300 F* TYS value	N	TYS.300		Index in Numeric IKSMAT field.					Display: IKSMAT only Not selected

Percent Room Temperature Fcy-L Curve Data (IKSMAT)

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
%YS11C	Percent Room Temperature Compressive Yield Strength	Numeric value	U	CYS%RT		Index in Numeric field CYS%RT					Display: see layouts Not selected
			A	FA	FA	Index 'CYS%RT' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for CYS%RT in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Percent Room Temperature CYS' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of %YS11C field, index 'L' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected
CYS.300	Fcy value at 300 deg F	Calculate by value of CYS%RT @ 300 F* CYS value	N	CYS.300		Index in Numeric IKSMAT field.					Display: IKSMAT only Not selected

Percent Room Temperature Fcy-LT Curve Data (IKSMAT)

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
%YS22C	Percent Room Temperature Compressive Yield Strength	Numeric value	U	CYS%RT		Index in Numeric field CYS%RT					Display: see layouts Not selected
			A	FA	FA	Index 'CYS%RT' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for CYS%RT in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Percent Room Temperature CYS' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of %YS22C field, index 'LT' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected
CYS.300	Fcy value at 300 deg F	Calculate by value of CYS%RT @ 300 F* CYS value	N	CYS.300		Index in Numeric *IKSMAT field.*					Display: IKSMAT only Not selected

Percent Room Temperature Fsu Curve Data (IKSMAT)

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
%US12S	Percent Room Temperature Shear Strength	Numeric value	U	USS%RT		Index in Numeric field USS%RT					Display: see layouts Not selected
			A	FA	FA	Index 'USS%RT' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for USS%RT in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Percent Room Temperature USS' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
USS.300	Fsu value at 300 deg F	Calculate by value of USS%RT @ 300 F* USS value	N	USS.300		Index in Numeric IKSMAT field.					Display: IKSMAT only Not selected

Percent Room Temperature Fbru Curve Data (IKSMAT)

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
%US_B	Percent Room Temperature Bearing Ultimate Strength	Numeric value	U	BRU%RT		Index in Numeric field BRU%RT					Display: see layouts Not selected
			A	FA	FA	Index 'BRU%RT' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for BRU%RT in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Percent Room Temperature BRU' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
BRU.300	Fbru value at 300 deg F	Calculate by value of BRU%RT @ 300 F* BRU value	N	BRU.300		Index in Numeric IKSMAT field.					Display: IKSMAT only Not selected

Percent Room Temperature Fbry Curve Data

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
%YS_B	Percent Room Temperature Bearing Yield Strength	Numeric value	U	BRY%RT		Index in Numeric field BRY%RT					Display: see layouts Not selected
			A	FA	FA	Index 'BRY%RT' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		*Index text for BRY%RT* in THI as a bound phrase.					*Not displayed* Not selected
			A	PRPFA	PRPFA	Index 'Percent Room Temperature BRY' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing

Percent Room Temperature e (elongation) Curve Data

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
%UE11	Percent Room Temperature Elongation	Numeric value	U	ELON%RT		Index in Numeric field ELON%RT					Display: see layouts Not selected .
			A	FA	FA	Index 'ELON%RT' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for ELON%RT in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Percent Room Temperature Elongation' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of %UE11 field, index 'L' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Percent Room Temperature RA-L Curve Data

Input field no.	Content	Input Format	ANU	SEA	DIS	Index/Search	L	P	S	A/W	Display/Select
TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
%RA11	Percent Room Temperature Reduction in Area	Numeric value	U	RA%RT		Index in Numeric field RA%RT					Display: see layouts Not selected
			A	FA	FA	Index 'RA%RT' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for RA%RT in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Percent Room Temperature RA' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of %RA11 field, index 'L' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Percent Room Temperature E-L Curve Data (IKSMAT)

TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
%E11T	Percent Room Temperature Tensile Modulus of Elasticity	Numeric value	U	E%RT		Index in Numeric field E%RT					Display: see layouts Not selected
			A	FA	FA	Index 'E%RT' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for E%RT in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Percent Room Temperature E' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of %E11T field, index 'L' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected
E.300	E value at 300 deg F	Calculate by value of E%RT @ 300 F* E value	N	E.300		Index in Numeric IKSMAT field.					Display: IKSMAT only Not selected

Percent Room Temperature E (dynamic) Curve Data

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
%E_D	Percent Room Temperature Dynamic Modulus of Elasticity	Numeric value	U	E%RT		Index in Numeric field E%RT					Display: see layouts Not selected
			A	FA	FA	Index 'E%RT' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for E%RT in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Percent Room Temperature E' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
E.300	E value at 300 deg F	Calculate by value of E%RT @ 300 F* E value	N	E.300		Index in Numeric IKSMAT field.					Display: IKSMAT only Not selected

Percent Room Temperature Ec-L Curve Data (IKSMAT)

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
%E11C	Percent Room Temperature Compressive Modulus of Elasticity	Numeric value	U	EC%RT		Index in Numeric field EC%RT					Display: see layouts Not selected
			A	FA	FA	Index 'EC%RT' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for EC%RT in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Percent Room Temperature Ec' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of %E11C field, index 'L' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected
EC.300	Ec value at 300 deg F	Calculate by value of EC%RT @ 300 F* EC value	N	EC.300		Index in Numeric IKSMAT field.					Display: IKSMAT only Not selected

Percent Room Temperature G Curve Data

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	DIS	Index/Search	Proximity L	P	S	A/W	Display/Select
%G12	Percent Room Temperature Shear Modulus of Elasticity	Numeric value	U	EG%RT		Index in Numeric field EG%RT					Display: see layouts Not selected
			A	FA	FA	Index 'EG%RT' and text in FA. See Appendix A.					Display code.and text in FA. FA not selected
			A	THI		Index text for EG%RT in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Percent Room Temperature EG' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing

Percent Room Temperature G (dynamic) Curve Data

Input field no.	Content	Input Format	ANU	STN Field SEA	DIS	Index/Search	Proximity L	P	S	A/W	Display/Select
TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Displa., see layout
			A	FA	FA	*Index 'EXTEMP' and* text in FA. See Appendix A.					Display code and text in FA. FA not selected
%G_D	Percent Room Temperature Dynamic Shear Modulus	Numeric value	U	EG%RT		Index in Numeric field EG%RT					Display: see layouts Not selected
			A	FA	FA	Index 'EG%RT' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for EG%RT in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Percent Room Temperature EG' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
Percent Room Temperature Kic Curve Data											
TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
%KIC	Percent Room Temperature Plane Strain Fracture Toughness	Numeric value	U	KIC%RT		Index in Numeric field KIC%RT					Display: see layouts Not selected
			A	FA	FA	Index 'KIC%RT' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for KIC%RT in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Percent Room Temperature KIC' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
Percent Room Temperature Poisson's Ratio Curve Data											
TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
%NU	Percent Room Temperature Poisson's Ratio	Numeric value	U	PRNU%RT		Index in Numeric field PRNU%RT					Display: see layouts Not selected
			A	FA	FA	Index 'PRNU%RT' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for PRNU%RT in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Percent Room Temperature PRNU' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Effect of Temperature on Poisson's Ratio Curve Data (IKSMAT)

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
NU	Poisson's Ratio	Numeric value	N	PRNU		Index in Numeric field PRNU					Display: see layouts Not selected
			A	FA	FA	Index 'PRNU' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for PRNU in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Poisson's Ratio' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing

Tensile Stress-Strain (L, LT, ST) Curve Data (NOT USED IN IKSMAT/STN FILE)

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
EPS	Tensile Strain	Numeric value				Not searched					Not displayed
SIG11T	Tensile Stress	Numeric value				Not searched					Not displayed

Input field no.	Content	Input Format	A N U	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
EPS	Tensile Strain	Numeric value				Not searched					Not displayed
SIG22T	Tensile Stress	Numeric value				Not searched					Not displayed
EPS	Tensile Strain	Numer.c value				Not searched					Not displayed
SIG33T	Tensile Stress	Numeric value				Not searched					Not displayed
Compressive Stress-Strain (L, LT, ST) Curve Data (NOT USED IN IKSMAT/STN FILE)											
EPS	Compressive Strain	Numeric value				Not searched					Not displayed
SIG11C	Compressive Stress	Numeric value				Not searched					Not displayed
EPS	Compressive Strain	Numeric value				Not searched					Not displayed
SIG22C	Compressive Stress	Numeric value				Not searched					Not displayed
EPS	Compressive Strain	Numeric value				Not searched					Not displayed
SIG33C	Compressive Stress	Numeric value				Not searched					Not displayed
Compressive Tangent Modulus (L, LT, ST) Curve Data (NOT USED IN IKSMAT/STN FILE)											
ETN_C	Compressive Tangent Modulus	Numeric value				Not searched					Not displayed
SIG11C	Compressive Stress	Numeric value				Not searched					Not displayed

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
ETN_C	Compressive Tangent Modulus	Numeric value				Not searched					Not displayed
SIG22C	Compressive Stress	Numeric value				Not searched					Not displayed
ETN_C	Compressive Tangent Modulus	Numeric value				Not searched					Not displayed
SIG33C	Compressive Stress	Numeric value				Not searched					Not displayed

Biaxial Stress-Strain Curve Data (NOT USED IN IKSMAT/STN FILE)

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
EPS	Biaxial Strain	Numeric value				Not searched					Not displayed
SIG_P	Maximum Principal Stress	Numeric value				Not searched					Not displayed

Biaxial Yield Stress Envelope Curve Data

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
%YS_H	Hoop Stress as Percent TYS	Numeric value	U	TYS%H		Index numeric value in TYS%H					Display, see layout Not selected.
			A	FA	FA	Index 'TYS%H' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
%YS_A	Axial Stress as Percent TYS	Numeric value	U	TYS%A		Index in Numeric field TYS%A					Display: see layouts Not selected
			A	FA	FA	Index 'TYS%A' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for TYS%A in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Axial Stress as Percent TYS' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
Best Fit S/N (L, LT, ST) Curve Data (IKSMAT)											
N	Fatigue Life	Numeric value	U	FATL		Index numeric value in FATL					Display, see layout Not selected.
			A	FA	FA	Index 'FATL' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
SIG11	Fatigue Strength	Numeric value	U	FAT		Index in Numeric field FAT					Display: see layouts Not selected
			A	FA	FA	Index 'FAT' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for FAT in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Fatigue Strength' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of SIG11 field, index 'L' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected
N	Fatigue Life	Numeric value	U	FATL		Index numeric value in FATL					Display, see layout Not selected.
			A	FA	FA	Index 'FATL' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	ANU	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	
SIG22	Fatigue Strength	Numeric value	U	FAT		Index in Numeric field FAT					Display: see layouts Not selected
			A	FA	FA	Index 'FAT' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for FAT in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Fatigue Strength' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of SIG22 field, index 'LT' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected
N	Fatigue Life	Numeric value	U	FATL		Index numeric value in FATL					Display, see layout Not selected.
			A	FA	FA	Index 'FATL' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
SIG33	Fatigue Strength	Numeric value	U	FAT		Index in Numeric field FAT					Display: see layouts Not selected
			A	FA	FA	Index 'FAT' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for FAT in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Fatigue Strength' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
	Specimen Orientation	Codes of 1-3 of the characters: L, T, S. (Use thesaurus to explain these terms)	A A A	SPEOR THI BI	SPEOR	For each occurence of SIG33 field, index 'ST' in SPEOR BI, and THI.					Display, see layouts. Not selected.
			A	FA	FA	Index 'SPEOR' and tex in FA. See Appendix A.					Display code and text in FA. FA not selected

Best Fit epsilon/N Curve Data

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
N	Fatigue Life	Numeric value	U	FATL		Index numeric value in FATL					Display, see layout Not selected.
			A	FA	FA	Index 'FATL' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
DEPS	Fatigue Strain Range	Numeric value	U	FATSTRA		Index in Numeric field FATSTRA					Display: see layouts Not selected
			A	FA	FA	Index 'FATSTRA' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for FATSTRA in THI as a bound phrase.					Not displayed Not selected
			A	PRPFA	PRPFA	Index 'Fatigue Strain Range' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
Cyclic Stress-Strain Curve Data (NOT USED IN IKSMAT/STN FILE)											
EPS	Cyclic Strain	Numeric value				Not searched					Not displayed
SIG_CYC	Cyclic Stress	Numeric value				Not searched					Not displayed
Fatigue Crack Propagation Curve Data (IKSMAT)											
DELK	Stress Intensity Factor Range	Numeric value	U	DELK		Index numeric value in DELK					Display, see layout Not selected.
			A	FA	FA	Index 'DELK' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
DADN	Fatigue Crack Propagation Rate	Numeric value	N	FCGR		Index in Numeric field FCGR					Display: see layouts Not selected
			A	FA	FA	Index 'FCGR' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for 'FCGR' in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'Fatigue Crack Propagation Rate' in MPDBRF for each workunit in which DADN values appear.	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Mean Stress Relaxation' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
Effect of Temperature on Ramberg Osgood Parameter Curve Data											
TEMP	Exposure Temperature	Numeric value	U	EXTEMP		Index numeric value in EXTEMP. If there is no TEMP value at the ENVIRON level, also index in TTEMP.					Display, see layout
			A	FA	FA	Index 'EXTEMP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
RAM_OSGT	Ramberg Osgood Parameter	Numeric value	N	ROP		Index in Numeric field ROP					Display: see layouts Not selected
			A	FA	FA	Index 'ROP' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for ROP in THI as a bound phrase.					Not displayed Not selected
			A	*PRPFA*	*PRPFA*	*Index 'Ramberg-Osgood* Parameter' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
Mean Stress Relaxation Curve Data											
DEPS_02	Strain Increment	Numeric value	U	STRAIN		Index numeric value in STRAIN					Display, see layout Not selected.
			A	FA	FA	Index 'STRAIN' and text in FA. See Appendix A.					Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
SIG_M	Mean Stress Relaxation	Numeric value	N	MSTREL		Index in Numeric fiel MSTREL					Display: see layouts Not selected
			A	FA	FA	Index 'MSTREL' and text in FA. See Appendix A.					Display code and text in FA. FA not selected
			A	THI		Index text for 'MSTREL in THI as a bound phrase.					Not displayed Not selected
			A	MPDBRF		Index 'Mean Stress Relaxation' in MPDBRF for each workunit in which SIG_M values appear.	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Mean Stress Relaxation' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing

Typical Creep Properties Data (NOT IN PDA DATA SET) (NOT USED IN IKSMAT/STN FILE)

Average Isothermal Creep Curve Data (NOT USED IN IKSMAT/STN FILE)
Average Isothermal Stress Rupture Curve Data (NOT USED IN IKSMAT/STN FILE)

TIME	Time to % Strain or to Rupture	Numeric value				Not searched					Not displayed
SIG	Creep Stress	Numeric value				Not searched					Not displayed

Bending Modulus of Rupture Curve Data (NOT USED IN IKSMAT/STN FILE)

DT	Diameter-to-thickness Ratio	Numeric value				Not searched					Not displayed
F_B	Bending Modulus of Rupture	Numeric value				Not searched					Not displayed
DT	Diameter-to-thickness Ratio	Numeric value				Not searched					Not displayed

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
F_BR	Normalized Bending Modulus of Rupture	Numeric value				Not searched					Not displayed

Allowable Column Stress (NOT IN PDA DATA SET)
Allowable Crushing Stress (NOT IN PDA DATA SET)

Torsional Modulus of Rupture Curve Data (NOT USED IN IKSMAT/STN FILE)

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
DT	Diameter-to-thickness Ratio	Numeric value				Not searched					Not displayed
F_ST	Torsional Modulus of Rupture	Numeric value				Not searched					Not displayed

Bearing Property Reductions (NOT IN PDA DATA SET)

Maximum Round Diameter Table Data

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
DIA_MAX_RND	Maximum Round Diameter	Numeric value	U	MAXDIA		Numeric value or range indexed in numeric field MAXDIA					Display, see layouts. Not selected.
			A	FA	FA	Index 'MAXDIA'and tex in FA. See Appendix A.					Display code and text in FA. Not selected.

Input field no.	Content	Input Format	A N U	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select
Tempering Temperatures Table Data											
H_RC	Rockwell Hardness	Numeric range	N	RHN		Index range in numeric field RHN.					Display, see layout. Not selected.
			A A	FA THI	FA	Index 'RHN' and text in FA. See Appendix A. Index text for FA in THI.					Display code and text in FA. FA not selected
			A	*MPDBRF*		*Index 'RHN' in MPDBRF* for each workunit in which H_RC values appear.	254	254			Display in BRF. See layout. Not selected
			A	PRPFA	PRPFA	Index 'Rockwell Hardness' as a bound phrase in PRPFA.	253	253			Display text. Select: no parsing
		Rockwell Hardness Scale	A	RHN.SC		Index 'C' in RHN.SC for each occurrence of H_RC in a workunit					Display, see layout. Not selected.
Precipitation Heat Treatments Table Data											
TEMP_ORIG	Original Temper, Precipitation Heat Treatment	Alphanumeric string	A			Not searched?					Display only?
TEMP_AGING	Aging Temper, Precipitation Heat Treatment	Alphanumeric string	A			Not searched?					Display only?
Temperature Exposure Limits for Low Alloy Steels Table Data											
TEMP_EXP_LIM	Temperature Exposure Limit	Alphanumeric string	U			Not searched?					Display only?

Input field no.	Content	Input Format	ANU	STN Field SEA	STN Field DIS	Index/Search	Proximity L	Proximity P	Proximity S	Proximity A/W	Display/Select

Effect of Elevated Temperature Exposure on Typical Tensile Properties Table (NOT IN PDA DATA SET)
Supplemental Information on Creep and Stress Rupture Properties (NOT IN PDA DATA SET)
Fabrication Weldability (NOT IN PDA DATA SET)

Generated Fields

Input field no.	Content	Input Format	ANU	SEA	DIS	Index/Search	L	P	S	A/W	Display/Select
	Basic Index	ALLOY UNS RN FRM COND TEMPR SPEOR MATCL MATSUB SCC MATTP	A	BI		Parsed to single word terms.					Not displayed Not selected.
	CAS Registry Number	Generated from Appendix ?	A A	RN	RN	Index as generated in RN	7	1	1		Display, see layout Select, no parsing
			A	BI		Parse at non-alpha-numerics and blanks but not hyphens and index single words in BI.	7	1	1	1-n	Not displayed. Not selected.
			A	FA	FA	Index 'RN' and text in FA. See Appendix A.	7	1	1		Display code and text in FA. FA not selected

Input field no.	Content	Input Format	A N U	STN Field		Index/Search	Proximity				Display/Select
				SEA	DIS		L	P	S	A/W	

File: MH5.2
Status: Proposed
File Design

Section: K2.227.1.2
Date: 92.04.17

Predefined Display Formats

ALL

BRF

IDE

ELON

MECH

MOD

PHYS

Other Formats

HIT

KWIC

QRD Specifications

ACC TAB/FIG NO.