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SACRD: A Data Base for Fast Reactor Safety Computer Codes—General Description

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SACRD: A DATA BASE FOR FAST REACTOR SAFETY COMPUTER CODES -- GENERAL DESCRIPTION

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ABSTRACT

SACRD* is a data base of material properties and other handbook data needed in computer codes used for fast reactor safety studies. Data are available in the thermodynamics, heat transfer, fluid mechanics, structural mechanics, aerosol transport, meteorology, neutronics, and dosimetry areas. Tabular, graphical and parameterized data are provided in many cases. A general description of the SACRD system is presented in this document.

INTRODUCTION

The SACRD data base effort was initiated in 1975 to provide a central computerized data collection for use in fast reactor safety computer codes. Initial intentions were to encompass "handbook" and other nonproblem-dependent data related to LMFBRs, especially at extreme conditions where little or no data are available; however, the scope was subsequently expanded to cover other advanced reactor concepts needing property data at accident conditions.

The advantages of a central data base are many. A single source of data makes it easier to compare results from different calculational schemes, since all codes can use identical data. An evaluated reference

*SACRD is an acronym for Safety Analysis Computerized Reactor Data.

source removes the problem of having to justify the use of a set of data, since the data have already received a thorough screening and review. Most important, however, is the improvement and expansion of the available data which can be assured with a data base that is maintained on a continuing basis. It was in consideration of these reasons that the Division of Reactor Research and Technology (RRT) of the Department of Energy (DOE) requested Oak Ridge National Laboratory (ORNL) to accept the responsibility for establishing and coordinating activities relative to the SACRD data base.

SACRD is organized much along the same lines as several other successful data collections, in particular the *Evaluated Nuclear Data File* (ENDF)[1] and the *Nuclear Systems Materials Handbook* (NSMH).[2] Like these, the SACRD effort is directed by a central committee composed of experts and interested parties from government, universities, national laboratories and industry. This committee, called the Safety Analysis Data Coordinating Group (SADCG), coordinates the activities of a number of subcommittees, whose primary responsibilities are in the data evaluation area. A list of the current SADCG members is included in Table I. A subcommittee is typically composed of five to ten members. Present committees are:

Thermophysical Properties Committee,

Structural Mechanical Properties Committee,

Fuel Mechanical Properties Committee,

Aerosol Transport Properties Committee,

Radiological Data Committee,

Neutronic Data Committee, and

External Code Interfaces and Formats Committee.

Table I. SADCG Members

DOE [illegible] Harry Alter U.S. Department of Energy Division of [illegible] Research and Technology Safety [illegible] Branch Washington, DC [illegible]	[illegible] CG Com. [illegible] [illegible] Ridge National Laboratory [illegible] P. [illegible] Oak Ridge, TN [illegible]	At-Large Member [illegible] [illegible] [illegible] [illegible] Albuquerque, NM [illegible]	At-Large Member M. G. Stevenson Los Alamos Scientific Laboratory [illegible] P. O. [illegible] Los Alamos, NM 87545
Fuel Mechanical Properties Data Com. [illegible] Westinghouse Advanced Reactor Division P. O. Box 158 Madison, PA 15663	Data Base [illegible] [illegible] Oak Ridge National Laboratory [illegible] [illegible] Oak Ridge, TN [illegible]	[illegible] Data Com. [illegible] [illegible] National Laboratory [illegible] [illegible] Oak Ridge, TN 37830	At-Large Member [illegible] Westinghouse Advanced Reactors Div. P. O. Box 158 Madison, PA 15663
[illegible] [illegible] [illegible] Drive Carlsbad, CA [illegible]	At-Large Member [illegible] Hanford Engineering Development Lab. [illegible] [illegible] Richland, WA [illegible]	[illegible] Data Com. [illegible] Argonne National Laboratory [illegible] [illegible] Cass Avenue Argonne, IL [illegible]	At-Large Member [illegible] General Atomic Company P. O. Box [illegible] San Diego, CA [illegible]
NRC Representative R. Curtis Nuclear Regulatory Commission Reactor Safety Division Washington, DC 20555	At-Large Member [illegible] General Electric Company [illegible] Avenue Sunnyvale, CA [illegible]	[illegible] Com. [illegible] [illegible] [illegible] [illegible], CA [illegible]	At-Large Member Eric Siegman Combustion Engineering, Inc. [illegible] Prospect Hill Road Windsor, CT 06095
Neutronics Data Com. D. [illegible] Argonne National Laboratory Reactor Analysis & Safety Division 9700 South Cass Avenue Argonne, IL [illegible]	Structural Mech. Data Com. [illegible] Hanford Engineering Development Lab. P. O. Box 1970 Richland, WA 99352	NRC Representative [illegible] Nuclear Regulatory Commission Washington, DC [illegible]	Interfaces and Fmt. Com. [illegible] Hanford Engineering Development Lab. [illegible] 121 Federal Building P. O. Box 1970 Richland, WA 99352

The successful evaluation and utilization of the data bank will be dependent, to a large extent, on the performance of these committees.

In order to avoid duplication, the SACRD committees include individuals who are also members of similar committees for other evaluation efforts. This ensures that the SACRD evaluation work will focus on extending and augmenting existing data to cover the "extreme" ranges needed by the reactor safety analyst.

DATA MANAGEMENT

The data in SACRD, with the exception of meteorology- and dosimetry-related parameters, are managed by the . . . system,[3] a modular programming system developed at Savannah River Laboratories.

SACRD Data Under JOSHUA Control

A major JOSHUA feature is the general data base manager used to catalog and retrieve data from the large data banks needed by the application modules in the system. The cataloging schemes used in its data banks are particularly attractive for SACRD data, because they are both simple to use and, since all data are cataloged separate from the data itself, can be searched very efficiently. Figure 1 illustrates the relationship of a computer program to a JOSHUA data bank.

Most property data in SACRD are classified according to five qualifiers:

1. File - an arbitrary division of the data into groupings which correspond to the type of data; e.g., Thermodynamic, Structural Mechanics, Heat Transfer, etc.

2. Property - the property or function.

3. Material - the isotope, mixture, compound, etc.

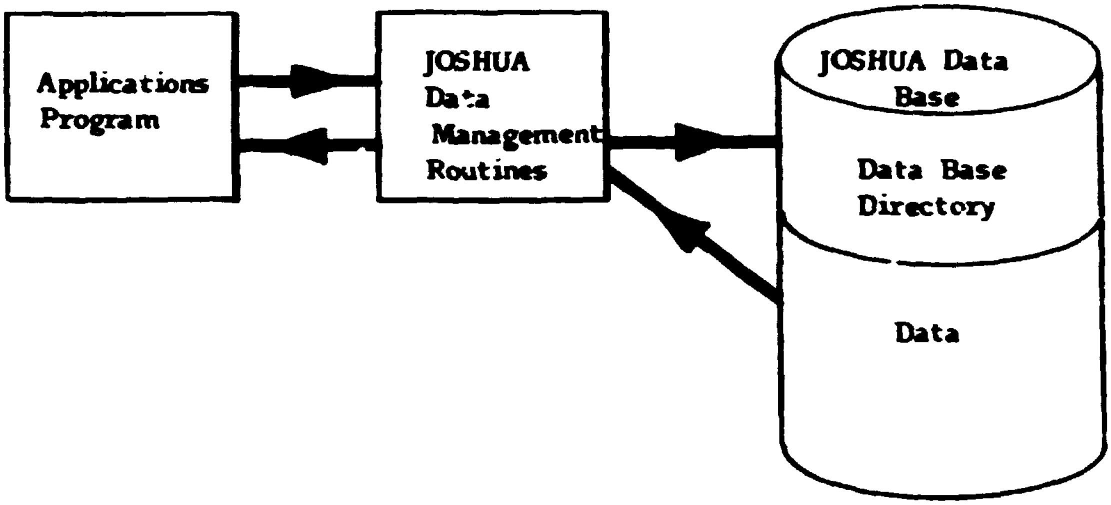

Fig. 1. Relation of computer code to JOSHUA data bank.

4. Version - the version of the data.

5. Type - the kind of information desired, which presently can include:

   a. abstractual information,

   b. tabular data,

   c. parameterized data.

These qualifiers are designated by eight-character alphanumeric names which, in most cases, can be chosen to make sense. A portion of an index of a very small subset of data taken from the NSMH is shown in Fig. 2. In this listing the version abbreviation "NSMH" is seen on the top line, and the material abbreviations are alphabetically arranged in the left-most columns, with the property abbreviations alphabetically arranged and indented under these. It will be noted that Al-6061 is an abbreviation for Aluminum-6061, NAK for sodium-potassium, etc., while CHCØMP stands for chemical composition, CV for c_v, the specific heat at constant volume, etc. (It should be noted that the SACRD user will have to concern himself only with these special abbreviations when he communicates directly with the data base using one of the SACRD interactive

```
VERSION NSMH--NUCLEAR SYSTEMS MATERIALS HANDBOOK
                                                                    PAGE  1
                     M A T E R I A L   I N D E X                    -------

AL-6061. ALUMINUM ALLOY 6061
    CHCOMP. CHEMICAL COMPOSITION/STOICHIOMETRY/CRYSTAL
            STRUCTURE                                               A
    RA. REDUCTION OF AREA                                           CT
    TE. TOTAL ELONGATION                                            CT
    UTS. ULTIMATE TENSILE STRENGTH                                  CT
    YS. YIELD STRENGTH                                              CT

A286. STEEL A-286
    CHCOMP. CHEMICAL COMPOSITION/STOICHIOMETRY/CRYSTAL
            STRUCTURE                                               A
    K. THERMAL CONDUCTIVITY                                         ACPT
    POISRAT. POISSON'S RATIO                                        ACPT
    RA. REDUCTION OF AREA                                           ACPT
    SM. SHEAR MODULUS (MODULUS OF RIGIDITY)                         CPT
    SR. STRESS-RUPTURE STRENGTH                                     CT
    TD. THERMAL DIFFUSIVITY                                         CPT
    TE. TOTAL ELONGATION                                            CPT
    UTS. ULTIMATE TENSILE STRENGTH                                  CPT
    YM. YOUNG'S MODULUS (MODULUS OF ELASTICITY)                     CPT
    YS. YIELD STRENGTH                                              ACPT

I600. INCONEL I600
    BRINELL. HARDNESS                                               ACT
    CHCOMP. CHEMICAL COMPOSITION/STOICHIOMETRY/CRYSTAL
            STRUCTURE                                               AA
    K. THERMAL CONDUCTIVITY                                         ACPT
    MRTP. MINIMUM SPECIFIED PROPERTIES                              AA
    PF. PRODUCT FORMS/APPLICABLE SPECIFICATION                      A
    POISRAT. POISSON'S RATIO                                        ACPT
    RA. REDUCTION OF AREA                                           ACT
    SM. SHEAR MODULUS (MODULUS OF RIGIDITY)                         ACPT
    SWELLING. SWELLING                                              A
    TD. THERMAL DIFFUSIVITY                                         ACPT
    TE. TOTAL ELONGATION                                            ACT
    UTS. ULTIMATE TENSILE STRENGTH                                  ACPT
    YM. YOUNG'S MODULUS (MODULUS OF ELASTICITY)                     ACPT
    YS. YIELD STRENGTH                                              ACT

I718. INCONEL I718
    CHCOMP. CHEMICAL COMPOSITION/STOICHIOMETRY/CRYSTAL
            STRUCTURE                                               AA
    K. THERMAL CONDUCTIVITY                                         ACPT
    MSP. MINIMUM SPECIFIED PROPERTIES                               A
    PF. PRODUCT FORMS/APPLICABLE SPECIFICATION                      A
    POISRAT. POISSON'S RATIO                                        ACPT
    RA. REDUCTION OF AREA                                           ACPT
    SM. SHEAR MODULUS (MODULUS OF RIGIDITY)                         CPT
    SR. STRESS-RUPTURE STRENGTH                                     ACT
    TD. THERMAL DIFFUSIVITY                                         ACPT
    TE. TOTAL ELONGATION                                            CPT
    UTS. ULTIMATE TENSILE STRENGTH                                  PT
    YM. YOUNG'S MODULUS (MODULUS OF ELASTICITY)                     ACPT
    YS. YIELD STRENGTH                                              ACPT

MCS. MEDIUM CARBON STEEL
    CHCOMP. CHEMICAL COMPOSITION/STOICHIOMETRY/CRYSTAL
```

Fig. 2. Abbreviated listing of SACRD data taken from the *Nuclear Systems Materials Handbook* to illustrate use of eight-character qualifiers.

terminal programs. In other cases his verbal or written requests will be translated by SACRD personnel into the proper terminology.)

Figure 3 illustrates the hard copy services presently available from SACRD.

Catalogs listing the contents of the data base will be issued periodically. In the early phase of Version 1, these issues will be made every three to six months, depending on the amount of new data put into the data base during a period. Current listings of the data base contents will be available upon request at any time intermediate to the issue of the normal catalogs.

It is intended that each property in SACRD have an abstract that identifies the data source, tells when the evaluation was made, lists references, and addresses any obvious shortcomings in the evaluation, etc. Figure 4 is an example of a SACRD abstract.

The schemes used to store tabular data are most efficient when the property is given in curvilinear form. Provisions are included to allow the "curves" to vary as a function of an arbitrary number of independent variables. This is accomplished by splitting the tabular data into several parts: a "contents" entry that catalogs all the fixed independent variables (names and units) for all curves; and tabular entries for each curve. This keeps the data structures very simple, while providing a scheme that can handle a very general situation where a property may vary with one or more variables. Figure 5 is an example of a "contents" entry; Fig. 6 is a listing of the first of the two curves for the ultimate tensile stress data for steel with 2-1/4% Cr and 1% Mo.

In some cases, evaluation groups have taken the trouble to determine parameterized forms to fit property data. In SACRD, the fits are put into

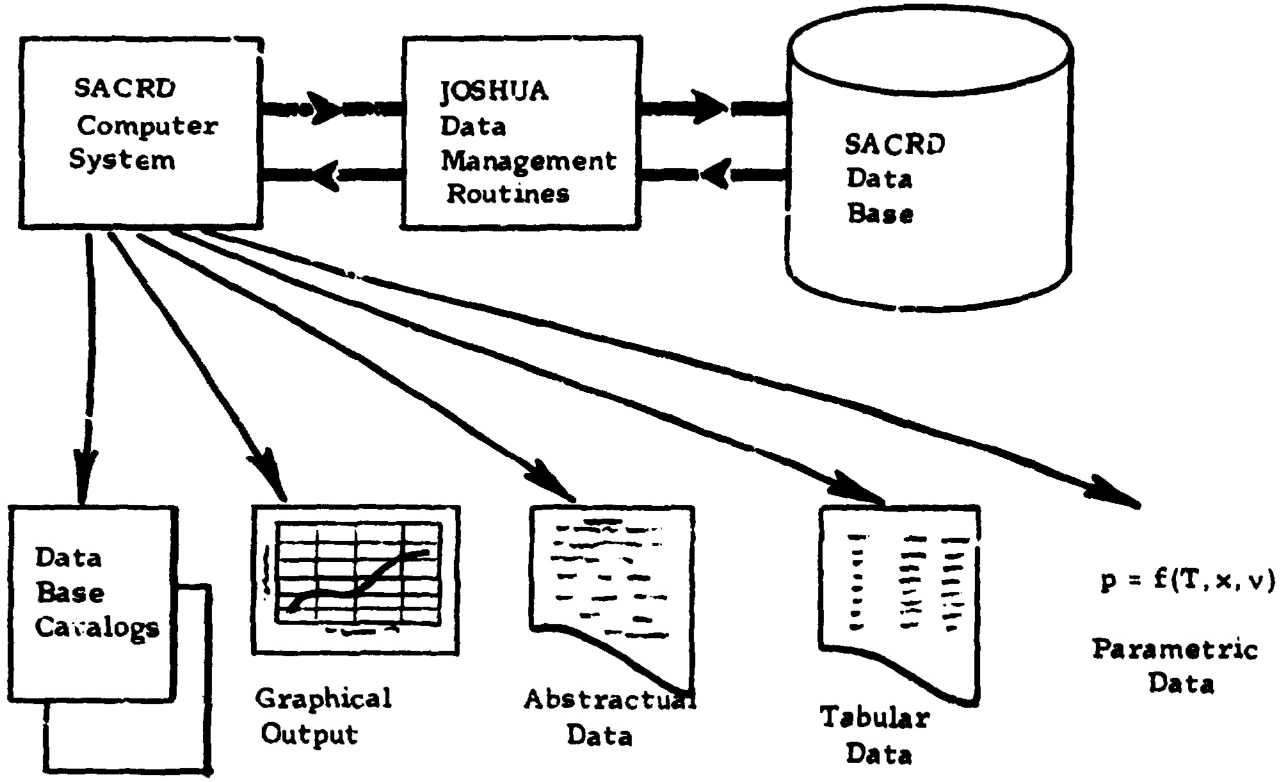

Fig. 3. Hard copy SACRD services.

```
**********************************************************

  SR FILE        MATERIAL=S-CR            PROPERTY=UTS
      VERSION=1                ABSTRACT

**********************************************************

IT CONTAINS
 208  LINES IN THE ABSTRACT AND    0  KEYWORDS

                    A B S T R A C T

**********************************************************

**********************************************************

THIS PORTION OF THE ABSTRACT WAS TAKEN FROM THE
  NUCLEAR SYSTEMS MATERIALS HANDBOOK, TID-26666

**********************************************************

  MATHEMATICAL MODEL FOR ULTIMATE TENSILE STRENGTH FOR
 ANNEALED AND ISOTHERMALLY ANNEALED 2 1/4 CR-1 MO STEEL

INTRODUCTION
------------
     EXPECTED VALUES OF ULTIMATE TENSILE STRENGTH WITH
UPPER AND LOWER BOUNDS AS DEFINED BY TOLERANCE LIMITS
ARE PRESENTED IN THIS ANALYSIS OF [illegible] TESTS ON 2 1/4
CR-1 MO STEEL. ONLY ANNEALED AND ISOTHERMALLY ANNEALED
PLATE, BAR/ROD, AND TUBE/PIPE ARE CONSIDERED. TESTS
BASED ON KNOWN AGED AND STRESS RELIEVED MATERIAL ARE
EXCLUDED FROM THIS STUDY.

     THE MATHEMATICAL MODEL, A THIRD ORDER POLYNOMIAL IN
TEMPERATURE, IS PRESENTED FIRST, FOLLOWED BY A
DISCUSSION OF DATA COLLECTION AND LIMITATIONS. A
COMPLETE LISTING OF THE DATA WITH SOURCE INFORMATION
ACCOMPANIES A TABULATED AND GRAPHICAL DISPLAY OF THE
RESULTS IN REF. 11.

METHOD OF ANALYSIS
------------------
     A THIRD ORDER POLYNOMIAL IN TEMPERATURE ADEQUATELY
DESCRIBED ULTIMATE TENSILE STRENGTH.

    UTS = B0 + B1*T + B2*(T**2) + B3*(T**3)          (1)

WHERE

     UTS = EXPECTED VALUE OF ULTIMATE TENSILE STRENGTH
     (MPA OR KSI),

     T = TEST TEMPERATURE ( C OR F),

     B0,B1
     B2,B3 = UNKNOWN CONSTANTS; LEAST SQUARES ESTIMATES
             ARE GIVEN BELOW:

          SI UNITS                  ENGINEERING UNITS
          (MPA, C)                      (KSI, F)
          --------                  -----------------
B0        527 (+/-7)                79.3 (+/-1.3)

B1        -1.03 (+/-0.14)           -0.61E-2 (+/-1.1E-2)

B2        4.54E-3 (+/-4.6E-4)       2.17E-4 (+/-2.2E-5)

B3        -5.93E-6 (+/-4.7E-7)      -1.05E-7 (+/-1.2E-8)

RESIDUAL
STANDARD
 ERROR    48.0 (445 D.F.)           6.96 (445 D.F.)

     STANDARD ERRORS OF UNKNOWN CONSTANTS ARE GIVEN IN
PARENTHESES. THE RELATIVELY LOW COEFFICIENT OF
DETERMINATION (R**2 = 0.69) REFLECTS A LARGE VARIABILITY
INHERENT IN THE DATA AND AN INCREASE IN SCATTER AT
HIGHER TEMPERATURES. THIS GREATER SCATTER AT HIGHER
TEMPERATURES IS ATTRIBUTED TO STRAIN RATE EFFECTS NOT
SEPARATED OUT IN THE ANALYSIS. A PLOT OF THE DATA WITH
CURVES FOR EXPECTED VALUES AND TOLERANCE LIMITS IS
SHOWN ON PAGE 1.3 OF REF. 11.
```

Fig. 4. SACRD abstract for ultimate tensile strength of steel with 2-1/4% Cr and 1% Mo.

```
*****************************************************************

  SM FILE          MATERIAL=S-CR                  PROPERTY=UTS
         VERSION=1                CONTENTS

*****************************************************************

YNAME     UTS
YUNITS    MPA
XNAME     TEMP
XUNITS    K
CDATE     04/08/78
NENTRY      3
NLEVEL      2

          INDEP       INDEP      INTERPOLATION
          VARIABLE    VARIABLE     BETWEEN
LEVEL     NAME        UNITS        LEVELS
-----     --------    --------   -------------

  1       STATE       NONE          FLAT

  2       RANGE       NONE          FLAT

THE VALUES OF THE INDEPENDENT VARIABLE(S)
ARE

ENTRY      STATE(NONE)           RANGE(NONE)
-----   ---------------       ---------------
  1          SOLID             EXPECTED VALUE
  2          SOLID              UPPER LIMIT
  3          SOLID              LOWER LIMIT
```

Fig. 5. SACRD contents entry for ultimate tensile strength of steel with 2-1/4% Cr and 1% Mo.

the data base in the form of FORTRAN subprograms. This type of entry has the advantages of being ready for use by a computer code needing the property data and of being able to handle practically any imaginable fit. (Version 1 SACRD data will not have many parameterized entries, as much of this release was formed by combining NSMH data with data from the *Properties for LMFBR Safety Analysis*[4] Handbook. The fits in the NSMH do not extend to the higher temperatures covered in the latter handbook.)

Any of the abstractual, tabular, or parameterized SACRD data will be listed on request for members of the safety analysis community.

```
*****************************************************************
SM FILE        MATERIAL=S-CR                  PROPERTY=UTS
      VERSION=1                TABULAR    1
*****************************************************************

YNAME     UTS
YUNITS    MPA
XNAME     TEMP
XUNITS    K
NLEVEL         2
```

VARIABLE	VALUE	UNITS	TYPE OF VAR.
UTS	(TABULATED)	MPA	DEP. VARIABLE (Y)
TEMP	(TABULATED)	K	IND. VARIABLE (X)
STATE	SOLID	NONE	FIXED IND. VAR.
RANGE	EXPECTED VALUE	NONE	FIXED IND. VAR.

1 INTERPOLATION RANGE(S)
ARE IN THIS RECORD

RANGE	BREAK POINT	INTERPOLATION BETWEEN LEVELS
1	25	FLAT

25 POINT(S) ARE GIVEN

POINT	TEMP(K)	UTS(MPA)
1	2.9815D 02	5.0400D 02
2	3.2315D 02	4.8610D 02
3	3.4815D 02	4.7280D 02
4	3.7315D 02	4.6360D 02
5	3.9815D 02	4.5780D 02
6	4.2315D 02	4.5500D 02
7	4.4815D 02	4.5450D 02
8	4.7315D 02	4.5600D 02
9	4.9815D 02	4.5970D 02
10	5.2315D 02	4.6220D 02
11	5.4815D 02	4.6580D 02
12	5.7315D 02	4.6920D 02
13	5.9815D 02	4.7170D 02
14	6.2315D 02	4.7270D 02
15	6.4815D 02	4.7170D 02
16	6.7315D 02	4.6830D 02
17	6.9815D 02	4.6170D 02
18	7.2315D 02	4.5160D 02
19	7.4815D 02	4.3730D 02
20	7.7315D 02	4.1820D 02
21	7.9815D 02	3.9400D 02
22	8.2315D 02	3.6390D 02
23	8.4815D 02	3.2740D 02
24	8.7315D 02	2.8410D 02
25	8.9815D 02	2.3330D 02

Fig. 6. SACRD tabular data for ultimate tensile strength of steel with 2 1/4% Cr and 1% Mo.

These listings can be collected by material, by property, by data type, etc., or in any reasonable listing order. (Requestors should note that a complete listing of the data base requires a stack of output 0.3 to 0.6 meters -- SI units -- high. Future complete distributions will probably require microfiche or alternate forms for compacting this large volume.)

In addition to the listings, plots can be made of the tabular entries in the data base. A complete set of plots of SACRD data will be issued periodically. Current copies for data not in these reports can be obtained on user request.

Interactive facilities are provided for the user with a teletype-compatible terminal. With these programs, a remote user can display any of the types of information listed above, except for the plots. These programs are under continuous development with many modifications to make them easier and more convenient to use. In most cases, "prompters" from the program give enough information (combined with a listing of SACRD abbreviations) to allow even a novice user to communicate with the data base. In addition to the display function, these programs contain provisions for the user who wishes his data output in units other than the SI units employed in most of SACRD. A user's guide for the interactive program is available on request.

SACRD Data Not Under JOSHUA Control

In some areas, the scheme implemented for SACRD using JOSHUA will not interface efficiently with the kinds of data and data requests expected. In most cases, the user knows exactly which properties, which materials, and which kinds of data he wants. There are few cases wherein he wishes to request all property data on a particular material or all materials which have a specific property, because most of what he will find will have little relevance for his particular problem. This situation is ideally covered by JOSHUA where one can pick a list of important qualifiers with which to catalog the data; these catalogs are separate from the data, making for efficient searches.

In the dosimetry area, the concept of a material, a property, a version, and a type of data still applies, but this is not the way a user wants to access the data. In a dose rate calculation, one generally wants all of the data that can be included. Typically, several hundred radionuclides, each with its own half-life, selection of particles emitted, decay chains, etc., must be considered. It is asking too much for the user to have to make individual requests for so many items. "Universal" requests can be made using JOSHUA software, but each separate entry still would have to be cataloged in the JOSHUA data directories. This would lead to a large data storage overhead. (In fact, in many cases, these directories would require more space than the data itself.)

Therefore, for these and other considerations, data for dosimetry and meteorological calculations are not presently stored by JOSHUA. In these areas, data are stored in online disk files in a form very closely related to the input streams of the various computer programs generally used in these areas. For example, COMRADEX-III[5] is used for many dosimetry and radionuclide transport calculations in fast reactor safety studies. The file of COMRADEX-related properties contains dose factors by radionuclide and body organ and Pasquill factor data, among other things. These files can be listed by small display programs which produce edits such as shown in Fig. 7. These programs may ultimately be tailored for interactive communication to these special files.

Among the special (non-JOSHUA) files presently available are:

I. A file of AIRDOS-II[6] related data. For each radionuclide it contains:

   a. the nuclide name
   b. the decay constant
   c. dose conversion factor for submersion in air
   d. dose conversion factor for submersion in water
   e. dose conversion factor for surface exposure
   f. dose conversion factor for food
   g. dose conversion factor for drinking water
   h. concentration of element in meat
   i. concentration of element in forage
   j. concentration of element in soil

   etc.

II. A file of INREM[7] related data. For each radionuclide it contains:

   a. effective half-lives by body organ
   b. effective absorbed energies by organ
   c. inhalation uptake fractions by organ
   d. ingestion uptake fraction by organ
   e. maximum permissible concentrations in air and water for soluble and insoluble material

III. A file of EXREM-III[8] related data. For each radionuclide it contains:

   a. important β's emitted per decay
   b. important positrons emitted per decay
   c. important photons emitted per decay
   d. important conversion electrons emitted per decay

   In addition, it contains much information related to possible decay pathways of important radionuclides.

P A S Q U I L L   F A C T O R S   (AS USED BY COMRADEX-III)
BASED ON HILSMEIER AND GIFFORD CURVES IN JULY 1968 COPY OF
METEOROLOGY AND ATOMIC ENERGY

CLASS	WIND CHARACTERISTICS
A	EXTREMELY UNSTABLE
B	MODERATELY UNSTABLE
C	SLIGHTLY UNSTABLE
D	NEUTRAL
E	SLIGHTLY STABLE
F	MODERATELY STABLE
G	EXTREMELY STABLE

	DOWNWIND DISTANCE (METERS)	VERTICAL DISPERSAL FACTORS BY CLASS A	B	C	D	E	F	G
1	1.00E 00	2.20E-01	1.60E-01	1.20E-01	7.80E-02	1.80E-02	2.70E-02	1.95E-02
2	4.00E 00	7.70E-01	5.50E-01	4.30E-01	2.70E-01	1.75E-01	1.20E-01	7.80E-02
3	1.00E 01	1.60E 00	1.20E 00	9.70E-01	6.70E-01	4.05E-01	2.80E-01	1.90E-01
4	2.00E 01	3.35E 00	2.20E 00	1.80E 00	1.15E 00	8.50E-01	5.70E-01	3.45E-01
5	4.00E 01	6.30E 00	4.20E 00	3.25E 00	2.12E 00	1.60E 00	1.00E 00	6.60E-01
6	7.00E 01	1.05E 01	7.00E 00	[illegible]	3.50E 00	2.40E 00	1.65E 00	1.00E 00
7	1.00E 02	1.50E 01	1.00E 01	7.40E 00	4.80E 00	3.40E 00	2.20E 00	1.40E 00
8	2.00E 02	3.15E 01	2.00E 01	1.45E 01	8.70E 00	6.30E 00	4.00E 00	2.40E 00
9	4.00E 02	6.00E 01	4.50E 01	2.75E 01	1.62E 01	1.15E 01	6.80E 00	4.10E 00
10	7.00E 02	2.60E 02	9.00E 01	4.73E 01	2.40E 01	1.80E 01	1.10E 01	6.50E 00
11	1.00E 03	7.00E 02	1.45E 02	6.50E 01	3.25E 01	2.25E 01	1.40E 01	8.50E 00
12	2.00E 03	1.00E 04	4.00E 02	1.22E 02	5.10E 01	3.50E 01	2.20E 01	1.40E 01
13	4.00E 03	1.00E 04	1.75E 03	2.25E 02	8.30E 01	5.00E 01	3.10E 01	1.95E 01
14	7.00E 03	1.00E 04	1.00E 04	3.35E 02	1.19E 02	6.95E 01	3.95E 01	2.50E 01
15	1.00E 04	1.00E 04	1.00E 04	4.40E 02	1.45E 02	8.10E 01	4.60E 01	2.80E 01
16	2.00E 04	1.00E 04	1.00E 04	7.40E 02	2.05E 02	1.20E 02	5.80E 01	3.60E 01
17	4.00E 04	1.00E 04	1.00E 04	1.22E 03	2.90E 02	1.55E 02	7.30E 01	4.30E 01
18	7.00E 04	1.00E 04	1.00E 04	1.75E 03	3.80E 02	1.75E 02	8.40E 01	5.00E 01
19	1.00E 05	1.00E 04	1.00E 04	2.25E 03	4.50E 02	1.95E 02	9.00E 01	5.80E 01
20	2.00E 05	1.00E 04	1.00E 04	2.20E 03	6.20E 02	2.00E 02	1.00E 02	6.20E 01

	DOWNWIND DISTANCE (METERS)	HORIZONTAL DISPERSAL FACTORS BY CLASS A	B	C	D	E	F	G
1	1.00E 00	2.90E-01	1.75E-01	1.30E-01	1.00E-01	7.00E-02	5.00E-02	3.15E-02
2	1.00E 01	2.60E 00	1.65E 00	1.22E 00	8.80E-01	6.50E-01	4.60E-01	3.04E-01
3	1.00E 02	2.25E 01	1.60E 01	1.20E 01	9.00E 00	6.00E 00	4.00E 00	2.80E 00
4	5.00E 02	1.[illegible]E 02	7.90E 01	5.50E 01	3.80E 01	2.70E 01	1.90E 01	1.20E 01
5	1.00E 03	2.10E 02	1.52E 02	1.07E 02	7.40E 01	5.30E 01	3.60E 01	2.10E 01
6	5.00E 03	8.70E 02	5.50E 02	4.65E 02	3.15E 02	2.25E 02	1.55E 02	1.00E 02
7	1.00E 04	1.64E 03	1.20E 03	8.60E 02	5.80E 02	4.20E 02	2.85E 02	2.00E 02
8	5.00E 04	6.20E 03	4.80E 03	3.50E 03	2.32E 03	1.63E 03	1.12E 03	6.40E 02
9	1.00E 05	1.10E 04	8.60E 03	6.40E 03	4.20E 03	2.95E 03	2.00E 03	1.10E 03
10	2.00E 05	2.00E 04	1.60E 04	1.20E 04	7.70E 03	5.10E 03	3.60E 03	2.20E 03

Fig. 7. Sample data for COMRADEX-III.

IV. Two files related to CONRADEX-III. The first file includes:

a. Pasquill data

b. fifty-year commitment dose factors by radionuclide and organ

The second file contains the Regulatory Guide 1-109[9] Dose Factors by radionuclide and organ.

V. A file of abstracts on computer codes related to the methodology of calculating dose rates, etc.

Computer listings of the data in these files can be obtained upon request.

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