PACKAGE ID - 000433IBMPC00 DATING-A

KWIC TITLE - Temperature for Spent Fuel Dry Storage

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LIMITATION CODE -UNL **AUDIENCE CODE -** UNL

COMPLETION DATE - 02/01/1989 **PUBLICATION DATE -** 02/01/1989

DESCRIPTION - DATING (Determining Allowable Temperatures in Inert and Nitrogen Gases) calculates allowable initial temperatures for dry storage of light-water-reactor spent fuel and the cumulative damage fraction of Zircaloy cladding for specified initial storage temperature and stress and cooling histories. It is made available to ensure compliance with NUREG 10CFR Part 72, Licensing Requirements for the Storage of Spent Fuel in an Independent Spent Fuel Storage Installation (ISFSI). Although the program's principal purpose is to calculate estimates of allowable temperature limits, estimates for creep strain, annealing fraction, and life fraction as a function of storage time are also provided. Equations for the temperature of spent fuel in inert and nitrogen gas storage are included explicitly in the code; in addition, an option is included for a user-specified cooling history in tabular form, and tables of the temperature and stress dependencies of creep-strain rate and creep-rupture time for Zircaloy at constant temperature and constant stress or constant ratio of stress/modulus can be created. DATING includes the GEAR package for the numerical solution of the rate equations and DPLOT for plotting the time-dependence of the calculated cumulative damage-fraction, creep strain, radiation damage recovery, and temperature decay.

PACKAGE CONTENTS - Media Directory; Software Abstract; PNL-6639; Media Includes Source, Executable, Sample Problem Input and Output, Auxiliary Information, Control Information;

SOURCE CODE INCLUDED? - Yes

MEDIA QUANTITY - 1 5.25 Diskette

METHOD OF SOLUTION - The calculations are based on the life fraction rule using both measured data and mechanistic equations as reported by Chin et al. The cumulative life-fraction model assumes that the creep-rupture limit during temperature and stress transients can be estimated by summing damage which occurs in increments of time. The fraction of life consumed at the temperature and stress during each time increment is calculated and summed. The creep-rupture limit is assumed to be achieved when the sum of the incremental life fractions equals unity. DATING uses this model to evaluate cladding integrity during dry storage of spent fuel. The maps of creep-strain and creep-rupture time included in the DATING model allow the rupture lifetime to be

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METHOD OF SOLUTION -(CONT) calculated using the appropriate limiting creep mechanism (fastest creep) and limiting rupture mechanism (usually, the least time). The mechanistic equations have been adjusted to fit published creep-rate and rupture-time experimental data. Similarly, the annealing kinetics for radiation damage are based on published annealing kinetics experimentally determined by Steinberg, Weidinger, and Schaa. Analytical integration of the life fraction cannot be obtained because of the complicated forms of equations for temperature decay, creep rate, rupture lifetime, and radiation-damage annealing. Therefore, DATING uses the variable time-step method of the GEAR numerical software.

COMPUTER - IBM PC

OPERATING SYSTEMS - MS-DOS

PROGRAMMING LANGUAGES - Microsoft FORTRAN

SOFTWARE LIMITATIONS - DATING calculates limiting conditions for dry storage of spent fuel based on creep-strain limits for fuel cladding and does not include other failure mechanisms such as those related to hydrogen. The temperature must be below the alpha/beta transition temperature of 800 degrees C for Zircaloy and the stress below the yield stress. Maximum of 50 entries in the user-specified temperature or temperature and stress history input file.

SOURCE CODE AVAILABLE (Y/N) - Y

OTHER PROG/OPER SYS INFO - Two releases of DATING are included - one for use without a math coprocessor (A) and the other with a math coprocessor (M). DPLOT is written in Advanced BASIC.

TIME REQUIREMENTS - One temperature limit can be calculated in 15 seconds on an IBM PC with a math coprocessor and in 5 minutes without a math coprocessor.

REFERENCES - E.P. Simonen and E.R. Gilbert, DATING - A Computer Code for Determining Allowable Temperatures for Dry Storage of Spent Fuel in Inert and Nitrogen Gases, PNL-6639, December 1988; DATING, NESC No. 9493, DATING Flexible Disk Cartridge Descriptions, National Energy Software Center Note 89-45, March 31, 1989\ B.A. Chin, M.A. Khan, and J. Tarn, Deformation and Fracture Map Methodology for Predicting Cladding Behavior During Dry Storage, PNL-5998, September 1986; E. Steinberg, H.G. Weidinger, and A. Schaa, Analytical Approaches and Experimental Verification to Describe the Influence of Cold Work and Heat Treatment on the Mechanical Properties of Zircaloy Cladding Tubes, Zirconium in the Nuclear Industry: Sixth International Symposium, American Society for Testing Materials, STP 824, pp. 106-122, 1984.

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ABSTRACT STATUS - Abstract first distributed March 1989. IBM PC version submitted February 1989.

SUBJECT CLASS CODE - DH

KEYWORDS -
COMPUTER PROGRAM DOCUMENTATION
D CODES
DRY STORAGE
TEMPERATURE MONITORING
RARE GASES
NITROGEN
WATER COOLED REACTORS
SPENT FUELS
COOLING
CREEP
ZIRCALOY
CLADDING
STRESSES

EDB SUBJECT CATEGORIES -
990200 050800

SPONSOR - DOE/RW

PACKAGE TYPE - SCREENED