1 of 3

SAND92-2863
Unlimited Release
Printed June 1993

Distribution
Category UC-~~010~~

MELCOR 1.8.1 Calculations of ISP31: The CORA-13 Experiment

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Abstract

The MELCOR code was used to simulate one of GRS's (a reactor research group in Germany) core degradation experiments conducted in the CORA out-of-pile test facility. This test, designated CORA-13, was selected as one of the International Standard Problems, Number ISP31, by the Organization for Economic Cooperation and Development. In this blind calculation, only initial and boundary conditions were provided. The experiment consisted of a small core bundle of twenty-five PWR fuel elements that was electrically heated to temperatures greater than 2800 K. The experiment comprised three phases: a 3000 second gas preheat phase, an 1870 second transient phase, and a 180 second water quench phase. MELCOR predictions are compared both to the experimental data and to eight other ISP31 submittals. Temperatures of various components, energy balance, zircaloy oxidation, and core blockage are examined. Up to the point where oxidation was significant, MELCOR temperatures agreed very well with the experiment -- usually to within 50 K. MELCOR predicted oxidation to occur about 100 seconds earlier and at a faster rate than experimental data. The large oxidation spike that occurred during quench was not predicted. However, the experiment produced 210 grams of hydrogen, while MELCOR predicted 184 grams, which was one of the closest integral predictions of the nine submittals. Core blockage was of the right magnitude; however, material collected on the lower grid spacer in the experiment at an axial location of 450 mm, while in MELCOR the material collected at the 50 to 150 mm location. In general, compared to the other submittals, the MELCOR calculation was superior.

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Table of Contents

1 Introduction.....	1
2 CORA-13 Facility and Test Description.....	3
3 MELCOR Computer Model of ISP31	11
4 MELCOR ISP31 Blind Calculation Results.....	21
4.1 Comparison to Experiment	21
4.2 Comparison to Other Code.....	56
5 Code Limitations and User Guidelines.....	81
6 Conclusions and Recommendations	85
7 References	89
Appendix A:Blind Calculation MELCOR Input Deck.....	91
Appendix B: Auxiliary Routines for Electrical Input to Rods.....	203

List of Figures

<u>Figure</u>	<u>Page</u>
2.1 Schematic of the CORA Test Facility.....	4
2.2 Schematic of the CORA-13 Bundle Arrangement showing the Location of the Test Bundle, Spacers, Shroud, and Insulation.....	5
2.3 Schematic of the CORA-13 Bundle Rod Arrangement.....	6
3.1 MELCOR Hydrodynamic Nodalization of the CORA-13 Experiment.....	13
3.2 MELCOR Heat Structures used for Simulation of the CORA-13 Experiment.....	16
3.3 MELCOR Nodalization of the CORA-13 Core.....	18
4.1.1 MELCOR Rod Resistance Rescale Factor for Both Rings.....	22
4.1.2 MELCOR Calculated Power to the Core.....	23
4.1.3 MELCOR and Experimental Hydrogen Generation Rate.....	25
4.1.4 Electrical and Oxidation Energy Produced in the MELCOR Calculation of ISP31.....	26
4.1.5 MELCOR Prediction of Energy Stored in the Core and Energy Leaving the System Radially Through the Shroud.....	27
4.1.6 MELCOR Prediction of Energy Stored in the Working Fluid, and Energy Lost Through the Core Top and Bottom.....	28
4.1.7 MELCOR Prediction of Energy Sources and Sinks for the CORA-13 Experiment.....	29
4.1.8 Experimental Temperature of the Second Ring (First Heated Ring) at +50 mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Second and Fourth Rings	31
4.1.9 Experimental Temperature of the Second Ring (First Heated Ring) at +350mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Second and Fourth Rings	32

List of Figures (continued)

<u>Figure</u>	<u>Page</u>
4.1.10 Experimental Temperature of the Second Ring (First Heated Ring) at +550mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Second and Fourth Rings	33
4.1.11 Experimental Temperature of the Second Ring (First Heated Ring) at +750mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Second and Fourth Rings	34
4.1.12 Experimental Temperature of the Second Ring (First Heated Ring) at +950mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Second and Fourth Rings	35
4.1.13 Experimental Temperature of the Second Ring (First Heated Ring) at +1150mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Second and Fourth Rings	36
4.1.14 Experimental Temperature of the Second Ring (First Heated Ring) at +1350mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Second and Fourth Rings	37
4.1.15 Experimental Temperature of the Third Ring at +150mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Third Ring.....	39
4.1.16 Experimental Temperature of the Third Ring at +350mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Third Ring.....	40
4.1.17 Experimental Temperature of the Third Ring at +750mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Third Ring.....	41
4.1.18 Experimental Temperature of the Third Ring at +1050mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Third Ring.....	42
4.1.19 Experimental Temperature of the Third Ring at +1350mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Third Ring.....	43
4.1.20 Experimental Temperature of the Shroud Compared to the Blind MELCOR Temperature of the Shroud at +50mm.....	44

List of Figures (continued)

<u>Figure</u>	<u>Page</u>
4.1.21 Experimental Temperature of the Shroud Compared to the Blind MELCOR Temperature of the Shroud at +350mm.....	45
4.1.22 Experimental Temperature of the Shroud Compared to the Blind MELCOR Temperature of the Shroud at +550mm.....	46
4.1.23 Experimental Temperature of the Shroud Compared to the Blind MELCOR Temperature of the Shroud at +750mm.....	47
4.1.24 Experimental Temperature of the Shroud Insulation at its Outer Diameter Compared to the Blind MELCOR Temperature at +50mm.....	48
4.1.25 Experimental Temperature of the Shroud Insulation at its Outer Diameter Compared to the Blind MELCOR Temperature at +350mm.....	49
4.1.26 Experimental Temperature of the Shroud Insulation at its Outer Diameter Compared to the Blind MELCOR Temperature at +550mm.....	50
4.1.27 Experimental Temperature of the Shroud Insulation at its Outer Diameter Compared to the Blind MELCOR Temperature at +750mm.....	51
4.1.28 Experimental Temperatures of the Inner Surface of the High Temperature Insulation at Various Axial Locations at a Circumference of 345°.....	54
4.1.29 MELCOR Single Curve Prediction of the Temperature of the High Temperature Insulation (Labeled HiTemp In -200 to 1000 mm).....	55
4.2.1 Experimental Bundle Power Compared to the Results of the Nine Submittals.....	57
4.2.2 Experimental Steam Inlet Flow Compared to the Results of the Nine Submittals.....	58
4.2.3 Experimental Fuel Temperature of Inner Heated Rod at +750 mm Compared to the Results of the Nine Submitted.....	60
4.2.4 Experimental Fuel Temperature of Inner Heated Rod at +50 mm Compared to the Results of the Nine Submittals.....	61

List of Figures (continued)

<u>Figure</u>	<u>Page</u>
4.2.5 Experimental Fuel Temperature of Inner Heated Rod at +350 mm Compared to the Results of the Nine Submittals.....	62
4.2.6 Experimental Fuel Temperature of Inner Heated Rod at +550 mm Compared to the Results of the Nine Submittals.....	63
4.2.7 Experimental Fuel Temperature of an Unheated Rod (MELCOR Ring 3) at +750 mm Compared to the Results of the Nine Submittals	64
4.2.8 Experimental Temperature of the Cladding from the Inner Heated Ring at +750 mm Compared to the Results of the Nine Submittals.....	66
4.2.9 Experimental Temperature of the Cladding from the Inner Heated Ring at +50 mm Compared to the Results of the Nine Submitta.....	67
4.2.10 Experimental Temperature of the Cladding from the Inner Heated Ring at +350 mm Compared to the Results of the Nine Submittals	68
4.2.11 Experimental Temperature of the Cladding from the Inner Heated Ring at +550 mm Compared to the Results of the Nine Submittals.....	69
4.2.12 Experimental Temperature of the Cladding from the Third MELCOR Ring at +750 mm Compared to the Results of Eight Submittals.....	70
4.2.13 Experimental Temperature of the High Temperature Insulation at +550 mm Compared to the Results of the Six Submittals.....	71
4.2.14 Fluid Temperature of the Nine Submittals at +750 mm	72
4.2.15 Zircaloy Oxidized in the Inner Heated Ring at 4250 Seconds. Results of the Nine Submittals.....	73
4.2.16 Zircaloy Oxidized in the Inner Heated Ring at 4750 Seconds. Results of the Nine Submittals.....	74
4.2.17 Molten Zircaloy in the Inner Heated Ring at 4750 Seconds. Results of the Six Submittals.....	75

List of Figures (continued)

<u>Figure</u>	<u>Page</u>
4.2.18 Total UO ₂ Mass at 4750 Seconds. Results of Seven Submittals.....	76
4.2.19 Zircaloy Total Mass at 4750 Seconds. Results of Seven Submittals.....	77
4.2.20 ZrO ₂ Total Mass at 4750 Seconds. Results of Seven Submittals.....	78
4.2.21 Accumulated Hydrogen Generation in Both the Bundle and Shroud. Results of Eight Submittals and the Experiment.....	79

List of Tables

<u>Table</u>	<u>Page</u>
2.1 Design Characteristics of CORA-13 Test Bundle.....	7
3.1 Time Dependent Sources for the CORA-13 Experiment used by MELCOR.....	14
4.1.1 Experimental and MELCOR Calculated Core Blockage.....	52
4.2.1 Organizations and Computer Codes Used for ISP31.....	59

Acknowledgments

First, we would like to thank the NRC/RES/Accident Evaluation Branch for funding and supporting this effort. We would also like to thank several individuals who contributed to this work. Randy Summers modified the COR Package to accommodate an additional core material and also accept energy input from separate electrical heater routines. Randy Cole diagnosed early problems caused by debris falling into the quench control volume, splashing water into upper regions of the core, and causing the problem to become very stiff in a numerical sense. This difficulty was readily corrected. Ed Boucheron and Fred Davis conducted the final, formal review of this document

1 Introduction

MELCOR [1] is a fully-integrated, engineering-level computer code being developed at Sandia National Laboratories for the US Nuclear Regulatory Commission (USNRC). The term "fully-integrated" refers to the high level of uniformity and integration of the database that ties the various packages together, as well as the input and output structure. The term "engineering level" means that MELCOR was designed to model the progression of severe accidents in light water reactor nuclear power plants, but its flexibility allows it to be used in a wide range of physical problems, as evinced in this report. The entire spectrum of severe accident phenomena -- reactor coolant systems; containment thermal and hydraulic response; core heatup, degradation and relocation; and fission product release and transport -- is treated in MELCOR for several types of nuclear reactors. MELCOR has been successfully applied in severe accident analyses [2, 3].

As part of an ongoing quality and technical assessment program, MELCOR is being used in the International Standard Problem (ISP) Program. The ISP Program is structured such that the analyses are conducted in a blind or semi-blind manner, *i.e.* most or all of the experimental results were not released until after all calculational results are submitted to the governing agency. MELCOR has previously been used to simulate ISP28 [4], which consisted of the SFD Phebus B9+ Experiment. This was a semi-blind problem in that some internal temperature data was made available. Application of MELCOR to ISP31 represents the second endeavor in this area. ISP31 was a totally blind calculation -- only initial and boundary conditions were made available to the analysts.

ISP31 consisted of the CORA-13 experiment, which was conducted in Germany on November 15, 1990 [5]. The core assembly was electrically heated. Its purpose was to examine core meltdown behavior such as might occur during an unmitigated severe LWR accident. Beside thermal data, there was also interest in such phenomena as chemical interactions of the different rod materials, melting, material relocations, blockage formation, and hydrogen generation. This application of MELCOR to one of the many CORA experiments performed was the first such effort, and as such, required the creation of an input deck for MELCOR from scratch. This was in direct contrast to some of the other submittal to ISP31. Input decks geared towards CORA experiments for codes such as SCDAP/RELAP, for instance, had the advantage of years of effort and refinement.

At the time of this computational effort, MELCOR lacked the capability to include electrically heated rods in its core software. As part of this effort, a special MELCOR COR Package was created. Beside the special COR Package, further coding was necessary to properly enter the CORA-13 electrical energy in both a temporal and spatial sense. The special COR Package and additional heater routines were compiled with the remaining mainstream MELCOR software to create a special version of MELCOR. This special MELCOR version was applied to the ISP31 Problem. After the completion of the ISP31 MELCOR calculations, the COR Package capability to model electrically heated rods has become part of mainstream MELCOR. MELCOR version 1.8LF should be

considered the earliest version in which to perform calculations which incorporate electrically heated cores.

Reported are the comparison of the blind MELCOR results to the experimental data and to eight other submittals to ISP31. MELCOR code limitations discovered in the course of completing this project are discussed, as well as providing user guidelines for MELCOR calculations for this type of problem. Finally, conclusions are discussed and recommendations for further work in this area are made.

2 Facility and Test Description

The experimental geometry of the ISP31 (CORA-13) test, excerpted with permission from [5], is shown in Figures 2.1 and 2.2. Water was injected into a steam generator/superheater and mixed with argon to serve as the coolant gas. This gas mixture then entered the test bundle via the steam distribution tube near the bottom of the bundle. The gas then flowed upward through the twenty-five rod bundle test section to the top bundle flange, and from thence to the condenser.

The test bundle itself consisted of twenty-five PWR rods, shown in Figure 2.3. Sixteen of the rods had fuel pellets in the middle annular region replaced with a tungsten heater rod and were termed heated rods. Seven of the rods were typical fuel elements common to PWR's and were unheated rods. Two of the rods were absorber (Ag 80%, In 15%, Cd 5%) rods which had stainless steel cladding and were contained in zircaloy guide tubes. The rod arrangement was organized in four "rings" (See Figure 2.3). The first ring was the center unheated rod. The second ring consisted of four heated rods. The third ring contained six unheated rods plus the two absorber rods. The fourth ring comprised of twelve heated rods. The bundle was enclosed in a zircaloy shroud backed by ZrO_2 fiber insulation. After the insulation there was an annular space followed by a high temperature radiation shield (See Figure 2.2). Below the bundle was a quench unit composed of a water-filled quench cylinder, which was raised around the bundle to terminate the experiment.

The 1000 mm tall tungsten part of the heated rods was screwed into molybdenum electrodes at both the top and bottom. The molybdenum electrodes were in turn connected to copper electrodes to give a total heated rod length of 1960 mm. The design characteristics of the CORA-13 test bundle are given in Table 2.1 [5].

The reference "zero" height was the location of the steam inlet pipe (See Figure 2.2). Important dimensions were the location of the upper bundle flange at +1471 mm, the bottom of the water level at -220 mm, the bottom of an unheated rod at -200 mm, and the bottom of a heated rod at -489 mm. The rods were held in place by three grid spacers located at -5 mm, +436 mm, and +880 mm. The top and bottom spacers were composed of zircaloy, while the middle spacer was made of Inconel.

The high temperature radiation shield consisted of an inner layer of plates made of ZrO_2 and an outer layer of Al_2O_3 . The shield itself was pierced by three 30 mm high by 40 mm wide viewing holes, or windows, for observation purposes. These holes were not physically obstructed (with glass, for instance) so that there was flow leakage from the test bundle to the annular space between the bundle and high temperature shield and energy leakage from the test bundle to the environment. The radiation heat loss also caused local refreezing of melt that contributed to additional core blockage, and altered the experimental results more than was desirable. Thus, these openings were a source of major perturbations in an otherwise well-designed experiment.

Figure 2.1 Schematic of the CORA Test Facility

CORA Bundle Arrangement

Figure 2.2 Schematic of the CORA-13 Bundle Arrangement showing the Location of the Test Bundle, Spacers, Shroud, and Insulation.

Table 2.1 Design Characteristics of CORA-13 Test Bundle

Bundle Type:		PWR
Bundle Size:		25 Rods
Number of Heated Rods:		16
Number of Unheated Rods:		7
Pitch:		14.3 mm
Rod Outside Diameter:		10.75 mm
Cladding Material:		Zircaloy-4
Cladding Thickness:		0.725 mm
<hr/>		
Rod Length	Heated Rods:	1960 mm
	Elevation:	-489 to +1471 mm
	Unheated Rods:	1672 mm
	Elevation:	-201 to +1471 mm
<hr/>		
Heater	Material:	Tungsten
	Length:	1024 mm
	Diameter:	6 mm
<hr/>		
Fuel Pellets	Heated Rods:	UO ₂ annular pellets
	Unheated Rods:	UO ₂ full pellets
Pellet Stack	Heated Rods:	0 to 1000 mm
	Unheated Rods:	-199 to +1295 mm
<hr/>		
U-235 Enrichment:		0.2%
Pellet Outer Diameter:		9.1 mm
<hr/>		
Grid Spacer	Material:	Zircaloy-4, Inconel 718
	Length:	Zr 42 mm
		In 38 mm
		Lower (Zr) -5 mm
	Locations:	Center (In) +496 mm Upper (Zr) +880 mm
<hr/>		
Shroud	Material:	Zircaloy-4
	Wall Thickness:	1.2 mm
	Outside Dimensions:	89.4 x 90.4 mm
	Elevation:	+36 to +1231 mm

Table 2.1 (con't)

Shroud Insulation	Material: Thickness: Elevation:	ZrO ₂ Fiber 19 mm +36 to +1036 mm
Electrodes	Material: Length: Diameter: Material: Length: mm Diameter:	Molybdenum 300 mm 8.6 mm Copper 189 (Lower), 669 (Upper) 8.6 mm
Absorber Rod (wt.)	Number: Material Composition: Cladding: Cladding OD: Cladding ID: Length: Elevation:	2 80% Ag, 15% In, 5% Cd Stainless Steel 11.2 mm 10.2 mm 1660 mm -189 to +1300 mm
Absorber Rod Guide Tube:	Material: Outer Diameter: Tube Wall Thickness:	Zircaloy-4 13.8 mm 0.8 mm
Plenum Volume	Heated Rods: Unheated Rods: Absorber Rods:	$12.0 \times 10^{-6} \text{ m}^3$ $87.0 \times 10^{-6} \text{ m}^3$ $71.0 \times 10^{-6} \text{ m}^3$

The CORA-13 experiment was divided into three phases: (1) a gas preheat phase from 0 to 3000 seconds and a low constant electric power input of 0.65 kW; (2) a transient heatup phase from 3000 to 4870 seconds in which the electrical power was increased from 6 to 27 kW; and (3) a cooling phase from 4870 to 5050 seconds initiated by the rise of the quench cylinder. For the entire time the argon flowrate was about 8 g/s. From 3300 to 4900 seconds, steam in addition to the argon was flowed into the bundle at a rate of 6 g/s. Total power, and the corresponding voltage and current to the heater rods were also provided, as well as the rate of water rise during the quench sequence.

The experiment was terminated by the quench phase, which operationally involved raising a long tube filled with water (Figure 2.1). During the raising of this tube, the gas inlet pipe was cut. In a desire to prevent cutting of instrumentation as well, all thermocouples for collecting temperature data were introduced at the top of the bundle. Unfortunately, this resulted in a strong chemical attack on the compensation cable located in the upper part of the bundle at the beginning of oxidation. Thus, the data exhibited irregular temperature readings after 4200 seconds, and much of the temperature data after this time must be considered unreliable. This determination was made in [7].

3 MELCOR Computer Model

Because the CORA-13 experiment was essentially a rod bundle experiment, the most important aspect of the MELCOR model was the input to the MELCOR COR Package. One constraint placed on the COR model was that the delivery of results to Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) in Germany had very exact specifications. One specification was that the temperature of a number of bundle components be specified every 100 mm from -50 mm to at least 1250 mm, using the previously discussed axial "zero" reference location. If these temperatures were to represent the center of a COR node, then the COR model needed nodes at least every 100 mm between -100 mm and +1300 mm elevations. A second specification was that the temperatures at each axial location be provided in each of the four "rings" of the bundle. Thus, the ISP specification required a minimum of fifteen axial times four radial, or sixty total, COR Package nodes. (Fewer nodes could have been used if one was willing to take the MELCOR output and interpolate on it.)

In MELCOR, each COR node must be assigned to a Control Volume Hydrodynamics (CVH) Package control volume. It would be possible to create sixty control volumes, one to each COR node, but not very practical. For one thing, the flow network, especially in the radial direction, would be very large. For another, the Courant limit which is constrained by control volume size, would make the timestep so small that the entire ISP31 modeling effort would be constrained by the computer processing time required to run the problem. The modeling philosophy of MELCOR is to use a minimum number of control volumes. The previous section discussed the three windows that allowed flow radially out of the bundle assembly at three different axial locations. Thus, in the core region itself, three axial control volumes were created, each covering the entire radial extent of the bundle. MELCOR, of course, allows multiple flow paths in and out of a control volume, so one control volume could have been placed in the core region instead of the three. However, since the fluid temperature from the CVH Package effected the core temperatures and there was a significant thermal gradient in the axial direction, three control volumes were chosen for additional temperature resolution.

The MELCOR hydrodynamic nodalization is shown in Figure 3.1. There were a total of twelve control volumes. Control Volume 100 provided an input volume for the argon and steam, as did Control Volume 300 for the videoscope cooling source flow for the windows at the pressure tube wall. The three control volumes in the bundle were CV210, CV220, and CV230 which ran from -200 mm to +400 mm, +400 mm to +800 mm, and +800 mm to +1400 mm, respectively. In the experiment, the quench source was a moving tank of water that moved up into the bypass region and completely immersed the bundle, shroud, and part of the bypass region in water. MELCOR does not provide moving control volumes. Rather, the water source was modeled by two quench sources -- one beneath the lowest bundle control volume and one beneath the bypass control volume, CV310.

These quench sources were located in CV110 and CV111 (See Figure 3.1), and introduced water at the proper rate and energy to model the rising water level. The pressure tube was modeled by CV320. Finally, gas from the bundle flowed to the outlet region, CV240, and thence to an artificially large collector, CV250. Flow from the pressure tube was routed to a large environment control volume, CV330. The latter two control volumes were made arbitrarily large to avoid a pressure build-up, which would effect upstream flow conditions.

Control Volume Hydrodynamic (CVH) mass and energy sources were used to simulate the injection of argon and steam into Control Volume 100 and the videoscope cooling source in Control Volume 300. These sources, which were time dependent, are summarized in Table 3.1. The modeling of the quench source differed from the actual physical event in one important point. In the experiment, the rising cylinder of water rose in the bypass region between the outer shroud insulation and the high temperature insulation. In the MELCOR model, water was injected to fill the entire bypass region. The quench flow was adjusted to properly match the rate as in the experiment. As a result, after quench initiation the temperatures in the high temperature insulation, especially on the inner wall, were not representative of those of the experiment. In the experiment, that inner wall was still only exposed to a gaseous mixture, while in MELCOR it was exposed to cold water. Since the quench sequence occurred at the end of the experiment and its major purpose was to examine what the flooding did to the core, we believe this approximation was justified.

The bundle water quench energy was tied to a control function which uses the time-dependent temperature of the water in Control Volume 110.

Refer to Appendix A for initial temperatures of control volumes, heat structures and COR nodes.

As can be seen from Figure 3.1, generally, axial flow paths connected each successive control volume in series. For the radial flow paths, FL100 represented the steam inlet pipe and connected the mass sources to the lower bundle control volume. FL221 and FL311 represented the lower window openings from bundle to bypass and bypass to pressure tube, respectively. FL222 and FL312 represented the middle window openings, and FL223 and FL313 represented the upper window openings. In the geometry data given in [5], it was also clear that there were small leaks from the bundle to the bypass region both at the top and bottom of the bundle. These two flow paths were represented by FL231 and FL211, respectively.

Figure 3.1 MELCOR Hydrodynamic Nodalization of the CORA-13 Experiment

Table 3.1. Time Dependent Sources for the CORA-13 Experiment used by MELCOR

<u>Time</u>	<u>Argon Flow Rate (kg/s)</u>
0.0	0.008
4870.0	0.008
4880.0	0.0
5050.0	0.0

<u>Time</u>	<u>Argon Temperature (K)</u>
0.0	803.0
3440.0	803.0
3600.0	837.0
3800.0	873.0
4000.0	896.0
4200.0	913.0
4315.0	923.0
4885.0	923.0
4900.0	393.0
5050.0	393.0

<u>Time</u>	<u>Steam Flow Rate (kg/s)</u>
0.0	0.0
3300.0	0.0
3350.0	0.006
4870.0	0.006
4880.0	0.0
5050.0	0.0

Table 3.1. (con't)

<u>Time</u>	<u>Steam Enthalpy (J/s)</u>
0.0	0.0
3300.0	0.0
3350.0	21305.5
3600.0	21747.7
3800.0	22220.9
4000.0	22526.0
4200.0	22753.0
4315.0	22887.0
4870.0	22887.0
4880.0	0.0
5050.0	0.0

<u>Time</u>	<u>Bundle Water Quench Flow Rate (kg/s)</u>
0.0	0.0
4870.0	0.0
4880.0	0.060
4993.0	0.060
4993.5	0.0
5050.0	0.0

From [6], an estimation of the flow rates versus time in the bypass regions and the top and bottom leak paths was obtained. The flow rates in these flow paths were small, usually much less than 0.5 g/s. An exception was that the lower window and upper leak did slightly exceed 1 g/s. However, MELCOR, being a control volume code, does not have any knowledge concerning the spatial nature of flow patterns. In this geometry, primarily axial flow is bleeding off small portions of its flow in a radial direction. MELCOR uses pressures, velocities, areas, and flow resistances to divide flow to and from control volumes with multiply connected flow paths. Using standard loss coefficients [8] resulted in flows through the windows and leak paths that were much too high. The flow through these paths was adjusted to more realistic levels by increasing the loss coefficients assigned these flow paths significantly (See Appendix A). The results of [6] were used as a guide to achieve more realistic flows.

The heat structures used in the MELCOR model are shown in Figure 3.2. The heat structure numbering convention was that the first three numbers were the control volume to which the heat structure was assigned, and the last two numbers were the axial level as given in Figure 3.3. HS11001, HS11002, HS21003, and HS21004 represented the

Figure 3.2 MELCOR Heat Structures used for Simulation of the CORA -13 Experiment

stainless steel cannister below the 0 mm mark. Above this, the stainless steel can was connected to the zircaloy shroud. HS21005 through HS23014 represented the shroud insulation. Material properties for the porous ZrO_2 shroud insulation were obtained from [5]. HS31020 represented the ceramic high temperature insulation located in-between the bypass region and the pressure tube up to the 1000 mm mark. Again, material properties were obtained from [6]. HS23015 to HS24019 represented the high temperature insulation up to the 1447 mm mark, which was the axial extent of the outlet control volume, CV240. From the figures provided in [6], it was apparent that an insulated section covered the radial area between the shroud and high temperature insulation at the 1200-1231 mm axial location. This insulation was represented by HS31021, which was the only heat structure which diverged from the established numbering convention. Each heat structure representing the shroud insulation contained six nodes, which gave each cell in the heat structure a width of about 2.5 mm. For the high temperature insulation there were a total of nineteen nodes, which gave each cell a width of about 7.0 mm. The finer resolution in the shroud insulation was deemed necessary to resolve the higher temperature gradients that were expected to be encountered in regions so close to the core.

The MELCOR model of the core, or bundle, was the most challenging and complex of the various packages to create. A total of nineteen axial sections from -489 mm to +1447 mm and four radial sections were created, for a total of seventy six COR Package nodes. The 24 mm thermal expansion gap for the rods that existed in the experiment was ignored in the MELCOR model, so the +1447 mm height in the MELCOR model was really the +1471 mm height of the experiment, where the top bundle flange was located. Figure 3.3 shows the axial extent of each of the nineteen nodes and, if heated rods existed, the material actually present in the experiment in that axial location for the heater. In MELCOR, only one electrical heating material is presently allowed. As a compromise in thermal properties for tungsten, molybdenum, and copper, the properties of uranium metal from the MELCOR Material Properties Package was used. For radial rings which contained more than one rod, the masses of all rods in that ring were lumped together in the input. Hydraulic diameters of various materials such as the UO_2 fuel and the zircaloy cladding were also properly adjusted. It should be clear from this discussion, then, that the MELCOR COR Package does not model individual fuel rods. The maximum ZrO_2 temperature permitted to hold up melt was 2750 K instead of the default value of 2500 K.

It was recognized that this value was artificially high, but, as shall be seen in Section 4.1, was necessary to offset early oxidation which caused premature melting and relocation. Only the lower spacer was modeled, and it was crudely modeled by adding its mass at the 0 to 100 mm axial level as "other structure" material, which MELCOR modeled as stainless steel in the ISP31 Problem. Parameters such as flow areas between the rods in a ring and surface areas were carefully computed based on the bundle geometry. The reason that the shroud insulation was broken into so many heat structures was that each COR axial level required its own unique heat structure assigned to it. A necessary change was also made to two of the COR sensitivity coefficients. The COR Package was originally intended to model large cores. The CORA-13 experiment represents a small core with very small masses. For proper computation of masses and energies, the

Figures 3.3 MELCOR Nodalization of the CORA-13 Core

minimum total mass of a component was changed from the default value of 0.001 to 1.0E-6 kg, and the minimum mass subject to timestep control was changed from 10.0 to 0.001 kg.

At the time that this blind calculation was being performed, MELCOR did not have the capability to model electrical resistance heating. Four routines, listed in Appendix B, were written to simulate the heaters in the experiment and input the correct energy, in both space and time, to the MELCOR core nodes. The COR Package was modified to include the tungsten heaters in the sixteen heated rods, and to interface with the four routines that passed energy to the COR Package. The methodology used to calculate the energy in each of the seventy six nodes at an instant in time is as follows. MELCOR temperatures were used to calculate the resistance in a representative rod in each of the two heated rings. Thus, each rod in a ring was treated identically, and only two calculations were performed -- one for each of the two heated radial rings. The inner rod result was multiplied by four and the outer rod result was multiplied by twelve to obtain the proper total energy input to each radial ring. Total rod resistance could directly be extracted from nodal temperatures. Experimental rod resistances were also available as a boundary condition. MELCOR computed resistances at an instant in time were not likely to match the experimental resistances unless rod temperatures for computation and experiment were identical. The ratio of these two resistances was used to create a scale factor. This scale factor was then used to correct the computational power to match that of the experimental power for that timestep. Thus, experimental power, and the corresponding current and rod resistances, in a global sense, was matched exactly. Since the coupling between the electrical energy routines and the COR Package was explicit, temperatures from the previous timestep were used. However, from timestep to timestep, rod temperatures were slowly varying. Also, note that the total rod resistance was obtained by summing over nineteen nodes, which allowed for local spatial variation in rod resistance and thus temperature between model and experiment.

The information from the model to be provided for ISP31 was required to be presented in two tables [5]. Table 1 had 230 entries, while Table 2 was specified to have 480 entries. The data for these two tables varied in time, but was roughly every 2.5 seconds for the duration of the experiment. Thus, the amount of information required to be submitted was substantial. To automate the creation of so much data as much as possible, extensive control function and external data function input was created. Many of the parameters required for the ISP31 tables was not available directly from MELCOR as either a control function or plotable output. Much of it, however, could be inferred from the available MELCOR information and be created by using a number of control functions. Once that data was available either from the control function or from the normal MELCOR database, it was outputted to two files in the required print format using the MELCOR External Data File (EDF) Package. Thus, every time MELCOR was run, the two required tables were provided. Even so, manipulation and addition to these tables was required after a calculation for several reasons. For example, the electrical heating information (for this early MELCOR version) was not available in MELCOR, and auxiliary software was required that took this information from a separate output file, and entered it into the ISP31 tables.

MELCOR was allowed to select its own timestep during the entire time of the calculation. Most of the time, a Courant limit on Control Volume 220, which was the smallest volume, was the constraining factor. The timestep began at 0.2 seconds, made a sudden step decrease to 0.06 seconds at 3400 seconds, and then linearly decreased to about 0.025 seconds at 4870 seconds. The timestep oscillated frequently during quench between about 0.01 and 0.10 seconds. The MELCOR simulation required about 6.2 hours of cpu time on an IBM RISC 6000 Model 550 workstation.

A copy of the MELGEN and MELCOR input used for the ISP31 blind calculation is given in Appendix A. The EDF input that was at the end of the MELGEN input has not been included in order to keep the length of the document reasonable. The four auxiliary routines specially written to compute the electrical energy input to the core for the ISP31 experiment are listed in Appendix B.

4 MELCOR ISP31 Blind Calculation Results

The MELCOR ISP31 calculation was a blind calculation. Only the experimental information necessary for geometry specification and initial and boundary conditions were available. The results discussed in this section represent the MELCOR calculation that were the most accurate that could be obtained from MELCOR using the available information. The blind calculation was performed on an IBM RISC 6000 Model 550 workstation using the IBM AIX 3.1.5 operating system and AIX XL FORTRAN 2.2.

4.1 Comparison to Experiment

The previous discussion illuminated the fact that experimental power, current, and global resistance were accurately matched by MELCOR through the use of the four auxiliary routines added. An important indicator of the overall global temperature accuracy of MELCOR within the core was the correction factor, which was the ratio of the total experimental resistance to the total MELCOR resistance of the rods. Since resistance was directly related to temperature, the value of this correction factor imparted knowledge concerning the global temperature accuracy of MELCOR within the core as compared to the experiment. Figure 4.1.1 shows the plot of the correction factor with time. When the correction factor was greater than one, the MELCOR core had a lower resistance than the experimental core and the MELCOR resistance for the next timestep needed to be increased. Conversely, when the correction factor was less than one, MELCOR core resistances were too high, and the MELCOR resistances for the next timestep were decreased by the correction factor. Initially, when the experimental power was ramped up (See Figure 4.1.2), the correction factor rose to its largest value of about 1.25, but then quickly dropped to a fairly steady value of about 1.1 from 3200 to 4200 seconds in time. The initial large correction at early time was probably due to: (1) thermocouples which provided initial conditions in [5] were cooler exterior rod temperatures, and not an average rod temperature, so MELCOR initial conditions were slightly too high; and (2) the MELCOR core model did not appear to respond to sudden power changes as quickly as the experiment. From 3200 to 4200 seconds, the MELCOR model was predicting global resistances in the core to within 10% accuracy. After 4200 seconds, when oxidation energy became more important, the MELCOR model overpredicted the resistances compared to experiment. The correction factor, as a result, dropped to a value of about 0.95. Due to the manner of implementing the quench sequence in MELCOR, there is an inverse spike in the correction factor near 4900 seconds, but its effect on the overall calculation was negligible. Thus, in a global sense, considering that the relation between temperature and resistance was almost linear, MELCOR appeared to match throughout most of the experiment inferred core temperatures to within 10% or less.

Oxidation of core materials was another important parameter that graded the accuracy of the MELCOR calculation with experiment. Oxidation created ZrO_2 from the cladding and grid spacers, and also was capable of oxidizing the steel from the cladding from the two control rods, although the latter was a small effect. The oxidation energy created was

Figure 4.1.1 MELCOR Rod Resistance Rescale Factor for Both Rings

Figure 4.1.2 MELCOR Calculated Power to the Core

49% [7] of the total energy input during the experiment. Figure 4.1.3 compares the experimental hydrogen production rate with that of the MELCOR result. MELCOR predicted hydrogen production to begin about 500 seconds earlier than experiment (however, MELCOR prediction of *rapid* oxidation was only 100 seconds early), and the initial oxidation rate (the slope in Figure 4.1.3) was higher than the experiment. The intense oxidation that occurred during the quench sequence was also severely underpredicted. Note, however, *that the areas under each curve, if the experimental quench spike was ignored, were about equal*. This is confirmed by the fact that in the experiment about 210 grams total of hydrogen was produced while MELCOR predicted about 184 grams of total hydrogen production. The experimental value includes the quench hydrogen spike; if this was subtracted, the two quantities would be in even closer agreement. During quench, MELCOR did predict a spike in hydrogen production, but it was only about 250 mg/sec, not the nearly 700 mg/sec in the experiment, and the duration of the spike for the MELCOR result was very small compared to experiment. MELCOR lacks a stress fracture/spalling model which removes the oxidation layer and exposes fresh zircaloy to steam for oxidation. This explains the lack of an oxidation spike in the MELCOR results during quench.

Energy was inputted to the experimental core in the form of electrical energy and oxidation energy. Figure 4.1.4 shows the MELCOR predictions of the contributions of these two energies. The MELCOR oxidation model is divided into two parts -- one for low temperatures and one for high temperatures. On a global average, Figures 4.1.4 shows that the transition from the low temperature model to the high temperature model occurred at about 4100 seconds in MELCOR. From that point in time, oxidation energy was as important as the electrical energy. This energy input to the system found its way to one of five places as expressed by the following thermodynamic first law equation:

$$E_{\text{electrical}} + E_{\text{oxidation}} = E_{\text{bundle storage}} + E_{\text{fluid}} + E_{\text{shroud}} + E_{\text{bottom}} + E_{\text{top}}, \quad (1)$$

which merely states that the energy produced by the electrical heaters and chemical reactions is manifested as energy stored in the bundle, energy in the coolant fluid, or energy leaving the system radially through the shroud or through the top or bottom of the core. Figures 4.1.5 and 4.1.6 show how the two energy sources in Equation 1 became distributed to the five sinks on the right-hand side of Equation 1. Energy stored in the core at first followed the electrical energy curve of Figure 4.1.4 (because oxidation was insignificant), but then followed the oxidation energy curve at 4100 seconds when oxidation became the dominant energy source. Energy leaving the core radially through the shroud was small, increasing to a peak value of about 7 kW at 4300 seconds. Energy in the fluid was small until about 4250 seconds, increased to 16 kW at 4700 seconds, and then remained fairly steady until quench. The handful of "peaks" for the fluid curve occurred when core debris fell into the quench pool and splashed water up into the core region which then flashed into steam and added momentarily to the fluid energy until it flowed out of the core. Energy lost through the top of the core was very small until 4200 seconds, when it became as significant as energy in the fluid. Energy lost through the bottom was insignificant. Figure 4.1.7 shows the totals of each side of Equation (1) (the left-hand side

Figure 4.1.3 MELCOR and Experimental Hydrogen Generation Rate

Figure 4.1.4 Electrical and Oxidation Energy Produced in the MELCOR Calculation of ISP31

Figure 4.1.5 MELCOR Prediction of Energy Stored in the Core and Energy Leaving the System Radially Through the Shroud

Figure 4.1.6 MELCOR Prediction of Energy Stored in the Working Fluid, and Energy Lost Through the Core Top and Bottom

Figure 4.1.7 MELCOR Prediction of Energy Sources and Sinks for the CORA-13 Experiment

represents "Total In"). The two curves do not match for a number of reasons. First, MELCOR only provided an integrated total both of $E_{\text{oxidation}}$ and $E_{\text{bundle storage}}$, so taking a derivative was necessary to obtain these quantities. Second, the heat flux to or from the shroud was not available, so a computation using available temperatures and average thermophysical properties was necessary. Similar approximations were made to obtain E_{bottom} and E_{top} . However, for the first 4250 seconds, the energies balanced very well. Even during the height of oxidation from 4250 to about 4700 seconds the balance was acceptable, although the Total Out begins to fall beneath the Total In. From 4700 seconds to the time of quench at 4870 seconds, the two curves disagree by a significant margin. Since at this time the core stored energy curve went to zero, the extreme inaccuracy after 4700 was due to this curve. After examining the data, $E_{\text{bundle storage}}$ after 4500 seconds was determined to be erratic, taking a derivative was extremely difficult, and the curve of $E_{\text{bundle storage}}$ after this time is unreliable.

Figures 4.1.8 to 4.1.14 show the temperatures in both the MELCOR second ring (the first heated ring containing four rods) and the fourth ring compared to experiment at different axial levels. The experimental temperatures were located on the outside of the rod, so both the MELCOR fuel and cladding temperatures are displayed. Although the MELCOR cladding temperature is more appropriate for comparison, the fuel temperatures were included to convey information concerning the radial gradient through the rods. Experimental results were given for both the second and fourth rings, but, at least on the outside of the rods, the experimental temperature gradient across rings was negligible, so only one curve was sufficient to display the data. Again, the temperatures at both MELCOR rings were displayed to provide information concerning the radial temperature gradient across rings in MELCOR. All of the experimental results displayed were digitized from curves provided in [7]. Finally, the maximum holdup temperature of 2750 K for the cladding is evident in all the figures. As soon as the cladding reached this temperature, the cladding at this level turned to debris and fell to lower core levels.

Figure 4.1.8 compares experiment to MELCOR predictions at the +50 mm level. The MELCOR prediction was 100 to 150 K higher than the experiment until a time of about 4700 seconds, at which point the MELCOR data matched the experimental result. Shortly thereafter, the thermocouple at this level failed. At +350 mm, shown in Figure 4.1.9, the MELCOR prediction was in excellent agreement with the experimental data right up to the point of thermocouple failure. Oxidation in the MELCOR model began earlier in the second ring than the fourth ring, so there was a larger thermal gradient in the MELCOR results after about 4600 seconds than in the experiment. At the +550 mm and +750 mm axial levels, agreement between MELCOR and experiment was again excellent up to the point of thermocouple failure (Figures 4.1.10 and 4.1.11). Figure 4.1.12 displays MELCOR and experimental temperatures for the rods at +950 mm. Again, the MELCOR prediction was 100 to 150 K higher than experiment. The experimental data leveled out at a time of about 4400 seconds and failed shortly thereafter. Since a rapid temperature run-up due to oxidation was occurring in the core during this time period, the experimental data after 4400 seconds for Figure 4.1.11 is suspect. Figure 4.1.13 compares experiment to MELCOR predictions at +1150 mm. Two observations concerning Figure 4.1.13 are

Figure 4.1.8 Experimental Temperature of the Second Ring (First Heated Ring) at +50 mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Second and Fourth Rings

Figure 4.1.9 Experimental Temperature of the Second Ring (First Heated Ring) at 350mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Second and Fourth Rings

Figure 4.1.10 Experimental Temperature of the Second Ring (First Heated Ring) at +550mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Second and Fourth Rings

Figure 4.1.11 Experimental Temperature of the Second Ring (First Heated Ring) at +750mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Second and Fourth Rings

Figure 4.1.12 Experimental Temperature of the Second Ring (First Heated Ring) at +950mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Second and Fourth Rings

Figure 4.1.13 Experimental Temperature of the Second Ring (First Heated Ring) at +1150mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Second and Fourth Rings

Figure 4.1.14 Experimental Temperature of the Second Ring (First Heated Ring) at +1350mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Second and Fourth Rings

that the radial gradient between rings in MELCOR at this level was greater than experiment (which was negligible) and that MELCOR predicts temperatures 200 to 300 K higher than experiment after oxidation became important at this level, which was at about 4200 seconds. Since the temperatures at the +950 mm level agreed better with the experimental data, either significant cooling occurred in the +950 to +1150 mm region that was not predicted by MELCOR and/or the MELCOR predicted energy production from electrical and oxidation sources was higher than experiment at this level. At +1350 mm, this trend continued, as shown in Figure 4.1.14. Again, MELCOR predicted a significant radial thermal gradient across the rings that was not observed in the experiment, and the temperature prediction worsened when oxidation began in the core.

The third MELCOR ring contained nine unheated rods, including two poison control rods. Figures 4.1.15 to 4.1.19 show the temperatures in this ring at the different axial positions. Figure 4.1.15 compares experiment to the MELCOR prediction at +150 mm. Overall, agreement is very good, especially for a blind calculation. At +350 mm, shown in Figure 4.1.16, the MELCOR calculation again compared very well with experiment. This agreement lasted right up to the time of thermocouple failure. At +750 mm (Figure 4.1.17) the MELCOR prediction again ran just slightly high until the time of oxidation. MELCOR took slightly more time for oxidation to become important (by perhaps 50 seconds), so the two curves crossed. However, overall, until thermocouple failure, agreement was again very good. Figure 4.1.18 compares the results for the unheated rods at +1050 mm. Again, the results compared very well up to the oxidation time with the MELCOR results just slightly high. As with the heated rods in the upper part of the core, after oxidation MELCOR significantly overpredicted the temperature. This trend continued at the +1350 mm level, shown in Figure 4.1.19.

Figures 4.1.20 to 4.1.23 compare predicted and experimental shroud temperatures at various axial levels. Again, at +50 mm, the MELCOR results ran consistently high, but not by a large margin -- about 50 to 100 K. At +350 mm, agreement between MELCOR and experiment was excellent. Time of significant oxidation was predicted fairly well. At +550 mm, the MELCOR prediction was actually somewhat lower, but the overall agreement until oxidation began must still be considered excellent. MELCOR slightly overestimated the time of significant oxidation at this level. At +750 mm, agreement was again excellent and the time of oxidation was again within about 50 seconds.

Comparison between MELCOR and experiment in the outer insulation of the shroud is shown in Figures 4.1.24 to 4.1.27. At +50 mm, MELCOR slightly overpredicted the insulation temperature. At late time at this spatial location there was obviously a large temperature excursion that caused thermocouple failure not predicted by the MELCOR code. At +350 mm, MELCOR again slightly overpredicted the experiment, but the experimental temperature excursion at late time due to oxidation has been somewhat damped. The results at +550 mm and +750 mm were similar to those at +50 mm.

Figure 4.1.15 Experimental Temperature of the Third Ring at +150mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Third Ring

Figure 4.1.16 Experimental Temperature of the Third Ring at +350mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Third Ring

Figure 4.1.17 Experimental Temperature of the Third Ring at +750mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Third Ring.

Figure 4.1.18 Experimental Temperature of the Third Ring at +1050mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Third Ring

Figure 4.1.19 Experimental Temperature of the Third Ring at +1350mm Compared to the Blind MELCOR Fuel and Cladding Temperatures of the Third Ring

Figure 4.1.20 Experimental Temperature of the Shroud Compared to the Blind MELCOR Temperature of the Shroud at +50mm

Figure 4.1.21 Experimental Temperature of the Shroud Compared to the Blind MELCOR Temperature of the Shroud at +350mm

Figure 4.1.22 Experimental Temperature of the Shroud Compared to the Blind MELCOR Temperature of the Shroud at +550mm

Figure 4.1.23 Experimental Temperature of the Shroud Compared to the Blind MELCOR Temperature of the Shroud at +750mm

Figure 4.1.24 Experimental Temperature of the Shroud Insulation at its Outer Diameter Compared to the Blind MELCOR Temperature at +50mm

Figure 4.1.25 Experimental Temperature of the Shroud Insulation at its Outer Diameter Compared to the Blind MELCOR Temperature at +350mm

Figure 4.1.26 Experimental Temperature of the Shroud Insulation at its Outer Diameter Compared to the Blind MELCOR Temperature at +550mm

Figure 4.1.27 Experimental Temperature of the Shroud Insulation at its Outer Diameter Compared to the Blind MELCOR Temperature at +750mm

Table 4.1.1 Experimental and MELCOR Calculated Core Blockage

Height	$100 * \{A_i(o) - A_i(t)\} / A_i(o)$ [Exp]	$100 * \{A_i(o) - A_i(t)\} / A_i(o)$ [MELCOR]
-150 mm	NA	+5.15
-50 mm	NA	+11.82
+50 mm	NA	+58.37
+150 mm	+13.7	+47.14
+250 mm	+12.2	+1.33
+350 mm	-2.2	-10.64
+450 mm	+39.1	-22.45
+550 mm	-15.1	-24.34
+650 mm	-10.8	-24.30
+750 mm	-7.9	-24.33
+850 mm	-16.5	-29.15
+950 mm	-15.1	-24.22
+1050 mm	-7.9	-6.62
+1150 mm	-3.6	-0.62
+1250 mm	+0.7	+3.35

Time-dependent experimental core blockage data was not available. A post-test epoxy process was used to determine the core blockage axially through the core. This process only gave the core blockage at the end of the experiment, and data below about +75 mm in the core could not be obtained. Table 4.1.1 compares the final experimental and MELCOR core blockage. The experimental values were given in [7]. As specified in [5], the percentage of core blockage was defined as:

$$100 * \{A_i(o) - A_i(t)\} / A_i(o) \quad (2)$$

where $A_i(t)$ is the open flow area available for the fluid at level i and time t , and $A_i(o)$ is the initial flow area available for the fluid at level i . Note that the above definition is not that used in [7], which provides a curve showing the ratio of solid area to the total available area in a cross section.

The experimental data showed that, as expected, a significant amount of material relocated from an axial height of +550 to about +1050 mm to the lower grid spacer in the +400 to +500 mm region and also in the +75 to +350 mm region. MELCOR predicted that material in the +350 to +1050 mm region relocated primarily in the +50 to +150 mm axial height region, which was, on average, lower than experiment. Also, MELCOR predicted that somewhat more material was relocated.

Energy loss radially in the experiment through the shroud and thence to bypass flow and heat transfer through the high temperature insulation was about 10% of the total, thus supporting the claim that the experiment was well-insulated. There was a significant axial temperature gradient at the inner surface of the high temperature insulation, as Figure 4.1.28 shows. Furthermore, because of the windows and perhaps for other unknown reasons, there was a significant circumferential temperature variation in the high temperature insulation. The MELCOR model used only one heat structure for the entire axial extent of the high temperature insulation - from -200 to +1000 mm. Thus, only one MELCOR temperature was available to compare to the rather extensive results from [7] available for the high temperature insulation. In comparing Figure 4.1.29, which shows the MELCOR result, to Figure 4.1.28, note that the MELCOR temperature curves follows the result for the +590 mm curve fairly well. The 590 mm level temperature curve in Figure 4.1.28 appears to be close to the axial temperature average for the high temperature insulation. The fact that the MELCOR result agrees with this "average" so well at least implies that, on average, MELCOR agreed with experiment fairly well for the radial heat loss.

Figure 4.1.28 Experimental Temperatures of the Inner Surface of the High Temperature Insulation at Various Axial Locations at a Circumference of 345°. Excerpted from [7].

Figure 4.1.29 MELCOR Single Curve Prediction of the Temperature of the High Temperature Insulation (Labeled HiTemp In -200 to 1000 mm)

A general observation concerning almost of the MELCOR data, including the rod temperatures, was that they ran higher than the experimental data up to the point of quench, especially in the upper regions. After oxidation become important, some time after 4100 seconds depending on the axial level in the core, the higher temperatures can be explained by the earlier and higher oxidation rates (See Figure 4.1.3). It does not, however, explain the consistently higher MELCOR temperatures prior to oxidation. Global energy production in the core up to oxidation was matched very well. As also seen, MELCOR predicted radial heat losses fairly well, so the model did not over-insulate the core.

4.2 Comparison to Other Codes

Other codes used to predict the ISP31 Problem were SCDAP/RELAP5, a code developed by the Idaho National Engineering Laboratory, USA; ICARE2, a code developed by the Commissariat à l'Énergie Atomique in France; KESS-III, a code from the Institut für Kernenergetik und Energiesysteme in Germany; and FRAS-SFD, from the Nuclear Research Institute Rez in Czechoslovakia. Five participants from the United Kingdom, Netherlands, Japan, Korea, and Finland used the SCDAP/RELAP5 code. A limited number of results comparing the results of all the participants along with the experimental data in some cases were published in [7]. Table 4.2.1 identifies the three-letter designator used in the figures to the country and which code was used.

Figure 4.2.1 shows the measured bundle power and the corresponding results of the various submittals. Only two others (ECN, IKE) besides the SNL MELCOR results included the external resistance. Five of the calculations (AEA, ECN, IKE, NRI, SNL) followed the measured data quite well, while two others (CEA, JAE) used a lower estimate of heating power and two (KAE, VTT) deviated considerably and shut power off considerably earlier than the time specified.

Steam inlet flow resulted from a water feed flow of 6 g/s between 3300 and 4900 seconds with a time constant of about 100 seconds. Figure 4.2.2 shows that NRI used this value.

Five participants (AEA, IKE, JAE, KAE, SNL) chose a shorter time constant, while three (CEA, ECN, VTT) used a much larger time constant which underestimated the steam flow. Although not shown, the inlet temperature was correctly used by all but one (ECN) participant.

Figure 4.2.1 Experimental Bundle Power Compared to the Results of the Nine Submittals (Excerpted from [7])

Figure 4.2.2 Experimental Steam Inlet Flow Compared to the Results of the Nine Submittals (Excerpted from [7])

Table 4.2.1 Organizations and Computer Codes Used for ISP31

<u>Organization</u>	<u>Computer Code</u>	<u>Designator</u>
AEA Reactor Services, UK	SCDAP/RELAP5/MOD2.5	AEA
Commissariat à L'Energie Atomique France	ICARE2	CEA
Netherlands Energy Research Foundation	SCDAP/RELAP5/MOD3	ECN
Institut für Kernenergetik und Energiesysteme, Germany	KESS-III	IKE
Japan Atomic Energy Research Institute	SCDAP/RELAP5	JAE
Korea Atomic Energy Research Institute	SCDAP/RELAP5/MOD2.5	KAE
Nuclear Research Institute Rez Czechoslovakia	FRAS-SFD	NRI
Sandia National Laboratories USA	MELCOR 1.8.0	SNL
Technical Research Centre of Finland	SCDAP/RELAP5/MOD2.5	VTT

Figure 4.2.3 shows the temperature of a heated rod (second MELCOR ring) at an axial level of +750 mm. As mentioned in [7], the experiment was quite well predicted during the heat up period. Figures 4.2.4 to 4.2.7 display further fuel temperature at different axial heights in the bundle. A comparison of Figure 4.2.3 and 4.2.7 shows that ECN and JAE predicted large temperature difference between the heated and unheated rods, while the other codes predicted temperature differences of about 100 K, which agreed fairly well with the measured temperature differences. KAE and VTT underpredicted rod temperatures, which was surmised in [7] to perhaps their underprediction of bundle power. AEA, CEA, IKE, NRI, and SNL were in good agreement with the experimental data.

Figure 4.2.3 Experimental Fuel Temperature of Inner Heated Rod at +750 mm Compared to the Results of the Nine Submittals (Excerpted from [7])

Figure 4.2.4 Experimental Fuel Temperature of Inner Heated Rod at +50 mm Compared to the Results of the Nine Submittals (Excerpted from [7])

Figure 4.2.5 Experimental Fuel Temperature of Inner Heated Rod at +350 mm Compared to the Results of the Nine Submittals (Excerpted from [7])

Figure 4.2.6 Experimental Fuel Temperature of Inner Heated Rod at +550 mm Compared to the Results of the Nine Submittals (Excerpted from [7])

Figure 4.2.7 Experimental Fuel Temperature of an Unheated Rod (MELCOR Ring 3)
at +750 mm Compared to the Results of the Nine Submittals
(Excerpted from [7])

Cladding temperatures at various axial heights in the bundle are shown in Figures 4.2.8 to 4.2.12. In four of the predictions, the temperature is underpredicted and the temperature escalation was significantly delayed (ECN, JAE) or not even reached (KAE, VTT). Although the experimental results is shown only in Figure 4.2.8, the MELCOR prediction was in very good agreement with the data.

The inner high-temperature insulation temperature at an axial height of +550 mm is shown in Figure 4.2.13. As reported in [7], two calculations (IKE, SNL) follow the measured data quite well, while AEA and KAE do not show the temperature increase at 4300 seconds.

The fluid temperature at axial height +750 mm is shown in Figure 4.2.14. Qualitatively, in four calculations (AEA, CEA, NRI, SNL) the fluid temperature followed the shroud temperature quite well, while the others (IKE, JAE, KAE, VTT) showed much lower temperatures.

Figures 4.2.15 to 4.2.20 display some of the quantities describing the core degradation. Experimental data at the present time was not available. Some of the submittals obviously did not provide results for some of this requested data. There was a considerable scattering of data in the predictions. The one result that several codes seemed to agree was the UO_2 total mass (Figure 4.2.18).

Finally, the accumulated hydrogen generation in the bundle and shroud is shown in Figure 4.2.21. For the codes, most of the hydrogen was produced during the time of the temperature excursion during initial oxidation, and very little during the quench phase. Only ECN and SNL appeared to predict close to proper quantities of hydrogen. Rates (the slopes) were matched fairly well by these two codes, although they were early in their prediction.

As reported in [7], all the codes: (1) overpredicted the oxidation during the temperature escalation phase; (2) underpredicted the oxidation during the high temperature phase when melting and relocation occurred; and (3) did not simulate the oxidation during quench when embrittlement and fragmentation took place.

Figure 4.2.8 Experimental Temperature of the Cladding from the Inner Heated Ring at +750 mm Compared to the Results of the Nine Submittals (Excerpted from [7])

Figure 4.2.9 Experimental Temperature of the Cladding from the Inner Heated Ring at +50 mm Compared to the Results of the Nine Submittals (Excerpted from [7])

Figure 4.2.10 Experimental Temperature of the Cladding from the Inner Heated Ring at +350 mm Compared to the Results of the Nine Submittals
(Excerpted from [7])

Figure 4.2.11 Experimental Temperature of the Cladding from the Inner Heated Ring at +550 mm Compared to the Results of the Nine Submittals
(Excerpted from [7])

Figure 4.2.12 Experimental Temperature of the Cladding from the Third MELCOR Ring at +750 mm Compared to the Results of Eight Submittals
(Excerpted from [7])

Figure 4.2.13 Experimental Temperature of the High Temperature Insulation at +550 mm Compared to the Results of the Six Submittals (Excerpted from [7])

Figure 4.2.14 Fluid Temperature of the Nine Submittals at +750 mm (Excerpted from [7])

Figure 4.2.15 Zircaloy Oxidized in the Inner Heated Ring at 4250 Seconds. Results of the Nine Submittals (Excerpted from [7])

Figure 4.2.17 Molten Zircaloy in the Inner Heated Ring at 4750 Seconds. Results of Six Submittals (Excerpted from [7])

Figure 4.2.18 Total UO_2 Mass at 4750 Seconds. Results of Seven Submittals.
(Excerpted from [7])

Figure 4.2.19 Zircaloy Total Mass at 4750 Seconds. Results of Seven Submittals
(Excerpted from [7])

Figure 4.2.20 ZrO₂ Total Mass at 4750 Seconds. Results of Seven Submittals
(Excerpted from [7])

Figure 4.2.21 Accumulated Hydrogen Generation in Both the Bundle and Shroud.
Results of Eight Submittals and the Experiment (Excerpted from [7])

5 Code Limitations and User Guidelines

Most of the code limitations concerning MELCOR in simulating the ISP31 experiment were related to the COR Package. Many of them have been addressed or are in the process of being addressed since these simulations were performed.

As a part of this project, a model for electrical heater rods was added to MELCOR. A prototype version was created for the ISP31 experiment. In the present implementation, included in the MELCOR 1.8.2 version release, the COR package input is provided to specify electrical heating, and a COR array has been created to receive calculated power. The user must provide the FORTRAN subroutines that specify these power values in time and space. The current core temperature distribution is provided to these routines so that temperature-dependent resistance can be determined. It is assumed that the heater rods do not melt, but all other rod materials can relocate. Development of these routines for a specific experiment can be a moderate programming task mainly involving modeling of the electrical circuit and experimentally defined boundary conditions. The subroutines used for ISP31 are shown in Appendix B. These routines should be sufficient to model other CORA tests with appropriate modification of the electrical boundary conditions.

The MELCOR COR Package at the time of these calculations lacked the ability to compute UO_2 dissolved, ZrO_2 dissolved, Zr dissolved by Ag-In-Cd, and other important bundle degradation variables. Most of these limitations have been addressed with the addition of a eutectic model in later versions of MELCOR, but the upgraded models have not been used to model ISP31.

The version of the MELCOR COR Package used in these calculations did not allow the transfer of mass between rings. Thus, melted and debris materials could not spread radially, which occurred in the CORA experiments. This limitation has been addressed with the addition of a radial relocation model in later versions of MELCOR but the upgraded model has not been used to model ISP31.

In the current MELCOR ISP31 model, the ZrO_2 failure temperature used for relocation was set to 2750 K, which is thought to be unrealistically high. This was necessary to obtain the desired agreement with experiment for a number of important variables. A major reason necessitating the high temperature was that MELCOR oxidation occurred too quickly and, more important, at a faster rate than experiment. Thus, the higher temperature delayed the early relocation of material caused by the excess oxidation. All of the submittals for the ISP31 experiment displayed the trends for early and excess oxidation. Two obvious possibilities exist. First, most of the submittals used similar oxidation models and these models might be inappropriate for the ISP31 experiment. Second, conditions in the experiment were not as the experimenters thought they were, and thus the modelers were provided inaccurate experimental specifications. The major possibility in this area concerns the flow split between the heater bundle and the bypass resulting from the presence of the view ports. The MELCOR calculation (and all other

submitted calculations) used time-independent geometrical factors for the bypass. This is unlikely to be correct as temperatures change and materials relocate. Redistribution of flows could cause local steam starvation to limit the oxidation. There is insufficient information to build a time-dependent model (which would vary from one CORA experiment to another).

Another issue concerning oxidation was that none of the codes, including MELCOR, predicted the massive oxidation that occurred during quench. The codes predicted most of the available material was oxidized during the first part of the experiment, leaving little material to oxidize during the reflood. However, in the MELCOR calculation, a significant quantity of unoxidized zircaloy still existed beneath the oxide crust that was assumed to form on the cladding. MELCOR lacks a model to remove the oxide crust caused by stress failure during the rapid cooling that occurs during reflood, thereby uncovered new zircaloy for further oxidation. A simple MELCOR model could be constructed to model this failure and the resulting "enhanced" oxidation. This area should be addressed in future MELCOR development.

A minor problem with the COR Package manifested itself during the modeling of ISP31. The Package is incapable of having two materials with the exact same melt temperature (the solution of the material equations is not unique). Although this deficiency was easily worked around by specifying the second material with a melt temperature 0.1 K less than that of the first material, MELCOR stopped ungracefully when this problem occurred and additional time was spent in discovering the cause of the problem and correcting it. This quirk needs to be documented in the MELCOR manuals.

MELCOR presently requires additional control volumes to be created specifically for mass and energy sources and sinks. For instance, in the ISP31 MELCOR model, if the steam/argon mixture has been entered directly into Control Volume 210 (Figure 3.1), then unacceptable flow and temperature oscillations occur. Adding extra control volumes alleviates the problem, but it does make model larger than necessary and adds computer processing time. This should be documented in the MELCOR manuals.

Another concern is the artificially high flow loss coefficients that the FL Package must use to obtain flows that match observed bypass flows in the experiment. The best solution would be to eliminate the view ports from the experiments that are used for code verification. The coefficients required to match the flow would have to be time-dependent to account for flow blockage due to material relocation. The difficulty and uncertainty associated with this effort seem counter-productive to the code verification purpose of the experiment.

Many of the user guidelines for the ISP31 problem are applicable to MELCOR modeling in general. The user should use a minimum reasonable number of control volumes. For ISP31, twelve control volumes were used, which is a typical number. Second, the user must place sufficient detail in regions where it is required. For the ISP31 problem, the

specification document virtually dictated that core cells 100 mm in height be used, and it may be noted that eight of the nine ISP31 submittals, including MELCOR, used the 100 mm core cell dimension. One submittal used a resolution double that, 50 mm. It was obvious for ISP31 that the COR Package input was the most critical. The small size of the core demanded that material masses be computed very accurately, as well as the dimensions of the geometries of various components and heat transfer areas.

Another MELCOR capability that proved useful for ISP31 was the External Data File Package. By specifying control functions representing variables demanded by the ISP31 Specification [5], these variables could be placed in a file of the proper format also required by the Specification. Thus, every time the ISP31 problem was run, two EDF files were created that corresponded to Table I and Table II in the Specification. Because certain variables such as bundle power and bundle resistance were available only from the four custom heater routines and not in MELCOR, an auxiliary program was written to properly compute these variables from the output of the electrical heater rod routines and include them in the tables. Using the EDF Package saved much time and effort for the ISP31 calculation because it was included early in the input and it was carefully planned. The main difficulty, particularly for a new user, is the extent of the input required to define the control functions to collect the proper EDF data.

6 Conclusions and Recommendations

The International Standard Problem 31, which is the CORA-13 Experiment, has been successfully modeled using the MELCOR computer code. Four FORTRAN subroutines were added to the standard MELCOR coding to incorporate electrical heating in the core. The COR Package was also modified to receive the data from these additional routines. This capability has since been added to latest standard MELCOR version (Version 1.8.2).

Agreement of MELCOR with the CORA-13 experiment was, in general, good, especially considering the fact that it was a totally blind calculation. The methodology used to enter electrical energy assured accurate input of energy and provided a check on bundle temperatures in a *global, integrated sense*. In this global sense, the MELCOR temperatures were within 10% of experiment for the entire length of the experiment (except for very early time). Temperatures of the rods, both heated and unheated, the cladding, the shroud, and the high temperature insulation were in fairly good agreement with the experiment; however, MELCOR temperatures near the top of bundle were higher than those measured. Because energy input was well-predicted, the disagreement was probably caused by underpredicting energy loss from core components and the gas mixture in the upper portion of the bundle. The source of this energy loss is presently unknown.

MELCOR predicted rapid oxidation to occur about 100 seconds earlier than experiment and at a higher rate. However, 210 grams of hydrogen were generated in the experiment, while MELCOR predicted 184 grams. The more rapid oxidation, of course, affected temperatures so that after oxidation became important the MELCOR temperatures did not agree as well with experiment as compared to pre-oxidation times. MELCOR also predicted a higher temperature gradient radially across the rings than was observed in the experiment.

MELCOR prediction of core blockage was somewhat on the high side. Further, since MELCOR does not have a core component that represents a grid spacer as a physical impediment to melt and debris, the major blockage occurred at a lower level. In the experiment, major core blockage occurred at an axial height of about +450 mm, approximately where the lower grid spacer was located. In MELCOR, the blockage occurred at +50 to +150 mm.

A preliminary report has been published by GRS and KfK [7] comparing all nine submittals made to ISP31 to the experiment. Very little information is presently available on the degradation variables. Concerning both initial and boundary conditions and temperatures, MELCOR, unlike some of the submittals, recorded no major errors or disagreement from experiment. In fact, the MELCOR submittal was one of the most accurate in terms of temperature prediction. Although this statement is subjective, an examination of Figures 4.2.1 to 4.2.8 and Figure 4.2.13 (figures that include experimental data) serve to justify it. Also, although none of the codes correctly predicted oxidation and hydrogen generation timing and rates, MELCOR provided one of the better integral hydrogen pro-

duction predictions. All of the codes: (1) overpredicted hydrogen production in the early phase and underpredicted it in the latter phase, and (2) did not predict the intensive hydrogen production during quench. The first observation, coupled with the fact that the rod resistance rescale factor early in the experiment was consistently greater than one (See Section 4.1) strongly suggests that initial and/or boundary conditions given the analysts for ISP31 were not representative of actual experimental conditions. The second fact was due to the lack of a reflood model in MELCOR to account for the stress fracture of oxidized zircaloy and the consequent uncovering of unoxidized zircaloy.

Many of the bundle degradation variables, such as UO_2 dissolved, ZrO_2 dissolved, and Zr dissolved by AG-IN-CD poison were unavailable or crudely inferred from other quantities in MELCOR. A eutectics model has recently been placed in MELCOR (Version 1.8.2) that is currently undergoing testing. This should greatly improved the capability of MELCOR to provide additional and more accurate information concerning these quantities. It should be noted that, judging from the decrease in submittals for many of the bundle degradation variable, MELCOR was not the only code that had difficulty in supplying this type of information.

Another conclusion of the ISP31 Program serves to further underscore the positive synergism that usually occurs between calculations and experiment. This experiment clearly pointed out some of the problem that today's best predictive tools have concerning oxidation, chemistry, debris formation, and relocation in abnormal events. The inverse is also true -- that the calculations can often point the experimentalists to inconsistencies in their experiments. For instance, Figure 4.2.3 shows that *all* of the codes predicted early fuel temperatures that were too high. The experimental result is the bottom most curve. The cause of this result can only be speculated, but the data suggest that perhaps thermal mass was larger than given in the initial conditions or there was some unknown additional or larger heat loss. Also, the three large windows in the experiment, although serving a minor data-gathering capability, was impossible to model correctly with MELCOR or other existing codes. Most reactor cores do not have this type of energy loss path, and most analysts would have suggested removing it. The fact is that experiment and calculation are both useful tools that operate in a supportive, positive feedback manner.

The present MELCOR calculation has been criticized for using a 2750 K temperature for failure of oxidized zircaloy, and that a 2500 K failure temperature is more appropriate. Also, a version of MELCOR that includes the eutectic models is now available. Various constraints have precluded performing additional calculations using the 2500 K failure criterion with the latest MELCOR improvements, but it is highly recommended that this be done. Also, a number of informal sensitivity studies were performed in the course of this work. One was a variation in loss coefficients to obtain realistic flowrates in the bypass region of the experiment. It is recommended that a more formal and extensive matrix of sensitivity studies be performed, also with the latest MELCOR version.

Finally, it has been pointed out [7] that modeling problems such as CORA-13 using large, complex computer codes is an art, and is very dependent on the user. A corollary of this is that, every time the user makes a run of the model, something additional is learned. Rarely is the answer obtained in one try. Thus, code efficiency *is* important. MELCOR required 6.2 hours to perform this calculation on a two-year-old workstation *and* it gave results that were at least as good if not better than other codes. Although the information on other codes is not available for this report, it would be instructive to investigate the processing requirements of all the codes used for ISP31 for comparison.

In summary, the ISP31 experiment represented a non-prototypic *blind* test that was extremely small scale and included large windows that could not be modeled (and do not exist in prototypic reactors), causing unquantified heat losses and unnecessary gas coolant leakage paths. In addition, for unknown reasons, MELCOR temperatures early in time were higher than indicated by the experiment, and the reasons could as much be due to experimental uncertainties as MELCOR modeling inaccuracies. For the author, ISP31 represented the first MELCOR applications work that entailed the creation of a large MELCOR input deck. Given these facts, we feel that the agreement between the MELCOR predictions and the experimental data was excellent.

7 References

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2. Kmetyk, L.N., "Survey of MELCOR Assessment", SAND92-1273, Sandia National Laboratories, January 1993.
3. Kmetyk, L.N., "MELCOR Assessment at SNL," NUREG/CP-0125, Transactions of the Twentieth Water Reactor Safety Information Meeting, Bethesda, Maryland, October 21-23, 1992, p. 10-15..
4. Martinez, G.M., "MELCOR Calculations of ISP28: SFD Phebus B9+ Experiment," Letter Report to the USNRC dated December 1991.
5. Firnhaber, M., *et. al.*, "Specification of the International Standard Problem ISP-31: CORA 13 Experiment on Severe Fuel Damage," Gesellschaft für Reaktorsicherheit(GRS) mbH, Revision 1, October 1991.
6. Ball, A., *et. al.*, "Determination of Boundary Conditions for Test CORA 13 using ATHLET-SA," ISP-31 Workshop, Kernforschungszentrum Karlsruhe (KfK), June 13, 1991.
7. Firnhaber, M., *et. al.*, "Draft of the Preliminary Comparison Report, International Standard Problem No. 31, CORA-13 Experiment on Severe Fuel Damage," GRS and KfK, August 1992.
8. Fluid Flow Data Book, Genium Publishing Company, September 1984.

Appendix A - CORA-13 Calculation Input Deck Does Not Include External Data File Input

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* isp31, cora13: MELCOR model of cora13 experiment
.
* Robert J. Gross and Gale M. Martinez
s
.....
.
TITLE      'CORA 13 - MODEL #1'
JOBID      'CORA 13 - MODEL #1'
CRTOUT
DIAGF      'cora13.gdia'
OUTPUTF    'cora13.gout'
RESTARTF   'cora13.rst'
TSTART     3000.0
.
.....
.
.
.....
***                ***
***  ISP31: MELCOR MODEL OF CORA 13 EXPERIMENT  ***
***                ***
***                ***
.....
.
* 12/23/91 - increase loss coefficients on FL211 and FL231
.      because too much flow through these leak paths
.
.....
...
*** NCG AND MP INPUT  ***
...
.....
...
NCG001  H2  4
NCG002  AR  5
NCG003  CO  6
NCG004  N2  7
.
.....
.
* REPLACE LITHIUM ALUMINUM WITH PROPERTIES OF POROUS ZR02
* REPLACE URANIUM ALUMINUM WITH PROPERTIES OF AL-SI INSULATION
.
.....
* PROPERTIES FOR URANIUM DIOXIDE
.
MPMAT10000 'URANIUM DIOXIDE'
MPMAT10051 DEN  11000.
.
MPMAT10011 RHO  201
*MPMAT10012 CPS  202
MPMAT10013 THC  203
.
TF20100 'DENU02' 2  1.
TF20111 200.  11000.
TF20112 1673. 11000.
.

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2 of 3

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*TF20200 'CPU02' 10 1.
*   TEMP (K) CP HEAT (J/(KG-K))
*TF20210 295 235.0
*TF20211 373 260.0
*TF20212 573 290.0
*TF20213 773 305.0
*TF20214 1023 315.0
*TF20215 1273 325.0
*TF20216 1523 335.0
*TF20217 1773 350.0
*TF20218 2023 380.0
*TF20219 2273 425.0
.

TF20300 'THCUO2' 11 1.
*   TEMP (K) COND (W/(Kg-K))
* Too much heat is escaping - lower by 30% - rjg - 10/16/92
*TF20310 573 5.3
*TF20311 673 4.7
*TF20312 773 4.3
*TF20313 873 3.9
*TF20314 1073 3.3
*TF20315 1173 3.0
*TF20316 1373 2.7
*TF20317 1573 2.3
*TF20318 2573 2.4
*TF20319 2973 3.0
*TF20320 3173 3.2
.

TF20310 573 3.7
TF20311 673 3.3
TF20312 773 3.0
TF20313 873 2.7
TF20314 1073 2.3
TF20315 1173 2.0
TF20316 1373 1.9
TF20317 1573 1.6
TF20318 2573 1.7
TF20319 2973 2.0
TF20320 3173 2.2
.

.....
* PROPERTIES FOR TUNGSTEN - SUBSTITUTE WITH URANIUM METAL
* MUMETL = 13 IN THE MP DATABASE
.

MPMAT11000 'URANIUM METAL'
MPMAT11011 RHO 204
MPMAT11012 CPS 205
MPMAT11013 THC 206
MPMAT11014 ENH 219
MPMAT11015 TMP 220
.

MPMAT11051 DEN 19600.
MPMAT11052 MLT 3473.
MPMAT11053 LHF 192556
.

TF20400 'DENW' 2 1.
TF20411 200 19600.
TF20412 3000 19600.
.

TF20500 'CPW' 13 1
*   TEMP (K) HT CAP (J/(KG-K))
TF20510 295 138.2
TF20511 373 141.2
TF20512 573 148.6
TF20513 773 155.6
TF20514 1023 163.9

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TF20515	1273.	171.6
TF20516	1523.	178.8
TF20517	1773.	185.3
TF20518	2023.	191.3
TF20519	2273.	196.7
TF20520	2523.	201.6
TF20521	2723.	205.1
TF20522	3073.	210.2

TF21900 'ENHW' 13 1.
 * TEMP (K) ENTHALPY (J/Kg)

TF21910	295.	20384.5
TF21911	373.	31281.1
TF21912	573.	60261.1
TF21913	773.	90681.1
TF21914	1023.	130618.6
TF21915	1273.	172556.1
TF21916	1523.	216356.1
TF21917	1773.	261868.6
TF21918	2023.	308943.6
TF21919	2273.	357443.6
TF21920	2523.	407231.1
TF21921	2723.	447901.1
TF21922	3073.	519033.6

TF22000 'TMPW' 13 1.
 * ENTHALPY (J/Kg) TEMP (K)

TF22010	20384.5	295.
TF22011	31281.1	373.
TF22012	60261.1	573.
TF22013	90681.1	773.
TF22014	130618.6	1023.
TF22015	172556.1	1273.
TF22016	216356.1	1523.
TF22017	261868.6	1773.
TF22018	308943.6	2023.
TF22019	357443.6	2273.
TF22020	407231.1	2523.
TF22021	447901.1	2723.
TF22022	519033.6	3073.

TF20600 'THCW' 10 1.
 * TEMP (K) COND (W/(KG-K))

TF20610	573.	124.7
TF20611	673.	122.9
TF20612	773.	119.4
TF20613	873.	116.1
TF20614	1073.	114.5
TF20615	1173.	111.5
TF20616	1373.	108.6
TF20617	1573.	96.73
TF20618	2573.	93.16
TF20619	3173.	91.63

.....
 * PROPERTIES FOR STAINLES STEEL - SUBSTITUTE THE PROPERTIES OF
 * ZIRCONIUM FOR THAT OF STAINLESS STEEL IN ORDER TO DELAY MELTING
 * OF THE CONTROL RODS - RJG - 1/29/92

MPMAT17000 'STAINLESS STEEL'
 MPMAT17011 RHO 221
 MPMAT17012 CPS 222
 MPMAT17013 THC 223
 MPMAT17014 ENH 224
 MPMAT17015 TMP 225

*
 MPMAT17051 DEN 6500
 *MPMAT17052 MLT 2098
 * core package cannot handle two materials with same melt temperature
 * change melt temp of "stainless" 10 degrees higher
 * RJG - 2/5/92
 MPMAT17052 MLT 2108
 MPMAT17053 LHF 225000
 *
 TF22100 'DENS' 2 1.
 TF22111 200 6500.
 TF22112 5000 6500.
 *
 TF22200 'CPSS' 14 1
 * TEMP (K) HT CAP (J/(KG-K))
 TF22210 273.15 275 0
 TF22211 400 302.0
 TF22212 640 331.0
 TF22213 1090 375.0
 TF22214 1113 590 0
 TF22215 1133 615 0
 TF22216 1153 719 0
 TF22217 1173 816 0
 TF22218 1193 770 0
 TF22219 1213 619 0
 TF22220 1233 469 0
 TF22221 1248 356 0
 TF22222 2098 356 0
 TF22223 5000 356 0
 *
 TF22400 'ENHSS' 16 1
 * TEMP (K) ENTHALPY (J/Kg)
 TF22410 300 0 0
 TF22411 400 21915 0
 TF22412 640 105110 0
 TF22413 1090 263960 0
 TF22414 1093 265275 5
 TF22415 1113 276195 5
 TF22416 1133 288245 5
 TF22417 1153 301585 5
 TF22418 1173 316935 5
 TF22419 1193 332795 5
 TF22420 1213 346685 5
 TF22421 1233 357565 5
 TF22422 1248 363753 0
 *TF22423 2098 666353 0
 *TF22424 2098.01 891353 0
 * core package cannot handle two materials with same melt temp
 * change enthalpy table to match change in melt temp
 TF22423 2108 669913 0
 TF22424 2108.01 894913 0
 TF22425 3598 1425353 0
 *
 TF22500 'TMPSS' 16 1.
 * ENTHALPY (J/Kg) TEMP (K)
 TF22510 0 0 300.
 TF22511 21915 0 400
 TF22512 105110 0 640.
 TF22513 263960 0 1090.
 TF22514 265275 5 1093.
 TF22515 276195 5 1113
 TF22516 288245 5 1133.
 TF22517 301585 5 1153.
 TF22518 316935 5 1173.
 TF22519 332795 5 1193
 TF22520 346685 5 1213

TF22521 357565.5 1233
 TF22522 363753.0 1248.
 * core package cannot handle two materials with same melt temp
 * change enthalpy table to match change in melt temp
 *TF22523 666353.0 2098.
 *TF22524 891353.0 2098.01
 TF22523 669913.0 2108
 TF22524 894913.0 2108.01
 TF22525 1425353.0 3598
 .

TF22300 'THCSS' 12 1.
 * TEMP (K) COND (W/(KG-K))

TF22310 273.15 12.1
 TF22311 293.2 12.6
 TF22312 473.2 14.5
 TF22313 673.2 17.0
 TF22314 873.2 19.9
 TF22315 1073.2 23.1
 TF22316 1269.2 26.2
 TF22317 1508.2 31.7
 TF22318 1624.2 36.3
 TF22319 1771.2 41.8
 TF22320 2098.2 58.4
 TF22321 5000.0 58.4
 .

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 * PROPERTIES FOR ZIRCONIUM OXIDE
 .

*MPMAT12000 'ZIRCONIUM OXIDE'
 *MPMAT12011 RHO 207
 *MPMAT12012 CPS 208
 *MPMAT12013 THC 209
 .

*TF20700 DENZRO 5 1.
 *TF20711 300. 5800.
 *TF20712 1475. 5640.
 *TF20713 1480. 6050.
 *TF20714 2970. 5710.
 *TF20715 2975. 5990.
 .

*TF20800 CPZRO 9 1.
 * TEMP (K) HT CAP (J/(KG-K))

*TF20810 300. 460.
 *TF20811 305. 550.
 *TF20812 400. 610.
 *TF20813 500. 640.
 *TF20814 700. 680.
 *TF20815 1475. 740.
 *TF20816 1480. 600.
 *TF20817 2000. 600.
 *TF20818 2970. 820.
 .

*TF20900 THCZRO 2 1.
 * TEMP (K) COND (W/(KG-K))

*TF20910 300. 0.9
 *TF20911 2975. 1.4
 .

.....
 * PROPERTIES FOR MOLYBDENUM
 .

*MPMAT14000 'MOLYBDENUM'
 *MPMAT14011 RHO 210
 *MPMAT14012 CPS 211
 *MPMAT14013 THC 212
 .

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*TF21000 DENMOL 2 1.
*TF21011 200. 10200
*TF21012 3000. 10200.
.
*TF21100 CPMOL 10 1.
*   TEMP (K) HT CAP (J/(KG-K))
*TF21110 300. 240.3
*TF21111 600. 265.8
*TF21112 900. 283.9
*TF21113 1200. 304.6
*TF21114 1500. 327.9
*TF21115 1800. 353.8
*TF21116 2100. 382.3
*TF21117 2400. 413.5
*TF21118 2700. 447.2
*TF21119 3000. 483.6
.
*TF21200 THCMOL 10 1.
*   TEMP (K) COND (W/(KG-K))
*TF21210 300. 141.7
*TF21211 600. 129.8
*TF21212 900. 118.5
*TF21213 1200. 107.6
*TF21214 1500. 97.15
*TF21215 1800. 87.12
*TF21216 2100. 77.44
*TF21217 2400. 68.08
*TF21218 2700. 58.98
*TF21219 3000. 50.11
.
.....
* REPLACE LITHIUM ALUMINUM WITH PROPERTIES OF POROUS ZR02
.
MPMAT15000 'LITHIUM ALUMINUM'
MPMAT15011 RHO 213
MPMAT15012 CPS 214
MPMAT15013 THC 215
.
MPMAT15051 DEN 1380.
MPMAT15052 MLT 4000. * DUMMY VALUE
MPMAT15053 LHF 200000. * DUMMY VALUE
.
TF21300 DENINS 2 1.
TF21311 200. 1380.
TF21312 3360. 1380.
.
TF21400 CPINS 3 1.
*   TEMP (K) CP HEAT (J/(KG-K))
TF21410 300. 567.0
TF21411 1675. 681.0
TF21412 3360. 1584.0
.
TF21500 THCINS 10 1.
*   TEMP (K) COND (W/(KG-K))
*TF21510 300. 0.079
*TF21511 500. 0.084
*TF21512 600. 0.102
*TF21513 1050. 0.126
*TF21514 1300. 0.158
*TF21515 1540. 0.195
*TF21516 1780. 0.240
*TF21517 2020. 0.289
*TF21518 2260. 0.344
*TF21519 2500. 0.408
.
* TRY VALUES 0.75 AS LARGE

```

```

TF21510 300. 0.056
TF21511 500. 0.063
TF21512 600. 0.077
TF21513 1050. 0.095
TF21514 1300. 0.119
TF21515 1540. 0.146
TF21516 1780. 0.180
TF21517 2020. 0.217
TF21518 2260. 0.258
TF21519 2500. 0.306
.
.....
* REPLACE URANIUM ALUMINUM WITH PROPERTIES OF AL-SI INSULATION
.
MPMAT16000 'URANIUM ALUMINUM'
MPMAT16011 RHO 216
MPMAT16012 CPS 217
MPMAT16013 THC 218
.
MPMAT16051 DEN 320
MPMAT16052 MLT 4000. * DUMMY VALUE
MPMAT16053 LHF 200000. * DUMMY VALUE
.
TF21600 DENIN2 2 1.
TF21611 200. 320
TF21612 3360. 320.
.
TF21700 CPIN2 3 1.
* TEMP (K) CP HEAT (J/(KG-K))
TF21710 293. 795.0
TF21711 673. 1090.0
TF21712 1273. 1260.0
.
TF21800 THCIN2 5 1.
* TEMP (K) COND (W/(KG-K))
TF21810 300. 0.075
TF21811 533. 0.090
TF21812 811. 0.110
TF21813 1089. 0.140
TF21814 1366. 0.200
.
* try values half as large
.
*TF21800 THCIN2 5 1.
* TEMP (K) COND (W/(KG-K))
*TF21810 300. 0.038
*TF21811 533. 0.045
*TF21812 811. 0.055
*TF21813 1089. 0.070
*TF21814 1366. 0.100
.
.....
.....
.....
...
*** CONTROL VOLUME HYDRODYNAMICS *
...
.....
...
.....
.
* CV 100 IS THE INLET SOURCE - CORA 13 *
.
* SOURCE VOL FOR STEAM AND ARGON *
.....
...

```

```

CV10000 'INLET SOURCES' 2 2 1      * NON-EQUIL, VERTICAL FLOW, RCS VOL.
CV100A1 PVOL 2.2E5      * INITIAL PRESSURE
CV100A2 TATM 803.0      * INITIAL INLET ARGON TEMPERATURE
CV100A3 PH2O 0.0        * INITIALLY NO STEAM
CV100A4 MLFR.5 1.0      * MOLE FRACTION OF ARGON (NCG #5)
...
*** ALTITUDE/VOLUME TABLE FOR THE INLET SOURCE VOLUME
...
*** ALTITUDE VOLUME
...
CV100BA -0.019 0.0
CV100BB +0.019 0.01 *APPROXIMATE DIA OF INLET PIPE, MAKE VOLUME
* LARGER THAN ACTUAL SO IT DOESN'T CONTROL
* THE TIME STEP
...
*** COOLANT INJECTION
...
CV100C1 MASS.5 10 2 * UNIT KG/S, ARGON MDOT IN TF010
CV100C2 TE 20 8 * UNIT K, TEMP OF ARGON FOR ENTHALPY IN TF020
CV100C3 MASS.3 30 2 * UNIT KG/S, STEAM MDOT IN TF030
CV100C4 AE 40 2 * UNIT J/S, STEAM ENERGY (ENTHALPY) IN TF040
...
*****NOTE: MAY WANT TO USE MORE DETAILED ARGON FLOW RATE HISTORY IN
***** FIG 3.2.2
...
TF01000 'ARGON FLOW RATE' 4 1.0 0.0
*** TIME (S) MDOT (KG/S)
TF01011 0.0 0.008
TF01012 4870.0 0.008
TF01013 4880.0 0.0
TF01014 5050.0 0.0
...
* USE TABLE IN APPENDIX A, P. 5
...
TF02000 'ARGON TEMP' 10 1.0 0.0
*** TIME (S) TEMP(K)
TF02011 0.0 803.0 * EXAMINE SUPERHEATER OUTLET TEMP
TF02012 3440.0 803.0
TF02013 3600.0 837.0
TF02014 3800.0 873.0
TF02015 4000.0 896.0
TF02016 4200.0 913.0
TF02017 4315.0 923.0
TF02018 4885.0 923.0
TF02019 4900.0 393.0
TF02020 5050.0 393.0
...
*TF02012 3000.0 803.0 * SEE DISCUSSION P. 13
*TF02015 4000.0 789.0
*TF02018 4885.0 789.0
...
***** NOTE: STEAM FLOW RATE & ENTHALPY SHOULD BE ADJUSTED WITH FLOW
***** INCREASE TIME CONSTANT SUGGESTED IN APP A PG 4
...
* USE TABLE IN APPENDIX A, P. 4
...
TF03000 'STEAM FLOW RATE' 6 1.0 0.0
*** TIME(S) FLOW RATE (KG/S)
TF03011 0.0 0.0
TF03012 3300.0 0.0
TF03013 3350.0 0.006

```

•

... TIME (S) ENERGY (J/S)

•

.....

•

• •

• •

...

•

•

5

99

* SOURCE AT THE PRESENT TEMPERATURE OF THE POOL. THIS SHOULD MAINTAIN THE
 * WATER LEVEL. REMOVE TABULAR FUNCTION 60, AND INTRODUCED CONTROL FUNCTION
 * 60.
 *
 *
 * PUT IN STEAM INTO CV210 FROM WATER TAKEN OUT OF CV110
 *
 *CV110C4 MASS.1 62 2 * UNIT KG/S, STEAM EVAP IN TF062
 *CV110C5 PE 63 2 * UNIT J/S, STEAM ENERGY (ENTHALPY) IN TF063
 *
 * comment out for now - RJG - 1/2/92
 *
 *
 * USE TABLE IN APPENDIX A, P. 4
 *
 TF05000 'BUNDLE QUENCH M' 6 1.0 0.0
 *** TIME(S) FLOW RATE (KG/S)
 TF05011 0.0 0.0
 TF05012 4870.0 0.0
 TF05013 4880.0 0.060
 TF05014 4993.0 0.060 * NOTE DIFFERENCE IN TIMING FROM CV111
 * changed from 0.075 to 0.060 - RJG - 2/27/92
 TF05015 4993.5 0.0
 TF05016 5050.0 0.0 * BOTH TAKEN FROM APPEND A
 *
 *
 *TF06000 'BUNDLE QUENCH E' 5 1.0 0.0
 *** TIME (S) ENERGY (J/S)
 *TF06010 0.0 0.0
 *TF06011 4870.0 0.0
 *TF06012 4880.0 3.88316E4
 *TF06013 5000.0 3.88316E4
 *TF06014 5050.0 0.0
 *
 CF06000 'WATER ENERGY' EQUALS 1 1.0
 CF06010 1.0 0.0 CVH-TLIQ.110
 *
 TF06100 'ROD E TO POOL' 4 1.0 0.0
 * TIME(S) ENERGY (J/S)
 TF06111 0.0 46.6
 TF06112 3000.0 46.6
 TF06113 3005.0 171.9
 TF06114 5050.0 171.0
 *
 TF06200 'EVAP MASS' 11 1.0 0.0
 TF06211 0.0 -0.000015
 TF06212 1300.0 -0.000015
 TF06213 1310.0 -0.00004
 TF06214 2000.0 -0.00004
 TF06215 2010.0 -0.00009
 TF06216 4300.0 -0.00009
 TF06217 4305.0 -0.00014
 TF06218 4700.0 -0.00014
 TF06219 4705.0 -0.001
 TF06220 4870.0 -0.001
 TF06221 4872.0 -0.0
 *
 TF06300 'EVAP ENERGY' 11 1.0 0.0
 TF06311 0.0 -7.766
 TF06312 1300.0 -7.766
 TF06313 1310.0 -20.71
 TF06314 2000.0 -20.71
 TF06315 2010.0 -46.60
 TF06316 4300.0 -46.60
 TF06317 4305.0 -72.49
 TF06318 4700.0 -72.49


```

TF06319 4705.0 -517.76
TF06320 4870.0 -517.76
TF06321 4872.0 0.0
.
.....
.
.
* CV 111 IS THE BYPASS QUENCH SOURCE - CORA 13 *
.
* SOURCE VOL FOR LIQUID WATER TO BYPASS *
.....
...
CV11100 'BYPASS QUENCH' 2 2 1 * NON-EQUIL, VERTICAL FLOW, RCS VOL
CV111A1 PVOL 2.2E5 * INITIAL PRESSURE
CV111A2 ZPOL -0.22 * POOL COMPLETELY FILLS VOLUME
CV111A3 TPOL 313.0 * ASSUME POOL AT 40 C, ATM SATURATED (T=123 C)
CV111A4 TATM 396.0 * ASSUME ATM SAME AT CV100
CV111A5 PH2O 0.0 * NO INITIAL STEAM IN ATM
CV111A6 MLFR.5 1.0 * ARGON IN ATM
.....NOTE: SATURATED CONDITIONS ARE ASSUMED IN APP A BOUNDARY
..... CONDITIONS. HOWEVER, FIG 3.2.23 GIVES ACTUAL QUENCH
..... VOLUME TEMP HISTORY WHICH IS SUBCOOLED - MAY WANT TO
..... USE INSTEAD.
...
... ALTITUDE/VOLUME TABLE FOR THE BUNDLE QUENCH SOURCE VOLUME
...
... ALTITUDE VOLUME
...
CV111BA -1.720 0.0
CV111BB -0.200 0.042
.
...
... COOLANT INJECTION
.
CV111C1 MASS.1 70 2 * UNIT KG/S, WATER MDOT IN TF070
CV111C2 PE 80 2 * UNIT J/S, WATER ENERGY (ENTHALPY) IN TF080
.
TF07000 'BYPASS QUENCH M' 6 1.0 0.0
... TIME(S) FLOW RATE (KG/S)
TF07011 0.0 0.0
TF07012 4870.0 0.0
*TF07013 4880.0 0.214
*TF07014 4990.0 0.214 * NOTE DIFFERENCE IN TIMING FROM CV 110
TF07013 4880.0 0.8
TF07014 4993.0 0.8 * NOTE DIFFERENCE IN TIMING FROM CV 110
* TIMING SET IDENTICAL TO CV 110 - RJG - 2/19/92
* change from .214 to .6 - RJG - 1/2/92
* change from .214 to .8 - RJG - 2/17/92
TF07015 4993.5 0.0 * BOTH TAKEN FROM APP A
TF07016 5050.0 0.0
.
.
.....NOTE: IF USE ACTUAL QUENCH TEMP HISTORY- CHANGE THIS TABLE
TF08000 'BYPASS QUENCH E' 7 1.0 0.0
... TIME (S) ENERGY (J/S)
TF08010 0.0 0.0
TF08011 4870.0 0.0
TF08012 4880.0 4.14204E5 * MUST CHANGE THIS IF CHANGE FLOW RATE
TF08013 4990.0 4.14204E5 * MUST CHANGE THIS IF CHANGE FLOW RATE
TF08014 4990.5 0.0
TF08015 5000.0 0.0
TF08016 5050.0 0.0
.
..... NOTE: QUENCH CYLINDER EVAPORATION SOURCE HAS NOT BEEN ADDED
.
.....
.

```

```

* CV 210 IS BUNDLE 1 - CORA 13 *
.
* BOTTOM OF UNHEATED RODS TO BOTTOM *
* OF LOWER VIDEOSCOPE WINDOW *
.....
...
CV21000 'BUNDLE 1' 2 2 1 * NON-EQUIL, VERTICAL FLOW, RCS VOL
CV210A1 PVOL 2.2E5 * INITIAL PRESSURE
*CV210A2 TATM 683.0 * HEATED ROD AVG TEMP AT 3000 SEC
CV210A2 TATM 803.0 * INLET STEAM TEMP AT 3000 SEC
CV210A3 PH2O 0.0 * INITIALLY NO STEAM
CV210A4 MLFR 5 1.0 * MOLE FRACTION OF ARGON (NCG #5)
...
*** ALTITUDE/VOLUME TABLE FOR BUNDLE 1
.
* CONSISTENT WITH CORE MODEL NOW - ASSUME THAT SHROUD STARTS
* AT 0 MM RATHER THAN 36 MM - RJG - 11/22/91
.
...
*** ALTITUDE VOLUME
***
CV210BA -0.200 0.0 * BOTTOM OF UNHEATED RODS
CV210BB 0.000 2.3012E-3 * BOTTOM OF SHROUD
CV210BC 0.400 4.2743E-3 * BOTTOM OF LOWER VIDEOSCOPE WINDOW
.
* PUT IN STEAM INTO CV210 FROM WATER TAKEN OUT OF CV110
.
*CV210C1 MASS 3 64 2 * UNIT KG/S, STEAM EVAP IN TF064
*CV210C2 TE 65 9 * UNIT J/S, STEAM ENERGY (ENTHALPY) IN CF065
.
TF06400 'EVAP MASS' 11 1.0 0.0
TF06411 0.0 0.000015
TF06412 1300.0 0.000015
TF06413 1310.0 0.00004
TF06414 2000.0 0.00004
TF06415 2010.0 0.00009
TF06416 4300.0 0.00009
TF06417 4305.0 0.00014
TF06418 4700.0 0.00014
TF06419 4705.0 0.001
TF06420 4870.0 0.001
TF06421 4872.0 0.0
.
CF06500 'STEAM TEMP' EQUALS 1 1.0
CF06510 1.0 0.0 CVH-TVAP.210
.
*TF06500 'EVAP ENERGY' 11 1.0 0.0
*TF06511 0.0 7.766
*TF06512 1300.0 7.766
*TF06513 1310.0 20.71
*TF06514 2000.0 20.71
*TF06515 2010.0 46.60
*TF06516 4300.0 46.60
*TF06517 4305.0 72.49
*TF06518 4700.0 72.49
*TF06519 4705.0 517.76
*TF06520 4870.0 517.76
*TF06521 4872.0 0.0
.
.....
.
* CV 220 IS BUNDLE 2 - CORA 13 *
.
* BOTTOM OF LOWER WINDOW TO TOP OF *
* UPPER VIDEOSCOPE WINDOW *
.....

```

```

...
CV22000 'BUNDLE 2' 2 2 1 * NON-EQUIL, VERTICAL FLOW, RCS VOL
CV220A1 PVOL 2.2E5 * INITIAL PRESSURE
CV220A2 TATM 693.0 * HEATED ROD AVG TEMP AT 3000 SEC
CV220A3 PH2O 0.0 * INITIALLY NO STEAM
CV220A4 MLFR 5 1.0 * MOLE FRACTION OF ARGON (NCG #5)
...
*** ALTITUDE/VOLUME TABLE FOR BUNDLE 1
***
*** ALTITUDE VOLUME
***
CV220BA 0.400 0.0 * BOTTOM OF LOWER WINDOW
CV220BB 0.800 1.973E-3 * TOP OF UPPER WINDOW
.
.....
.
.
* CV 230 IS BUNDLE 3 - CORA 13 *
.
.
* TOP OF UPPER WINDOW TO TOP OF CORE *
.....
***
CV23000 'BUNDLE 3' 2 2 1 * NON-EQUIL, VERTICAL FLOW, RCS VOL
CV230A1 PVOL 2.2E5 * INITIAL PRESSURE
CV230A2 TATM 620.0 * HEATED ROD AVG TEMP AT 3000 SEC
CV230A3 PH2O 0.0 * INITIALLY NO STEAM
CV230A4 MLFR 5 1.0 * MOLE FRACTION OF ARGON (NCG #5)
...
*** ALTITUDE/VOLUME TABLE FOR BUNDLE 3
***
*** ALTITUDE VOLUME
***
CV230BA 0.800 0.0 * TOP OF UPPER WINDOW
CV230BB 1.231 2.126E-3 * TOP OF SHROUD LINER
CV230BC 1.387 1.385E-2 * BOTTOM OF LOWER VIDEOSCOPE WINDOW
CV230BD 1.400 1.882E-2 * TOP OF CORE NODALIZATION
.
.....
.
.
* CV 240 IS OUTLET - CORA 13 *
.
.
* TOP OF CORE TO BOTTOM OF BUNDLE *
* FLANGE *
.....
***
CV24000 'OUTLET' 2 2 1 * NON-EQUIL, VERTICAL FLOW, RCS VOL
CV240A1 PVOL 2.2E5 * INITIAL PRESSURE
CV240A2 TATM 397.0 * ASSUME INITIAL TEMP = 124 C
CV240A3 PH2O 0.0 * INITIALLY NO STEAM
CV240A4 MLFR 5 1.0 * MOLE FRACTION OF ARGON (NCG #5)
...
*** ALTITUDE/VOLUME TABLE FOR OUTLET
***
*** ALTITUDE VOLUME
***
CV240BA 1.400 0.0 * TOP OF CORE
CV240BB 1.471 2.715E-2 * BOTTOM OF BUNDLE FLANGE
.
.....
.
.
* CV 250 IS COLLECTOR - CORA 13 *
.
.
* LARGE VOLUME TO COLLECT ALL ARGON, *
* STEAM, H2, CO, CO2 FLOW *
.....
***
CV25000 'COLLECTOR' 2 2 1 * NON-EQUIL, VERTICAL FLOW, RCS VOL

```

```

CV250A1 PVOL 2.2E5 * INITIAL PRESSURE
CV250A2 TATM 397.0 * ASSUME INITIAL TEMP = 124 C
CV250A3 PH2O 0.0 * INITIALLY NO STEAM
CV250A4 MLFR.5 1.0 * MOLE FRACTION OF ARGON (NCG #5)
...
*** ALTITUDE/VOLUME TABLE FOR COLLECTOR
***
*** ALTITUDE VOLUME
***
CV250BA 1 471 0.0 * BOTTOM OF BUNDLE FLANGE
CV250BB 2.500 1.0E5 * TOP OF COLLECTOR (ESTIMATE) **
*
* * ASSUME VERY LARGE VOLUME!!!!
*
...
.....
*
*
* CV 300 IS THE VIDEOSCOPE COOLING SOURCE *
* CORA 13 *
* SOURCE VOL FOR ARGON COOLING FLOW *
.....
...
CV30000 'WINDOW COOLING' 2 2 1* NON-EQUIL, VERTICAL FLOW, RCS VOL
CV300A1 PVOL 2.2E5 * INITIAL PRESSURE
CV300A2 TATM 397.0 * ASSUME INITIAL TEMP = 124 C
CV300A3 PH2O 0.0 * INITIALLY NO STEAM
CV300A4 MLFR.5 1.0 * MOLE FRACTION OF ARGON (NCG #5)
...
*** ALTITUDE/VOLUME TABLE FOR THE INLET SOURCE VOLUME
***
*** ALTITUDE VOLUME
***
CV300BA -0.500 0.0
CV300BB -0.200 1.0E3 *ASSUME LARGE SOUCE VOLUME
*
...
*** COOLANT INJECTION
*
CV300C1 MASS.5 90 2 * UNIT KG/S, ARGON MDOT IN TF090
CV300C2 TE 95 8 * UNIT K, TEMP OF ARGON FOR ENTHALPY IN TF095
*
...
TF09000 'AR COOLANT FLOW' 2 1.0 0.0
*** TIME (S) MDOT (KG/S)
TF09011 0.0 0.001
TF09014 5050.0 0.001
*
TF09500 'AR COOLANT TEMP' 2 1.0 0.0
*** TIME (S) TEMP(K)
TF09511 0.0 397.0 * 124 C
TF09512 5050.0 397.0
*
.....
*
*
* CV 310 IS THE BYPASS VOLUME - CORA 13 *
*
* REGION BETWEEN SHROUD AND HTS *
.....
...
CV31000 'BYPASS' 2 2 1 * NON-EQUIL, VERTICAL FLOW, RCS VOL
CV310A1 PVOL 2.2E5 * INITIAL PRESSURE
CV310A2 TATM 397.0 * ASSUME INITIAL TEMP = 124 C
CV310A3 PH2O 0.0 * INITIALLY NO STEAM
CV310A4 MLFR.5 1.0 * MOLE FRACTION OF ARGON (NCG #5)
...
*** ALTITUDE/VOLUME TABLE FOR THE INLET SOURCE VOLUME
***

```

```

***  ALTITUDE  VOLUME
***
CV310BA  -0.200    0.0
CV310BB   0.036    1.3954E-2 *INCLUDES LOWER LEAK FLOW VOLUME FROM BUNDLE
CV310BC   1.036    7.5166E-2 *INCLUDES WINDOW FLOW VOLUME FROM BUNDLE &
*                                     HALF OF WINDOW FLOW VOLUME TO PRESSURE TUBE
CV310BD   1.275    9.1804E-2 *INCLUDES TOP LEAK FLOW VOLUME FROM BUNDLE
*
***
.....
*
*   CV 320 IS THE PRESSURE TUBE - CORA 13   *
*
*   REGION BETWEEN HTS AND PRESSURE TUBE   *
*   .....
***
CV32000 'BYPASS' 2 2 1   * NON-EQUIL, VERTICAL FLOW, RCS VOL.
CV320A1  PVOL  2.2E5     * INITIAL PRESSURE
CV320A2  TATM   397.0    * ASSUME INITIAL TEMP = 124 C
CV320A3  PH2O   0.0      * INITIALLY NO STEAM
CV320A4  MLFR.5 1.0      * MOLE FRACTION OF ARGON (NCG #5)
***
***  ALTITUDE/VOLUME TABLE FOR THE INLET SOURCE VOLUME
***
***  ALTITUDE  VOLUME
***
CV320BA  -0.200    0.0
CV320BB   1.275    0.14752 *INCLUDES HALF OF WINDOW FLOW VOLUME TO
*                                     PRESSURE TUBE
*
*   .....
*
*   CV 330 IS THE ENVIRONMENT - CORA 13   *
*
*   COLLECTS FLUID FROM BYPASS & P TUBE   *
*   .....
***
CV33000 'BYPASS' 2 2 1   * NON-EQUIL, VERTICAL FLOW, RCS VOL.
CV330A1  PVOL  2.2E5     * INITIAL PRESSURE
CV330A2  TATM   397.0    * ASSUME INITIAL TEMP = 124 C
CV330A3  PH2O   0.0      * INITIALLY NO STEAM
CV330A4  MLFR.5 1.0      * MOLE FRACTION OF ARGON (NCG #5)
***
***  ALTITUDE/VOLUME TABLE FOR THE INLET SOURCE VOLUME
***
***  ALTITUDE  VOLUME
***
CV330BA   1.275    0.0
CV330BB   2.500    1.0E5    *ASSUME VERY LARGE VOLUME
*
*   .....
*
***  FLOW PATHS   *
***
*
*   .....
*
**  FL100 - GAS INLET TO BUNDLE 1   *
*   CORA 13   *
*
*   .....
***
FL10000 'INLET-BUNDLE 1' 100 210 0.0 0.0 *FROM,TO -CV, ALT. AT 0 M
FL10001 0.001 0.35 1.0 0.0375 0.0375 *AREA, LENGTH, FR-OPEN, OPEN HT
FL10002 3 *HORIZ FLOW PATH

```

```

FL10003 0.001 1.0          *FORM LOSS COEF
FL100S1 0.001 0.35 0.0375 5.0E-5 16.0  *BUNDLE SEGMENT DATA
.
FL100V1 -1 197 197
.
CF19600 '110 TIME' L-GT 2 1. 0.
CF19601 .FALSE.
CF19605 LATCH
CF19611 1.0 0.0 TIME      * A1 > A2
CF19612 0.0 4880.0 TIME   * SHUT OFF AT 4880 SECONDS
.
CF19700 '110 CLOSURE' L-A-IFTE 3 1.0 0.0
CF19701 1.0
CF19711 1.0 0.0 CFVALU.196  * IF TEST
CF19712 0.0 0.0 TIME      * TRUE
CF19713 0.0 1.0 TIME      * FALSE
.
.....
* FL110 - QUENCH TO BUNDLE 1 - CORA 13 *
.
.....
...
FL11000 'QUENCH-BUNDLE 1' 110 210 -0.2 -0.2 *FROM,TO -CV, ALT.
FL11001 1.389E-02 1.06 1.0 0.02 0.02  *AREA, LENGTH, FR-OPEN, OPEN HT.
FL11002 0  *VERTICAL FLOW
FL11003 12.32 12.32  *FORM LOSS COEF (INCL LOWER GRID)
FL110S1 1.244E-02 0.76 0.052 5.0E-5 16.0 *SEGMENT DATA - CV110
FL110S2 1.151E-02 0.236 0.036 5.0E-5 16.0 *SEGMENT DATA - CV210 TO SHROUD
FL110S3 4.932E-03 0.064 0.017 5.0E-5 16.0 *SEGMENT DATA - SHROUD TO CENTER
.
      OF CV210
FL110V0 -1 195 195
.
.....
* FL210 - BUNDLE 1 TO BUNDLE 2 - CORA 13 *
.
.....
...
FL21000 'BUNDLE 1-2' 210 220 0.4 0.4  *FROM,TO -CV, ALT.
FL21001 4.9327E-3 0.50 1.0 0.04 0.04  *AREA, LENGTH, FR-OPEN, OPEN HT.
FL21002 0  *VERTICAL FLOW
FL21003 12.0 12.0  *FORM LOSS COEF (INCL MID GRID)
FL210S1 4.9327E-3 0.50 0.017 5.0E-5 16.0 *SEGMENT DATA
.
*FL210V0 -1 195 195
.
CF19400 '210 TIME' L-GT 2 1. 0.
CF19401 .FALSE.
CF19405 LATCH
CF19411 1.0 0.0 TIME      * A1 > A2
CF19412 0.0 5010.0 TIME   * SHUT OFF AT 5000 SECONDS
.
CF19500 '210 CLOSURE' L-A-IFTE 3 1.0 0.0
CF19501 1.0
CF19511 1.0 0.0 CFVALU.194  * IF TEST
CF19512 0.0 0.0 TIME      * TRUE
CF19513 0.0 1.0 TIME      * FALSE
.
.....
* FL220 - BUNDLE 2 TO BUNDLE 3 - CORA 13 *
.
.....
...
FL22000 'BUNDLE 2-3' 220 230 0.8 0.8  *FROM,TO -CV, ALT.
FL22001 4.9327E-3 0.50 1.0 0.04 0.04  *AREA, LENGTH, FR-OPEN, OPEN HT.
FL22002 0  *VERTICAL FLOW
FL22003 12.0 12.0  *FORM LOSS COEF (INCL TOP GRID)

```

```

FL220S1 4.9327E-3 0.50 0.017 5.0E-5 16.0 *SEGMENT DATA
.
.....
* FL230 - BUNDLE 3 TO OUTLET - CORA 13 *
.
.....
...
FL23000 'BUNDLE 3-OUTLET' 230 240 1.4 1.4 *FROM,TO -CV, ALT.
FL23001 0.3824 0.304 1.0 0.349 0.349 *AREA, LENGTH, FR-OPEN, OPEN HT.
FL23002 0 *VERTICAL FLOW
FL23003 1.52 1.52 *FORM LOSS COEF
FL230S1 4.9327E-3 0.131 0.017 5.0E-5 16.0 *SEGMENT DATA - CV230 - TOP SHROUD
FL230S2 7.5183E-2 0.156 0.160 5.0E-5 16.0 *SEGMENT DATA - TOP SHROUD TO HTS
FL230S3 0.3824 0.049 0.500 5.0E-5 16.0 *SEGMENT DATA - TOP CV230 & CV 240
.
.....
* FL240 - OUTLET TO COLLECTOR CORA 13 *
.....
...
FL24000 'OUTLET-COLLECTOR' 240 250 1.471 1.471 *FROM,TO -CV, ALT.
FL24001 0.3824 0.55 1.0 0.349 0.349 *AREA, LENGTH, FR-OPEN, OPEN HT
FL24003 0.1 0.1 *FORM LOSS COEF
FL240S1 0.3824 0.55 0.5 5.0E-5 16.0 *SEGMENT DATA
.
.....
* FL211 - BOTTOM BUNDLE LEAKAGE TO BYPASS - CORA 13 *
.....
...
***** GEOMETRY TAKEN FROM APPENDIX A TABLES
.
FL21100 'LOW BUNDLE LEAK' 210 310 -0.10 -0.10 *FROM,TO -CV, ALT.
FL21101 0.0002 0.02 1.0 0.016 0.016 *AREA, LENGTH, FR-OPEN, OPEN HT
FL21102 3 *HORIZ FLOW
FL21103 300.0 5.0 *FORM LOSS COEF
* changed from 1.0 to 3.0 - RJG 12/23/91
* changed from 3.0 to 9.0 - RJG 1/08/92
* changed from 9.0 to 25. - RJG 1/16/92
FL211S1 0.0002 0.02 0.003 5.0E-5 16.0 *SEGMENT DATA
.
FL211V0 -1 197 197
.
.....
* FL221 - LOWER WINDOW LEAK BUNDLE 2 TO BYPASS - CORA 13 *
.....
...
***** GEOMETRY TAKEN FROM APPENDIX A TABLES
.
FL22100 'W1-BYPASS' 210 310 0.375 0.375 *FROM,TO -CV, ALT.
FL22101 0.0019 0.02 1.0 0.05 0.05 *AREA, LENGTH, FR-OPEN, OPEN HT
FL22102 3 *HORIZ FLOW
FL22103 100.0 50.0 *FORM LOSS COEF
FL221S1 0.0019 0.02 0.03 5.0E-5 16.0 *SEGMENT DATA
.
FL221V0 -1 197 197
.
.....
* FL222 - MIDDLE WINDOW LEAK BUNDLE 2 TO BYPASS - CORA 13 *
.....
...
***** GEOMETRY TAKEN FROM APPENDIX A TABLES
.
FL22200 'W2-BYPASS' 220 310 0.55 0.55 *FROM,TO -CV, ALT.
FL22201 0.0019 0.02 1.0 0.05 0.05 *AREA, LENGTH, FR-OPEN, OPEN HT
FL22202 3 *HORIZ FLOW
FL22203 100.0 40.0 *FORM LOSS COEF
FL222S1 0.0019 0.02 0.03 5.0E-5 16.0 *SEGMENT DATA

```

```

*
FL222V0 -1 197 197
*
*****
* FL223 - UPPER WINDOW LEAK BUNDLE 2 TO BYPASS - CORA 13 *
*****
...
***** GEOMETRY TAKEN FROM APPENDIX A TABLES
*
FL22300 'W3-BYPASS' 230 310 0.825 0.825 *FROM,TO -CV, ALT.
FL22301 0.0019 0.02 1.0 0.05 0.05 *AREA, LENGTH, FR-OPEN, OPEN HT
FL22302 3 *HORIZ FLOW
FL22303 300.0 300.0 *FORM LOSS COEF
FL223S1 0.0019 0.02 0.03 5.0E-5 16.0 *SEGMENT DATA
*
FL223V0 -1 197 197
*
*****
* FL231 - TOP BUNDLE LEAKAGE TO BYPASS - CORA 13 *
*****
...
***** GEOMETRY TAKEN FROM APPENDIX A TABLES
*
*FL23100 'TOP BUNDLE LEAK' 310 240 1.260 1.400 *FROM,TO -CV, ALT
FL23100 'TOP BUNDLE LEAK' 230 310 1.275 1.260 *FROM,TO -CV, ALT.
*FL23101 0.0004 0.02 1.0 0.023 0.023 *AREA, LENGTH, FR-OPEN, OPEN HT
FL23101 0.0004 0.02 1.0 0.023 0.023 *AREA, LENGTH, FR-OPEN, OPEN HT
FL23102 3 *HORIZ FLOW
FL23103 100. 40. *FORM LOSS COEF
*changed from 1.6 to 4.8 - RJG 12/23/91
FL231S1 0.0004 0.02 0.003 5.0E-5 16.0 *SEGMENT DATA
*
*FL231V0 -1 197 197
*
*****
* FL111 - QUENCH TO BYPASS - CORA 13 *
*
*****
...
FL11100 'QUENCH-BYPASS' 111 310 -0.2 -0.2 *FROM,TO -CV, ALT
FL11101 2.765E-2 1.5 1.0 0.02 0.02 *AREA, LENGTH, FR-OPEN, OPEN HT
FL11102 0 *VERTICAL FLOW
FL11103 0.28 1.0 *FORM LOSS COEF
FL111S1 2.7654E-02 0.76 0.972 5.0E-5 16.0 *SEGMENT DATA - CV110
FL111S2 5.9101E-02 0.236 0.1656 5.0E-5 16.0 *SEGMENT DATA - C3210 TO SHROUD
FL111S3 6.1200E-02 0.502 0.158 5.0E-5 16.0 *SEGMENT DATA - SHROUD TO CENTER
* OF CV310
*
*****
* FL311 - LOWER WINDOW LEAK BYPASS TO PRESSURE TUBE - CORA 13 *
*****
...
***** GEOMETRY TAKEN FROM APPENDIX A TABLES
*
FL31100 'W1-PRESS TUBE' 310 320 0.4 0.4 *FROM,TO -CV, ALT.
FL31101 0.0001 0.14 1.0 0.01 0.01 *AREA, LENGTH, FR-OPEN, OPEN HT
FL31102 3 *HORIZ FLOW
FL31103 60.0 60.0 *FORM LOSS COEF
FL311S1 0.0001 0.14 0.01 5.0E-5 16.0 *SEGMENT DATA
*
FL311V0 -1 197 197
*
*****
* FL312 - MIDDLE WINDOW LEAK BYPASS TO PRESSURE TUBE - CORA 13 *
*****
...

```



```

***** GEOMETRY TAKEN FROM APPENDIX A TABLES
.
FL31200 'W2-PRESS TUBE' 310 320 0.6 0.6 *FROM,TO -CV, ALT.
FL31201 0.0001 0.14 1.0 0.01 0.01 *AREA, LENGTH, FR-OPEN, OPEN HT
FL31202 3 *HORIZ FLOW
FL31203 60.0 60.0 *FORM LOSS COEF
FL312S1 0.0001 0.14 0.01 5.0E-5 16.0 *SEGMENT DATA
.
FL312V0 -1 197 197
.
*****
* FL313 - UPPER WINDOW LEAK BYPASS TO PRESSURE TUBE - CORA 13 *
*****
***
***** GEOMETRY TAKEN FROM APPENDIX A TABLES
.
FL31300 'W3-PRESS TUBE' 310 320 0.8 0.8 *FROM,TO -CV, ALT.
FL31301 0.0001 0.14 1.0 0.01 0.01 *AREA, LENGTH, FR-OPEN, OPEN HT
FL31302 3 *HORIZ FLOW
FL31303 60.0 60.0 *FORM LOSS COEF
FL313S1 0.0001 0.14 0.01 5.0E-5 16.0 *SEGMENT DATA
.
FL313V0 -1 197 197
.
*****
* FL300 - VIDEO COOLING TO PRESSURE TUBE *
* CORA 13 *
*****
***
FL30000 'COOLING- PT' 300 320 -0.2 -0.2 *FROM,TO -CV, ALT.
FL30001 0.1 0.89 1.0 0.18 0.18 *AREA, LENGTH, FR-OPEN, OPEN HT.
FL30002 0 *VERTICAL FLOW
FL30003 0.001 1.0 *FORM LOSS COEF
FL300S1 0.1 0.89 0.1 5.0E-5 16.0 *SEGMENT DATA
.
*****
* FL320 - PRESSURE TUBE TO ENVIRONMENT *
* CORA 13 *
*****
***
FL32000 'PT - ENV' 320 330 1.275 1.275 *FROM,TO -CV, ALT
FL32001 0.1 1.35 1.0 0.18 0.18 *AREA, LENGTH, FR-OPEN, OPEN HT.
FL32002 0 *VERTICAL FLOW
FL32003 0.001 1.0 *FORM LOSS COEF
FL320S1 0.1 1.35 0.1 5.0E-5 16.0 *SEGMENT DATA
.
* MAX NUMBER OF CVH ITERATIONS
SC44010 4401 20.0 3
.
*****
* HEAT STRUCTURE INPUT FOR ISP31, CORA 13 EXPERIMENT
* SHROUD INSULATION CONSISTS OF 19 mm OF ZrO2 FIBER INSULATION
* RUNNING FROM A HEIGHT OF 0 mm TO 1000 mm
.
* ROBERT J. GROSS AND GALE M. MARTINEZ
* Initial Input - 10/30/91
.
* COMMENT OUT RADIATION FROM SHROUD INSULATION - RJG 1/08/92
* 23017, 23018, and 24019 all given constant temperature inner surfaces
* to cool down upper areas - RJG 2/13/92
.
*****
* HS11001000 - STAINLESS STEEL CAN, CORE LEVEL 1, -489mm to -300mm
* Left Inside Boundary is in CV110
* Right Outside Boundary is in CV110
.

```

```

*      Nodes Geom TempInit ITR
HS11001000  2    2    -1    0 * Two nodes, radial geom
*
*      Name
HS11001001  'Steel Can 1'
*
*      Elev Orient
HS11001002  -0.489  1.0          * Vertical surface
*
*      Local Format LocDist
HS11001100  -1    1    0.0665
*
*      Dist Node
HS11001102  0.0715  2          * ASSUME STEAM DIST TUBE 5MM THICK
*
*      MatLoc
HS11001200  -1
*
*      Material Mesh
HS11001201  'STAINLESS STEEL' 1
*
*      Power Source
HS11001300  0          * No Power Source
*
* Left Boundary Data
*      BCType CVNum Flow Pool Atmos
HS11001400  1    110  INT  0.1    * Inner CV is 110
*
* Zero out heat flux from the CVH Package with TF 101
* Heat Transfer to pool when pool fraction > 0.1
* No Radiation to the left (inner) surface that
* is adjacent to Zircaloy canister
*
*      SurfA CharL AxialL
HS11001500  0.0786  0.11966  0.189    * Char Length is Diameter
*
* SurfA parameter is ignored in cylindrical environment
*
* Right Boundary Data
*      BCType CVNum Flow Pool Atmos
HS11001600  1    110  INT  0.1    * Outer CV is 110
*
*      SurfA CharL AxialL
HS11001700  0.0845  0.15766  0.189    * Char Length is Diameter
*
* SurfA parameter is ignored in cylindrical environment
*
*      TempInit
HS11001800  -1
*
*      Temp Node
*HS11001801  313.  2          * 40 C at 0 sec
HS11001801  313.  2          * 40 C at 3000 sec
*
*.....
*.....
* HS11002000 - STAINLESS STEEL CAN, CORE LEVEL 2, -300mm to -200mm
* Left Inside Boundary is in CV110
* Right Outside Boundary is in CV110
*
*      Nodes Geom TempInit ITR
HS11002000  2    2    -1    0 * Two nodes, radial geom
*
*      Name
HS11002001  'Steel Can 2'
*

```

```

*      Elev  Orient
HS11002002  -0.300  1.0      * Vertical surface
*
*      Locat  Format  LocDist
HS11002100  -1    1    0.0665
*
*      Dist  Node
HS11002102  0.0715  2      * ASSUME STEAM DIST TUBE 5MM THICK
*
*      MatLoc
HS11002200  -1
*
*      Material  Mesh
HS11002201  'STAINLESS STEEL'  1
*
*      Power Source
HS11002300  0      * No Power Source
*
* Left Boundary Data
*      BCType  CVNum  Flow  Pool  Atmos
HS11002400  1    110  INT  0.1    * Inner CV is 110
*
* Zero out heat flux from the CVH Package with TF 101
* Heat Transfer to pool when pool fraction > 0.1
* No Radiation to the left (inner) surface that
* is adjacent to Zircaloy canister
*
*      SurfA  CharL  AxialL
HS11002500  0.0418  0.11966  0.099      * Char Length is Diameter
*
* SurfA parameter is ignored in cylindrical environment
*
* Right Boundary Data
*      BCType  CVNum  Flow  Pool  Atmos
HS11002600  1    110  INT  0.1    * Outer CV is 310
*
*      SurfA  CharL  AxialL
HS11002700  0.0449  0.15766  0.099      * Char Length is Diameter
*
* SurfA parameter is ignored in cylindrical environment
*
*      Templnit
HS11002800  -1
*
*      Temp  Node
*HS11002801  313.  2      * 40 C at 0 sec
HS11002801  313.  2      * 40 C at 3000 sec
*
*.....
*.....
* HS21003000 - STAINLESS STEEL CAN, CORE LEVEL 3, -200mm to -100mm
* Left Inside Boundary is in CV210
* Right Outside Boundary is in CV210
*
*      Nodes  Geom  Templnit  ITR
HS21003000  2    2    -1    0 * Two nodes, radial geom
*
*      Name
HS21003001  'Steel Can 3'
*
*      Elev  Orient
HS21003002  -0.200  1.0      * Vertical surface
*
*      Locat  Format  LocDist
HS21003100  -1    1    0.0665
*

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```

*      Dist  Node
HS21003102  0.0715  2      * ASSUME STEAM DIST TUBE 5MM THICK
*
*      MatLoc
HS21003200  -1
*
*      Material  Mesh
HS21003201  'STAINLESS STEEL'  1
*
*      Power Source
HS21003300  0      * No Power Source
*
* Left Boundary Data
*      BCType  CVNum  Flow  Pool  Atmos
HS21003400  1      210  INT  0.1      * Inner CV is 210
*
* Zero out heat flux from the CVH Package with TF 101
* Heat Transfer to pool when pool fraction > 0.1
* No Radiation to the left (inner) surface that
* is adjacent to Zircaloy canister
*
*      SurfA  CharL  AxialL
HS21003500  0.0418  0.11966  0.1      * Char Length is Diameter
*
* SurfA parameter is ignored in cylindrical environment
*
* Right Boundary Data
*      BCType  CVNum  Flow  Pool  Atmos
HS21003600  1      210  INT  0.1      * Outer CV is 210
*
*      SurfA  CharL  AxialL
HS21003700  0.0449  0.15766  0.1      * Char Length is Diameter
*
* SurfA parameter is ignored in cylindrical environment
*
*      TempInit
HS21003800  -1
*
*      Temp  Node
*HS21003801  313.  2      * 40 C at 0 sec
HS21003801  803.  2      * 530 C at 3000 sec
*
*.....
* HS21004000 - STAINLESS STEEL CAN, CORE LEVEL 4, -100mm to 0mm
* Left Inside Boundary is in CV210
* Right Outside Boundary is in CV210
*
*      Nodes  Geom  TempInit  ITR
HS21004000  2      2      -1      0 * Two nodes, radial geom
*
*      Name
HS21004001  'Steel Can 4'
*
*      Elev  Orient
HS21004002  -0.100  1.0      * Vertical surface
*
*      Locat  Format  LocDist
HS21004100  -1      1      0.0665
*
*      Dist  Node
HS21004102  0.0715  2      * ASSUME STEAM DIST TUBE 5MM THICK
*
*      MatLoc
HS21004200  -1
*
*      Material  Mesh

```

```

HS21004201  'STAINLESS STEEL' 1
*
*      Power Source
HS21004300  0      * No Power Source
*
* Left Boundary Data
*      BCType CVNum Flow Pool Atmos
HS21004400  1      210 INT 0.1      * Inner CV is 210
*
* Zero out heat flux from the CVH Package with TF 101
* Heat Transfer to pool when pool fraction > 0.1
* No Radiation to the left (inner) surface that
* is adjacent to Zircaloy canister
*
*      SurfA CharL AxialL
HS21004500  0.0418 0.11966 0.099      * Char Length is Diameter
*
* SurfA parameter is ignored in cylindrical environment
*
* Right Boundary Data
*      BCType CVNum Flow Pool Atmos
HS21004600  1      210 INT 0.1      * Outer CV is 210
*
*      SurfA CharL AxialL
HS21004700  0.0449 0.15766 0.099      * Char Length is Diameter
*
* SurfA parameter is ignored in cylindrical environment
*
*      TempInit
HS21004800  -1
*
*      Temp Node
*HS21004801  313 2      * 40 C at 0 sec
HS21004801  803 2      * 530 C at 3000 sec
*
*.....
*.....
* HS21005000 - SHROUD INSULATION, CORE LEVEL 5, 0 to 100mm
* Left Inside Boundary is in CV210
* Right Outside Boundary is in CV310
*
*      Nodes Geom TempInit ITR
HS21005000  6 2 -1 0 * Six nodes, radial geom
*
*      Name
HS21005001  'Shroud 1'
*
*      Elev Orient
HS21005002  0.0 1.0      * Vertical surface
*
*      Locat Format LocDist
HS21005100  -1 1 0.05983
*
*      Dist Node
HS21005102  0.06363 2
HS21005103  0.06743 3
HS21005104  0.07123 4
HS21005105  0.07503 5
HS21005106  0.07883 6
*
*      MatLoc
HS21005200  -1
*
*      Material Mesh
HS21005201  'LITHIUM ALUMINUM' 5      * 19mm of Porous Zirc Fiber
*

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```

*      Power Source
HS21005300  0      * No Power Source
*
* Left Boundary Data
*      BCType CVNum Flow Pool Atmos
HS21005400  4101  210  INT  0.1      * Inner CV is 210
*
* Zero out heat flux from the CVH Package with TF 101
* Heat Transfer to pool when pool fraction > 0.1
* No Radiation to the left (inner) surface that
* is adjacent to Zircaloy canister
*
TF10100  'HEAT FLUX BC' 2  1.0 0.0
TF10110  0.0  0.0      * TIME, HEAT TRANS COEF
TF10111  36000.0  0.0
*
*      SurfA CharL AxialL
HS21005500  0.0376 0.11966 0.1      * Char Length is Diameter
*
* SurfA parameter is ignored in cylindrical environment
*
* Right Boundary Data
*      BCType CVNum Flow Pool Atmos
HS21005600  1  310  INT  0.1      * Outer CV is 310
*
*      Rad Type PathL
*HS21005601  1.0 'GRAY GAS A' 0.03708      * PathL = CV310 Flow Annuli*0.5
*
*      SurfA CharL AxialL
HS21005700  0.0495 0.15766 0.1      * Char Length is Diameter
*
* SurfA parameter is ignored in cylindrical environment
*
*      TempInit
HS21005800  -1
*
*      Temp Node
*HS21005801  435.  6      * 162 C at 0 sec Table 2
HS21005801  633.  1
HS21005802  596.  2
HS21005803  559.  3
HS21005804  521.  4
HS21005805  484.  5
HS21005806  447.  6      * 174 C at 3000 sec Table 3
*
.....
* HS21006000 - SHROUD INSULATION IN CV210, CORE LEVEL 6, 100 to 200mm
* Left Inside Boundary is in CV210
* Right Outside Boundary is in CV310
*
*      Nodes Geom TempInit ITR
HS21006000  6  2  -1  0
*
*      Name
HS21006001  'Shroud 2'
*
*      Elev Orient
HS21006002  0.1  1.0      * Vertical surface
*
*      Local Format LocDist
HS21006100  -1  1  0.05983
*
*      Dist Node
HS21006102  0.06363 2
HS21006103  0.06743 3
HS21006104  0.07123 4

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```

HS21006105  0.07503  5
HS21006106  0.07883  6
*
*      MatLoc
HS21006200  -1
*
*      Material      Mesh
HS21006201  'LITHIUM ALUMINUM'  5      * 19mm of Porous Zirc Fiber
*
*      Power Source
HS21006300  0      * No Power Source
*
* Zero out heat flux from the CVH Package with TF 101
* Heat Transfer to pool when pool fraction > 0.1
* No Radiation to the left (inner) surface that
* is adjacent to Zircaloy canister
*
* Left Boundary Data
*      BCType CVNum  Flow Pool Atmos
HS21006400  4101  210  INT  0.1      * Inner CV is 210
*
*      SurfA  CharL  AxialL
HS21006500  0.0376  0.11966  0.1      * Char Length is Diameter
*
* SurfA parameter is ignored in cylindrical environment
*
* Right Boundary Data
*      BCType CVNum  Flow Pool Atmos
HS21006600  1      310  INT  0.1      * Outer CV is 310
*
*      Rad  Type  PathL
*HS21006601  1.0 'GRAY GAS A' 0.03708      * PathL = CV310 Flow Annuli*0.5
*
*      SurfA  CharL  AxialL
HS21006700  0.0495  0.15766  0.1      * Char Length is Diameter
*
* SurfA parameter is ignored in cylindrical environment
*
*      TempInit
HS21006800  -1
*
*      Temp      Node
*HS21006801  398.  6      * 125 C at 0 sec Table 2
HS21006801  718.  1
HS21006802  656.  2
HS21006803  593.  3
HS21006804  530.  4
HS21006805  468.  5
HS21006806  406.  6      * 133 C at 3000 sec Table 3
*
*.....
* HS21007000 - SHROUD INSULATION IN CV210, CORE LEVEL 7, 200 to 300mm
* Left Inside Boundary is in CV210
* Right Outside Boundary is in CV310
*
*      Nodes Geom  TempInit ITR
HS21007000  6  2  -1  0
*
*      Name
HS21007001  'Shroud 3'
*
*      Elev  Orient
HS21007002  0.2  1.0      * Vertical surface
*
*      Locat  Format  LocDist
HS21007100  -1  1  0.05983

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```

*
*      Dist  Node
HS21007102  0.06363  2
HS21007103  0.06743  3
HS21007104  0.07123  4
HS21007105  0.07503  5
HS21007106  0.07883  6
*
*      MatLoc
HS21007200  -1
*
*      Material      Mesh
HS21007201  'LITHIUM ALUMINUM' 5      * 19mm of Porous Zirc Fiber
*
*      Power Source
HS21007300  0      * No Power Source
*
* Left Boundary Data
*      BCType CVNum  Flow  Pool  Atmos
HS21007400  4101  210  INT  0.1      * Inner cv is 210
*
* Zero out heat flux from the CVH Package with TF 101
* Heat Transfer to pool when pool fraction > 0.1
* No Radiation to the left (inner) surface that
* is adjacent to Zircaloy canister
*
*      SurfA  CharL  AxialL
HS21007500  0.0376  0.11966  0.1      * Char Length is Diameter
*
* SurfA parameter is ignored in cylindrical environment
*
* Right Boundary Data
*      BCType CVNum  Flow  Pool  Atmos
HS21007600  1      310  INT  0.1      * Outer CV is 310
*
*      Rad  Type  PathL
*HS21007601  1.0 'GRAY GAS A' 0.03708      * PathL = CV310 Flow Annuli*0.5
*
*      SurfA  CharL  AxialL
HS21007700  0.0495  0.15766  0.1      * Char Length is Diameter
*
* SurfA parameter is ignored in cylindrical environment
*
*      Templnit
HS21007800  -1
*
*      Temp  Node
*HS21007801  396.  6      * 123 C at 0 sec Table 2
HS21007801  661.  1
HS21007802  610.  2
HS21007803  559.  3
HS21007804  509.  4
HS21007805  458.  5
HS21007806  407.  6      * 134 C at 3000 sec Table 3
*
*.....
* HS21008000 - SHROUD INSULATION IN CV220, CORE LEVEL 8, 300 to 400mm
* Left Inside Boundary is in CV210
* Right Outside Boundary is in CV310
*
*      Nodes Geom  Templnit  ITR
HS21008000  6      2      -1      0
*
*      Name
HS21008001  'Shroud 4'
*

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```

*      Elev  Orient
HS21008002  0.3  1.0      * Vertical surface
*
*      Locat  Format  LocDist
HS21008100  -1   1    0.05983
*
*      Dist  Node
HS21008102  0.06363  2
HS21008103  0.06743  3
HS21008104  0.07123  4
HS21008105  0.07503  5
HS21008106  0.07883  6
*
*      MatLoc
HS21008200  -1
*
*      Material      Mesh
HS21008201  'LITHIUM ALUMINUM' 5      * 19mm of Porous Zirc Fiber
*
*      Power Source
HS21008300  0      * No Power Source
*
* Left Boundary Data
*      BCType  CVNum  Flow  Pool  Atmos
HS21008400  4101  210  INT  0.1      * Inner CV is 220
*
* Zero out heat flux from the CVH Package with TF 101
* Heat Transfer to pool when pool fraction > 0.1
* No Radiation to the left (inr br) surface that
* is adjacent to Zircaloy canister
*
*      SurfA  CharL  AxialL
HS21008500  0.0376  0.11966  0.1      * Char Length is Diameter
*
* SurfA parameter is ignored in cylindrical environment
*
* Right Boundary Data
*      BCType  CVNum  Flow  Pool  Atmos
HS21008600  1     310  INT  0.1      * Outer CV is 310
*
*      Rad  Type  PathL
*HS21008601  1.0 'GRAY GAS A' 0.0370R      * PathL = CV310 Flow Annuli*0.5
*
*      SurfA  CharL  AxialL
HS21008700  0.0495  0.15766  0.1      * Char Length is Diameter
*
* SurfA parameter is ignored in cylindrical environment
*
*      TempInit
HS21008800  -1
*
*      Temp  Node
*HS21008801  394   6      * 121 C at 0 sec Table 2
HS21008801  656   1
HS21008802  607   2
HS21008803  558   3
HS21008804  508   4
HS21008805  459   5
HS21008806  410   6      * 137 C at 3000 sec Table 3
*
*.....
* HS22009000 - SHROUD INSULATION IN CV220, CORE LEVEL 9, 400 to 500mm
* Left Inside Boundary is in CV220
* Right Outside Boundary is in CV310
*
*      Nodes  Geom  TempInit  ITR

```

```

HS22009000  6   2   -1   0
.
.      Name
HS22009001  'Shroud 5'
.
.      Elev  Orient
HS22009002  0.4  1.0      * Vertical surface
.
.      Locat  Format  LocDist
HS22009100  -1   1   0.05983
.
.      Dist  Node
HS22009102  0.06363  2
HS22009103  0.06743  3
HS22009104  0.07123  4
HS22009105  0.07503  5
HS22009106  0.07883  6
.
.      MatLoc
HS22009200  -1
.
.      Material  Mesh
HS22009201  'LITHIUM ALUMINUM' 5      * 19mm of Porous Zirc Fiber
.
.      Power Source
HS22009300  0      * No Power Source
.
* Left Boundary Data
.      BCType  CVNum  Flow  Pool  Atmos
HS22009400  4101  220  INT  0.1      * Inner CV is 220
.
* Zero out heat flux from the CVH Package with TF 101
* Heat Transfer to pool when pool fraction > 0.1
* No Radiation to the left (inner) surface that
* is adjacent to Zircaloy canister
.
.      SurfA  CharL  AxialL
HS22009500  0.0376  0.11966  0.1      * Char Length is Diameter
.
* SurfA parameter is ignored in cylindrical environment
.
* Right Boundary Data
.      BCType  CVNum  Flow  Pool  Atmos
HS22009600  1    310  INT  0.1      * Outer CV is 310
.
.      Rad  Type  PathL
*HS22009601  1.0 'GRAY GAS A' 0.03708      * PathL = CV310 Flow Annuli*0.5
.
.      SurfA  CharL  AxialL
HS22009700  0.0495  0.15766  0.1      * Char Length is Diameter
.
* SurfA parameter is ignored in cylindrical environment
.
.      Templnit
HS22009800  -1
.
.      Temp  Node
*HS22009801  391.  6      * 118 C at 0 sec Table 2
HS22009801  649.  1
HS22009802  601.  2
HS22009803  553.  3
HS22009804  505.  4
HS22009805  457.  5
HS22009806  409.  6      * 136 C at 3000 sec Table 3
.
.....

```

* HS22010000 - SHROUD INSULATION IN CV220, CORE LEVEL 10, 500 to 600mm
 * Left Inside Boundary is in CV220
 * Right Outside Boundary is in CV310
 .
 * Nodes Geom TempInit ITR
 HS22010000 6 2 -1 0
 .
 * Name
 HS22010001 'Shroud 6'
 .
 * Elev Orient
 HS22010002 0.5 1.0 * Vertical surface
 .
 * Local Format LocDist
 HS22010100 -1 1 0.05983
 .
 * Dist Node
 HS22010102 0.06363 2
 HS22010103 0.06743 3
 HS22010104 0.07123 4
 HS22010105 0.07503 5
 HS22010106 0.07883 6
 .
 * MatLoc
 HS22010200 -1
 .
 * Material Mesh
 HS22010201 'LITHIUM ALUMINUM' 5 * 19mm of Porous Zirc Fiber
 .
 * Power Source
 HS22010300 0 * No Power Source
 .
 * Zero out heat flux from the CVH Package with TF 101
 * Heat Transfer to pool when pool fraction > 0.1
 * No Radiation to the left (inner) surface that
 * is adjacent to Zircaloy canister
 .
 * Left Boundary Data
 * BCType CVNum Flow Pool Atmos
 HS22010400 4101 220 INT 0 1 * Inner CV is 220
 .
 * SurfA parameter is ignored in cylindrical environment
 .
 * SurfA CharL AxialL
 HS22010500 0.0376 0.11966 0.1 * Char Length is Diameter
 .
 * Right Boundary Data
 * BCType CVNum Flow Pool Atmos
 HS22010600 1 310 INT 0.1 * Outer CV is 310
 .
 * Rad Type PathL
 * HS22010601 1.0 'GRAY GAS A' 0.03708 * PathL= CV310 Flow Annuli*0.5
 .
 * SurfA CharL AxialL
 HS22010700 0.0495 0.15766 0.1 * Char Length is Diameter
 .
 * SurfA parameter is ignored in cylindrical environment
 .
 * TempInit
 HS22010800 -1
 .
 * Temp Node
 * HS22010801 389. 6 * 116 C at 0 sec Table 2
 HS22010801 643 1
 HS22010802 596 2
 HS22010803 549 3

HS22010804 502. 4
 HS22010805 455. 5
 HS22010806 408. 6 * 135 C at 3000 sec Table 3
 *

 * HS22011000 - SHROUD INSULATION IN CV220, CORE LEVEL 11, 600 to 700mm
 * Left Inside Boundary is in CV220
 * Right Outside Boundary is in CV310
 *
 * Nodes Geom TempInit ITR
 HS22011000 6 2 -1 0
 *
 * Name
 HS22011001 'Shroud 7'
 *
 * Elev Orient
 HS22011002 0.6 1.0 * Vertical surface
 *
 * Locat Format LocDist
 HS22011100 -1 1 0.05983
 *
 * Dist Node
 HS22011102 0.05363 2
 HS22011103 0.06743 3
 HS22011104 0.07123 4
 HS22011105 0.07503 5
 HS22011106 0.07883 6
 *
 * MatLoc
 HS22011200 -1
 *
 * Material Mesh
 HS22011201 'LITHIUM ALUMINUM' 5 * 19mm of Porous Zirc Fiber
 *
 * Power Source
 HS22011300 0 * No Power Source
 *
 * Left Boundary Data
 * BCType CVNum Flow Pool Atmos
 HS22011400 4101 220 INT 0.1 * Inner CV is 220
 *
 * Zero out heat flux from the CVH Package with TF 101
 * Heat Transfer to pool when pool fraction > 0.1
 * No Radiation to the left (inner) surface that
 * is adjacent to Zircaloy canister
 *
 * SurfA CharL AxialL
 HS22011500 0.0376 0.11966 0.1 * Char Length is Diameter
 *
 * SurfA parameter is ignored in cylindrical environment
 *
 * Right Boundary Data
 * BCType CVNum Flow Pool Atmos
 HS22011600 1 310 INT 0.1 * Outer CV is 310
 *
 * Rad Type PathL
 * HS22011601 1.0 'GRAY GAS A' 0.03708 * PathL = CV310 Flow Annuli*0.5
 *
 * SurfA CharL AxialL
 HS22011700 0.0495 0.15766 0.1 * Char Length is Diameter
 *
 * SurfA parameter is ignored in cylindrical environment
 *
 * TempInit
 HS22011800 -1
 *

```

*      Temp      Node
*HS22011801  388.  6      * 115 C at 0 sec Table 2
HS22011801  636.  1
HS22011802  590.  2
HS22011803  544.  3
HS22011804  499.  4
HS22011805  453.  5
HS22011806  407.  6      * 134 C at 3000 sec Table 3
*
*****
* HS22012000 - SHROUD INSULATION IN CV220, CORE LEVEL 12, 700 to 800mm
* Left Inside Boundary is in CV220
* Right Outside Boundary is in CV310
*
*      Nodes Geom TempInit ITR
HS22012000  6  2  -1  0
*
*      Name
HS22012001  'Shroud B'
*
*      Elev Orient
HS22012002  0.7  1.0      * Vertical surface
*
*      Locat Format LocDist
HS22012100  -1  1  0.05983
*
*      Dist Node
HS22012102  0.06363  2
HS22012103  0.06743  3
HS22012104  0.07123  4
HS22012105  0.07503  5
HS22012106  0.07883  6
*
*      MatLoc
HS22012200  -1
*
*      Material Mesh
HS22012201  'LITHIUM ALUMINUM' 5      * 19mm of Porous Zirc Fiber
*
*      Power Source
HS22012300  0      * No Power Source
*
* Left Boundary Data
*      BCType CVNum Flow Pool Atmos
HS22012400  4101  220  INT  0.1      * Inner CV is 220
*
* Zero out heat flux from the CVH Package with TF 101
* Heat Transfer to pool when pool fraction > 0.1
* No Radiation to the left (inner) surface that
* is adjacent to Zircaloy canister
*
*      SurfA CharL AxialL
HS22012500  0.0376  0.11966  0.1      * Char Length is Diameter
*
* SurfA parameter is ignored in cylindrical environment
*
* Right Boundary Data
*      BCType CVNum Flow Pool Atmos
HS22012600  1  310  INT  0.1      * Outer CV is 310
*
*      Rad Type PathL
*HS22012601  1.0 'GRAY GAS A' 0.03708      * PathL = CV310 Flow Annuli*0.5
*
*      SurfA CharL AxialL
HS22012700  0.0495  0.15766  0.1      * Char Length is Diameter
*

```

```

* SurfA parameter is ignored in cylindrical environment
.
*      TempInit
HS22012800  -1
.
*      Temp      Node
*HS22012801  386   6      * 113 C at 0 sec Table 2
HS22012801  631.   1
HS22012802  586.   2
HS22012803  541.   3
HS22012804  496.   4
HS22012805  451.   5
HS22012806  406.   6      * 133 C at 3000 sec Table 3
.
.....
* HS23013000 - SHROUD INSULATION IN CV230, CORE LEVEL 13, 800 to 900 m
* Left Inside Boundary is in CV230
* Right Outside Boundary is in CV310
.
*      Nodes Geom TempInit ITR
HS23013000  6   2   -1   0
.
*      Name
HS23013001  'Shroud 9'
.
*      Elev Orient
HS23013002  0.8  1.0      * Vertical surface
.
*      Local Format LocDist
HS23013100  -1   1   0.05983
.
*      Dist Node
HS23013102  0.06363  2
HS23013103  0.06743  3
HS23013104  0.07123  4
HS23013105  0.07503  5
HS23013106  0.07883  6
.
*      MatLoc
HS23013200  -1
.
*      Material Mesh
HS23013201  'LITHIUM ALUMINUM' 5      * 19mm of Porous Zirc Fiber
.
*      Power Source
HS23013300  0      * No Power Source
.
* Left Boundary Data
*      BCType CVNum Flow Pool Atmos
HS23013400  4101  230  INT  0.1      * Inner CV is 230
.
* Zero out heat flux from the CVH Package with TF 101
* Heat Transfer to pool when pool fraction > 0.1
* No Radiation to the left (inner) surface that
* is adjacent to Zircaloy canister
.
*      SurfA CharL AxialL
HS23013500  0.0376 0.11966 0.1      * Char Length is Diameter
.
* SurfA parameter is ignored in cylindrical environment
.
* Right Boundary Data
*      BCType CVNum Flow Pool Atmos
HS23013600  1   310  INT  0.1      * Outer CV is 310
.
*      Rad Type PathL

```

*HS23013601 1.0 'GRAY GAS A' 0.03708 * PathL = CV310 Flow Annuli*0.5

.

* SurfA CharL AxialL

HS23013700 0.0495 0.15766 0.1 * Char Length is Diameter

.

* TempInit

HS23013800 -1

.

* SurfA parameter is ignored in cylindrical environment

.

* Temp Node

*HS23013801 383. 6 * 110 C at 0 sec Table 2

HS23013801 625. 1

HS23013802 580. 2

HS23013803 535. 3

HS23013804 489. 4

HS23013805 444. 5

HS23013806 399. 6 * 126 C at 3000 sec Table 3

.

.....

* HS23014000 - SHROUD INSULATION IN CV230, CORE LEVEL 14, 900 to 1000mm

* Left Inside Boundary is in CV230

* Right Outside Boundary is in CV310

.

* Nodes Geom TempInit ITR

HS23014000 6 2 -1 0

.

* Name

HS23014001 'Shroud 10'

.

* Elev Orient

HS23014002 0.9 1.0 * Vertical surface

.

* Locat Format LocDist

HS23014100 -1 1 0.05983

.

* Dist Node

HS23014102 0.06363 2

HS23014103 0.06743 3

HS23014104 0.07123 4

HS23014105 0.07503 5

HS23014106 0.07883 6

.

* MatLoc

HS23014200 -1

.

* Material Mesh

HS23014201 'LITHIUM ALUMINUM' 5 * 19mm of Porous Zirc Fiber

.

* Power Source

HS23014300 0 * No Power Source

.

* Left Boundary Data

* BCType CVNum Flow Pool Atmos

HS23014400 4101 230 INT 0.1 * Inner CV is 230

.

* Zero out heat flux from the CVH Package with TF 101

* Heat Transfer to pool when pool fraction > 0.1

* No Radiation to the left (inner) surface that

* is adjacent to Zircaloy canister

.

* SurfA CharL AxialL

HS23014500 0.0376 0.11966 0.1 * Char Length is Diameter

.

* SurfA parameter is ignored in cylindrical environment

.

```

* Right Boundary Data
*      BCType CVNum Flow Pool Atmos
HS23014600 1 310 INT 0.1 * Outer CV is 310
*
*      Rad Type PathL
*HS23014601 1.0 'GRAY GAS A' 0.03708 * PathL= CV310 Flow Annuli*0.5
*
*      SurfA CharL AxialL
HS23014700 0.0495 0.15766 0.1 * Char Length is Diameter
*
* SurfA parameter is ignored in cylindrical environment
*
*      TempInit
HS23014800 -1
*
*      Temp Node
*HS23014801 380 6 * 107 C at 0 sec Table 2
HS23014801 618 1
HS23014802 573 2
HS23014803 527 3
HS23014804 482 4
HS23014805 436 5
HS23014806 391 6 * 118 C at 3000 sec Table 3
*
*.....
* HS23015000 - High Temperature Insulation has CV310 on the inside and
*      CORE LEVEL 15 - CV320 on the outside = 1000 to 1100mm
*      This Heat Structure also referenced to Core HS
*
*      Nodes Geom TempInit ITR
HS23015000 19 2 -1 0 * 19 nodes, Radial geom
*
*      Name
HS23015001 'Insu 1000-1100'
*
*      Elev Orient
HS23015002 1.0 1.0 * Vertical surface
*
*      Local Format LocDist
HS23015100 -1 1 0.153
*
*      Dist Node
HS23015102 0.15950 2
HS23015103 0.16600 3
HS23015104 0.17250 4
HS23015105 0.17900 5
HS23015106 0.18550 6
HS23015107 0.19200 7
HS23015108 0.19775 8
HS23015109 0.20350 9
HS23015110 0.20925 10
HS23015111 0.21500 11
HS23015112 0.22475 12
HS23015113 0.23450 13
HS23015114 0.24425 14
HS23015115 0.25400 15
HS23015116 0.26375 16
HS23015117 0.27350 17
HS23015118 0.28325 18
HS23015119 0.29300 19
*
*      MatLoc
HS23015200 -1
*
*      Material Mesh
HS23015201 'LITHIUM ALUMINUM' 6 * Nodes 1-7 39mm of Porous Zirc Fiber

```



```

HS23015202 'LITHIUM ALUMINUM' 10 * Nodes 8-11 23mm of Air
HS23015203 'URANIUM ALUMINUM' 18 * Nodes 12-19 78mm of Al2O3
.
* Power Source
HS23015300 0 * No Power Source
.
* Left Boundary Data
* BCType CVNum Flow Pool Atmos
HS23015400 1 310 INT 0.1 * Inner CV is 310
.
* Rad Type PathL
HS23015401 1.0 'GRAY GAS A' 0.03708 * PathL = CV310 Flow Annuli*0.5
.
* SurfA CharL AxialL
HS23015500 0.096 0.30600 0.1 * Char Length is Inner Insu Diam
.
* Right Boundary Data
* BCType CVNum Flow Pool Atmos
HS23015600 2990 -1 INT 0.1 * Outer CV is 320
.
TF99000 'HI TEMP BC' 2 1.0 0.0
TF99011 0.0 313.0
TF99012 5050.0 313.0
.
* Constant Temperature Surface, No Radiation
.
* Rad Type PathL
*HS23015601 1.0 'GRAY GAS A' PATHL
.
* SurfA CharL AxialL
*HS23015700 0.1841 0.58600 0.1 * Char Length is Outer Insu Diam
.
* TempInit
HS23015800 -1
.
* Temp Node
*HS23015801 348 1 * 75 C at 0 sec, Table 2
*HS23015802 347 2 * 74 C at 0 sec, Table 2
*HS23015803 346 3 * 73 C at 0 sec, Table 2
*HS23015804 345 4 * 72 C at 0 sec, Table 2
*HS23015805 344 5 * 71 C at 0 sec, Table 2
*HS23015806 343 6 * 70 C at 0 sec, Table 2
*HS23015807 342 7 * 69 C at 0 sec, Table 2
*HS23015808 338 8 * 65.0 C at 0 sec, Table 2 Air
*HS23015809 333.5 9 * 60.5 C at 0 sec, Table 2
*HS23015810 329 10 * 56.0 C at 0 sec, Table 2
*HS23015811 324.5 11 * 51.5 C at 0 sec, Table 2 Air
*HS23015812 320 12 * 47 C at 0 sec, Table 2
*HS23015813 319 13 * 46 C at 0 sec, Table 2
*HS23015814 318 14 * 45 C at 0 sec, Table 2
*HS23015815 317 15 * 44 C at 0 sec, Table 2
*HS23015816 316 16 * 43 C at 0 sec, Table 2
*HS23015817 315 17 * 42 C at 0 sec, Table 2
*HS23015818 314 18 * 41 C at 0 sec, Table 2
*HS23015819 313 19 * 40 C at 0 sec, Table 2
.
HS23015801 359 1 * 86 C at 3000 sec, Table 2 + 11 C
HS23015802 358 2 * 85 C at 3000 sec, Table 2
HS23015803 357 3 * 84 C at 3000 sec, Table 2
HS23015804 356 4 * 83 C at 3000 sec, Table 2
HS23015805 355 5 * 82 C at 3000 sec, Table 2
HS23015806 354 6 * 81 C at 3000 sec, Table 2
HS23015807 353 7 * 80 C at 3000 sec, Table 2
HS23015808 346 8 * 73 C at 3000 sec, Table 2 Air
HS23015809 339 9 * 66 C at 3000 sec, Table 2
HS23015810 332 10 * 59 C at 3000 sec, Table 2

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HS23015811 325 11 * 52 C at 3000 sec, Table 2 Air
HS23015812 320 12 * 47 C at 3000 sec, Table 2
HS23015813 319 13 * 46 C at 3000 sec, Table 2
HS23015814 318 14 * 45 C at 3000 sec, Table 2
HS23015815 317 15 * 44 C at 3000 sec, Table 2
HS23015816 316 16 * 43 C at 3000 sec, Table 2
HS23015817 315 17 * 42 C at 3000 sec, Table 2
HS23015818 314 18 * 41 C at 3000 sec, Table 2
HS23015819 313 19 * 40 C at 3000 sec, Table 2
.
.....
* HS23016000 - High Temperature Insulation has CV310 on the inside and
* CV320 on the outside = 1100 to 1200mm
* This Heat Structure also referenced to Core HS
.
* Nodes Geom TempInit ITR
HS23016000 19 2 -1 0 * 19 nodes, Radial geom
.
* Name
HS23016001 'Insu 1100-1200'
.
* Elev Orient
HS23016002 1.1 1.0 * Vertical surface
.
* Locat Format LocDist
HS23016100 -1 1 0.153
.
* Dist Node
HS23016102 0.15950 2
HS23016103 0.16600 3
HS23016104 0.17250 4
HS23016105 0.17900 5
HS23016106 0.18550 6
HS23016107 0.19200 7
HS23016108 0.19775 8
HS23016109 0.20350 9
HS23016110 0.20925 10
HS23016111 0.21500 11
HS23016112 0.22475 12
HS23016113 0.23450 13
HS23016114 0.24425 14
HS23016115 0.25400 15
HS23016116 0.26375 16
HS23016117 0.27350 17
HS23016118 0.28325 18
HS23016119 0.29300 19
.
* MatLoc
HS23016200 -1
.
* Material Mesh
HS23016201 'LITHIUM ALUMINUM' 6 * Nodes 1-7 39mm of Porous Zirc Fiber
HS23016202 'LITHIUM ALUMINUM' 10 * Nodes 8-11 23mm of Air
HS23016203 'URANIUM ALUMINUM' 18 * Nodes 12-19 78mm of Al2O3
.
* Power Source
HS23016300 0 * No Power Source
.
* Left Boundary Data
* BCType CVNum Flow Pool Atmos
HS23016400 1 310 INT 0 1 * Inner CV is 310
.
* Rad Type PathL
HS23016401 1 0 'GRAY GAS A' 0 03708 * PathL = CV310 Flow Annuli*0.5
.
* SurfA CharL AxialL

```

```

HS23016500 0.096 0 30600 0 1 * Char Length is Inner Insu Diam
.
* Right Boundary Data
* BCType CVNum Flow Pool Atmos
HS23016600 2990 -1 INT 0.1 * Outer CV is 320
.
* Constant Temperature Surface, No Radiation
.
* Rad Type PathL
*HS23016601 1.0 'GRAY GAS A PATHL
.
* SurfA CharL AxialL
*HS23016700 0.1841 0 58600 0 1 * Char Length is Outer Insu Diam
.
* TempInit
HS23016800 -1
.
* Temp Node
*HS23016801 348 1 * 75 C at 0 sec, Table 2
*HS23016802 347 2 * 74 C at 0 sec, Table 2
*HS23016803 346 3 * 73 C at 0 sec, Table 2
*HS23016804 345 4 * 72 C at 0 sec, Table 2
*HS23016805 344 5 * 71 C at 0 sec, Table 2
*HS23016806 343 6 * 70 C at 0 sec, Table 2
*HS23016807 342 7 * 69 C at 0 sec, Table 2
*HS23016808 338 8 * 65.0 C at 0 sec, Table 2 Air
*HS23016809 333 5 9 * 60.5 C at 0 sec, Table 2
*HS23016810 329 10 * 56.0 C at 0 sec, Table 2
*HS23016811 324 5 11 * 51.5 C at 0 sec, Table 2 Air
*HS23016812 320 12 * 47 C at 0 sec, Table 2
*HS23016813 319 13 * 46 C at 0 sec, Table 2
*HS23016814 318 14 * 45 C at 0 sec, Table 2
*HS23016815 317 15 * 44 C at 0 sec, Table 2
*HS23016816 316 16 * 43 C at 0 sec, Table 2
*HS23016817 315 17 * 42 C at 0 sec, Table 2
*HS23016818 314 18 * 41 C at 0 sec, Table 2
*HS23016819 313 19 * 40 C at 0 sec, Table 2
.
HS23016801 359 1 * 86 C at 3000 sec, Table 2 + 11 C
HS23016802 358 2 * 85 C at 3000 sec, Table 2
HS23016803 357 3 * 84 C at 3000 sec, Table 2
HS23016804 356 4 * 83 C at 3000 sec, Table 2
HS23016805 355 5 * 82 C at 3000 sec, Table 2
HS23016806 354 6 * 81 C at 3000 sec, Table 2
HS23016807 353 7 * 80 C at 3000 sec, Table 2
HS23016808 346 8 * 73 C at 3000 sec, Table 2 Air
HS23016809 339 9 * 66 C at 3000 sec, Table 2
HS23016810 332 10 * 59 C at 3000 sec, Table 2
HS23016811 325 11 * 52 C at 3000 sec, Table 2 Air
HS23016812 320 12 * 47 C at 3000 sec, Table 2
HS23016813 319 13 * 46 C at 3000 sec, Table 2
HS23016814 318 14 * 45 C at 3000 sec, Table 2
HS23016815 317 15 * 44 C at 3000 sec, Table 2
HS23016816 316 16 * 43 C at 3000 sec, Table 2
HS23016817 315 17 * 42 C at 3000 sec, Table 2
HS23016818 314 18 * 41 C at 3000 sec, Table 2
HS23016819 313 19 * 40 C at 3000 sec, Table 2
.
.....
* HS23017000 - High Temperature Insulation has CV310 on the inside and
* CV320 on the outside = 1200 to 1300mm
* This Heat Structure also referenced to Core HS
.
* Nodes Geom TempInit ITR
HS23017000 7 2 -1 0 * 7 nodes, Radial geom
.

```

```

*      Name
HS23017001  'Insu 1200-1300'
*
*      Elev  Orient
HS23017002  1.2  1.0      * Vertical surface
*
*      Locat  Format  LocDist
HS23017100  -1    1    0.153
*
*      Dist  Node
HS23017102  0.15950  2
HS23017103  0.16600  3
HS23017104  0.17250  4
HS23017105  0.17900  5
HS23017106  0.18550  6
HS23017107  0.19200  7
*HS23017108  0.19775  8
*HS23017109  0.20350  9
*HS23017110  0.20925 10
*HS23017111  0.21500 11
*HS23017112  0.22475 12
*HS23017113  0.23450 13
*HS23017114  0.24425 14
*HS23017115  0.25400 15
*HS23017116  0.26375 16
*HS23017117  0.27350 17
*HS23017118  0.28325 18
*HS23017119  0.29300 19
*
*      MatLoc
HS23017200  -1
*
*      Material  Mesh
HS23017201  'LITHIUM ALUMINUM' 6      * Nodes 1-7 39mm of Porous Zirc Fiber
*HS23017202  'LITHIUM ALUMINUM' 11     * Nodes 8-11 23mm of Air
*HS23017203  'URANIUM ALUMINUM' 19     * Nodes 12-19 78mm of Al2O3
*
*      Power Source
HS23017300  0      * No Power Source
*
* Left Boundary Data
*      BCType  CVNum  Flow  Pool  Atmos
HS23017400  2102    230    INT  0 1      * Inner CV is 310
*
*      Rad  Type  PathL
HS23017401  1 0 'GRAY GAS A' 0 03708      * PathL = CV310 Flow Annuli*0 5
*
*      SurfA  CharL  AxialL
HS23017500  0.096  0 30600 0.1      * Char Length is Inner Insu Diam
*
* Right Boundary Data
*      BCType  CVNum  Flow  Pool  Atmos
HS23017600  2990    -1     INT  0.1      * Outer CV is 320
*
* Constant Temperature Surface, No Radiation
*
*      Rad  Type  PathL
*HS23017601  1 0 'GRAY GAS A' PATHL
*
*      SurfA  CharL  AxialL
*HS23017700  0 1206  0 38400 0 1      * Char Length is Outer Insu Diam
*
*      TempInit
HS23017800  -1
*
*      Temp  Node

```

```

*HS23017801 348. 1 * 75 C at 0 sec, Table 2
*HS23017802 347. 2 * 74 C at 0 sec, Table 2
*HS23017803 346. 3 * 73 C at 0 sec, Table 2
*HS23017804 345. 4 * 72 C at 0 sec, Table 2
*HS23017805 344. 5 * 71 C at 0 sec, Table 2
*HS23017806 343. 6 * 70 C at 0 sec, Table 2
*HS23017807 342. 7 * 69 C at 0 sec, Table 2
.
HS23017801 359. 1 * 86 C at 3000 sec, Table 2 + 11 C
HS23017802 358. 2 * 85 C at 3000 sec, Table 2
HS23017803 357. 3 * 84 C at 3000 sec, Table 2
HS23017804 356. 4 * 83 C at 3000 sec, Table 2
HS23017805 355. 5 * 82 C at 3000 sec, Table 2
HS23017806 354. 6 * 81 C at 3000 sec, Table 2
HS23017807 353. 7 * 80 C at 3000 sec, Table 2
.
.....
.....
* HS23018000 - High Temperature Insulation has CV230 on the inside and
* CV230 on the outside = 1300 to 1400mm
.
* Nodes Geom Templnit ITR
HS23018000 7 2 -1 0 * 7 nodes, Radial geom
.
* Name
HS23018001 'Insu 1300-1400'
.
* Elev Orient
HS23018002 1.3 1.0 * Vertical surface
.
* Locat Format LocDist
HS23018100 -1 1 0 153
.
* Dist Node
HS23018102 0.15950 2
HS23018103 0.16600 3
HS23018104 0.17250 4
HS23018105 0.17900 5
HS23018106 0.18550 6
HS23018107 0.19200 7
*HS23018108 0.19775 8
*HS23018109 0.20350 9
*HS23018110 0.20925 10
*HS23018111 0.21500 11
*HS23018112 0.22475 12
*HS23018113 0.23450 13
*HS23018114 0.24425 14
*HS23018115 0.25400 15
*HS23018116 0.26375 16
*HS23018117 0.27350 17
*HS23018118 0.28325 18
*HS23018119 0.29300 19
.
* MatLoc
HS23018200 -1
.
* Material Mesh
HS23018201 'LITHIUM ALUMINUM' 6 * Nodes 1-7 39mm of Porous Zirc Fiber
*HS23018202 'LITHIUM ALUMINUM' 11 * Nodes 8-11 23mm of Air
*HS23018203 'URANIUM ALUMINUM' 19 * Nodes 12-19 78mm of Al2O3
.
* Power Source
HS23018300 0 * No Power Source
.
* Left Boundary Data
* BCType CVNum Flow Pool Atmos

```

```

HS23018400  2102  230  INT  0.1      * Inner CV is 310
*
*      Rad   Type   PathL
HS23018401  1.0 'GRAY GAS A' 0.03708      * PathL = CV310 Flow Annuli*0.5
*
*      SurfA  CharL  AxialL
HS23018500  0.096  0.30600  0.1      * Char Length is Inner Insu Diam
*
* Right Boundary Data
*      BCType CVNum  Flow Pool Atmos
HS23018600  2990  -1   INT  0.1      * Outer CV is 320
*
* Constant Temperature Surface, No Radiation
*
*      Rad   Type   PathL
*HS23018601  1.0 'GRAY GAS A' PATHL
*
*      SurfA  CharL  AxialL
*HS23018700  0.1206  0.38400  0.1      * Char Length is Outer Insu Diam
*
*      TempInit
HS23018800  -1
*
*      Temp   Node
HS23018801  393.15  7      * 120 C = Initial Temp of Entire Struc
*                      * Obtained from Appendix A
*
* .....
* HS24019000 - High Temperature Insulation has CV240 on the inside and
*      CV240 on the outside = 1400 to 1447mm
*
*      Nodes Geom  TempInit ITR
HS24019000  7  2  -1  0 * 7 nodes, Radial geom
*
*      Name
HS24019001  'Insu 1400-1447'
*
*      Elev  Orient
HS24019002  1.405  1.0      * Vertical surface
*
*      Local Format LocDist
HS24019100  -1  1  0.153
*
*      Dist  Node
HS24019102  0.15950  2
HS24019103  0.16600  3
HS24019104  0.17250  4
HS24019105  0.17900  5
HS24019106  0.18550  6
HS24019107  0.19200  7
*HS24019108  0.19775  8
*HS24019109  0.20350  9
*HS24019110  0.20925  10
*HS24019111  0.21500  11
*HS24019112  0.22475  12
*HS24019113  0.23450  13
*HS24019114  0.24425  14
*HS24019115  0.25400  15
*HS24019116  0.26375  16
*HS24019117  0.27350  17
*HS24019118  0.28325  18
*HS24019119  0.29300  19
*
*      MatLoc
HS24019200  -1
*

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*      Material      Mesh
HS24019201 'LITHIUM ALUMINUM' 6 * Nodes 1-7 35mm of Porous Zirc Fiber
*HS24019202 'LITHIUM ALUMINUM' 11 * Nodes 8-11 23mm of Air
*HS24019203 'URANIUM ALUMINUM' 19 * Nodes 12-19 78mm of Al2O3
*
*      Power Source
HS24019300 0 * No Power Source
*
* Left Boundary Data
*      BCType CVNum Flow Pool Atmos
HS24019400 2102 240 INT 0.1 * Inner CV is 240
*
*      Rad Type PathL
*HS24019401 10 'GRAY GAS A' 0.03708 * PathL = CV310 Flow Annuli*0.5
*
*      SurfA CharL AxialL
HS24019500 0.096 0.30600 0.047 * Char Length is Inner Insu Diam
*
* Right Boundary Data
*      BCType CVNum Flow Pool Atmos
HS24019600 2102 240 INT 0.1 * Outer CV is 240
*
TF10200 'TSURF' 2 10 0.0
*      TIME TEMP (K)
TF10210 0.0 393.15
TF10211 6000.0 393.15
*
* Constant Temperature Surface, No Radiation
*
*      Rad Type PathL
*HS24019601 10 'GRAY GAS A' 0.03708
*
*      SurfA CharL AxialL
HS24019700 0.1206 0.38400 0.047 * Char Length is Outer Insu Diam
*
*      TempInit
HS24019800 -1
*
*      Temp Node
HS24019801 393.15 7 * 120 C = Initial Temp of Entire Structure
*
*.....
* HS31020000 - High Temperature Insulation has CV310 on the inside and
* CV320 on the outside = -200 to 1000mm
*
*      Nodes Geom TempInit ITR
HS31020000 19 2 -1 0 * 19 nodes, Radial geom
*
*      Name
HS31020001 'Hi Temp Insu'
*
*      Elev Orient
HS31020002 -0.2 1.0 * Vertical surface
*
*      Locat Format LocDist
HS31020100 -1 1 0.153
*
*      Dist Node
HS31020102 0.15950 2
HS31020103 0.16600 3
HS31020104 0.17250 4
HS31020105 0.17900 5
HS31020106 0.18550 6
HS31020107 0.19200 7
HS31020108 0.19775 8
HS31020109 0.20350 9

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HS31020110 0.20925 10
HS31020111 0.21500 11
HS31020112 0.22475 12
HS31020113 0.23450 13
HS31020114 0.24425 14
HS31020115 0.25400 15
HS31020116 0.26375 16
HS31020117 0.27350 17
HS31020118 0.28325 18
HS31020119 0.29300 19
*
*      MatLoc
HS31020200 -1
*
*      Material      Mesh
HS31020201 'LITHIUM ALUMINUM' 6      * Nodes 1-7 39mm of Porous Zirc Fiber
HS31020202 'LITHIUM ALUMINUM' 10     * Nodes 8-11 23mm of Air
HS31020203 'URANIUM ALUMINUM' 18     * Nodes 12-19 78mm of Al2O3
*
*      Power Source
HS31020300 0      * No Power Source
*
* Left Boundary Data
*      BCType CVNum Flow Pool Atmos
HS31020400 1      310 INT 0.1      * Inner CV is 310
*
*      Rad Type PathL
HS31020401 1.0 'GRAY GAS A' 0.03708      * PathL = CV310 Flow Annuli*0.5
*
*      SurfA CharL AxialL
HS31020500 1.2526 0.30600 1.2      * Char Length is Inner Insu Diam
*
* Right Boundary Data
*      BCType CVNum Flow Pool Atmos
HS31020600 2990 -1 INT 0.1      * Outer CV is 320
*
* Constant Temperature Surface, No Radiation
*
*      Rad Type PathL
*HS31020601 1.0 'GRAY GAS A' PATHL
*
*      SurfA CharL AxialL
*HS31020700 2.3988 0.58600 1.2      * Char Length is Outer Insu Diam
*
* TempInit
HS31020800 -1
*
*      Temp Node
*HS31020801 348 1      * 75 C at 0 sec, Table 2
*HS31020802 347 2      * 74 C at 0 sec, Table 2
*HS31020803 346 3      * 73 C at 0 sec, Table 2
*HS31020804 345 4      * 72 C at 0 sec, Table 2
*HS31020805 344 5      * 71 C at 0 sec, Table 2
*HS31020806 343 6      * 70 C at 0 sec, Table 2
*HS31020807 342 7      * 69 C at 0 sec, Table 2
*HS31020808 338 8      * 65.0 C at 0 sec, Table 2 Air
*HS31020809 333.5 9      * 60.5 C at 0 sec, Table 2
*HS31020810 329 10      * 56.0 C at 0 sec, Table 2
*HS31020811 324.5 11      * 51.5 C at 0 sec, Table 2 Air
*HS31020812 320 12      * 47 C at 0 sec, Table 2
*HS31020813 319 13      * 46 C at 0 sec, Table 2
*HS31020814 318 14      * 45 C at 0 sec, Table 2
*HS31020815 317 15      * 44 C at 0 sec, Table 2
*HS31020816 316 16      * 43 C at 0 sec, Table 2
*HS31020817 315 17      * 42 C at 0 sec, Table 2
*HS31020818 314 18      * 41 C at 0 sec, Table 2

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*HS31020819 313. 19 * 40 C at 0 sec, Table 2
.
HS31020801 359 1 * 86 C at 3000 sec, Table 2 + 11 C
HS31020802 358 2 * 85 C at 3000 sec, Table 2
HS31020803 357 3 * 84 C at 3000 sec, Table 2
HS31020804 356 4 * 83 C at 3000 sec, Table 2
HS31020805 355 5 * 82 C at 3000 sec, Table 2
HS31020806 354 6 * 81 C at 3000 sec, Table 2
HS31020807 353 7 * 80 C at 3000 sec, Table 2
HS31020808 346 8 * 73 C at 3000 sec, Table 2 Air
HS31020809 339 9 * 66 C at 3000 sec, Table 2
HS31020810 332 10 * 59 C at 3000 sec, Table 2
HS31020811 325 11 * 52 C at 3000 sec, Table 2 Air
HS31020812 320 12 * 47 C at 3000 sec, Table 2
HS31020813 319 13 * 46 C at 3000 sec, Table 2
HS31020814 318 14 * 45 C at 3000 sec, Table 2
HS31020815 317 15 * 44 C at 3000 sec, Table 2
HS31020816 316 16 * 43 C at 3000 sec, Table 2
HS31020817 315 17 * 42 C at 3000 sec, Table 2
HS31020818 314 18 * 41 C at 3000 sec, Table 2
HS31020819 313 19 * 40 C at 3000 sec, Table 2
.
.....
* HS31021000 - ANNULAR TOP INSULATION AT ELEV 1271mm
* BETWEEN THE SHROUD INSULATION AND HI-TEMP INSULATION
* BOTTOM LOCATED INSIDE CV310
* TOP LOCATED INSIDE CV230
.
* Nodes Geom TempInit ITR
HS31021000 6 1 -1 0 * Rectangular Geometry
.
* Name
HS31021001 'Top Insu'
.
* Elev Orient
HS31021002 1 275 0 0 * Horizontal Surface
.
* Locat Format LocDist
HS31021100 -1 1 0 0 * LocDist Immaterial for Rect
.
* Dist Node
HS31021102 0 00760 2
HS31021103 0 01520 3
HS31021104 0 02280 4
HS31021105 0 03040 5
HS31021106 0 03800 6
.
* MatLoc
HS31021200 -1
.
* Material Mesh
HS31021201 'LITHIUM ALUMINUM' 5 * Nodes 1-6 38mm of Porous Zirc Fiber
.
* Power Source
HS31021300 0 * No Power Source
.
* Left Boundary Data
* BCType CVNum Flow Pool Atmos
HS31021400 1 310 INT 0 1
.
* Rad Type PathL
HS31021401 1 0 'GRAY GAS A' 0 1 * PathL is estimate here
.
* SurfA CharL AxialL
HS31021500 0 06588 0 10363 0 10363
.

```

```

* Right Boundary Data
*      BCType CVNum  Flow Pool Atmos
HS31021600  1    230  INT  0.1
*
* Constant Temperature Surface, No Radiation
*
*      Rad   Type   PathL
HS31021601  1.0 'GRAY GAS A' 0.1
*
*      SurfA  CharL  AxialL
HS31021700  0.06588 0.15766 0.10363
*
*      TempInit
HS31021800  -1
*
*      Temp    Node
HS31021801  570.15  6      * 300 C = Initial Temp of Entire Struc
*
.....
*
* CORE INPUT FOR THE CORA 13, ISP 31 EXPERIMENT
* 4 RADIAL RINGS AND 19 AXIAL LEVELS
* COR PRESENTLY COVERS FROM -300 MM TO + 1447 MM
* WHICH INCLUDES 1000 MM OF TUNGSTEN, TWO 300 MM
* LENGTHS OF MOLY AT TOP AND BOTTOM, AND 147 MM
* OF COPPER AT THE TOP UNTIL THE WATER-COOLED
* BUNDLE FLANGE IS REACHED
*
* THE EXTRA 24MM LENGTH OF TUNGSTEN IS NEGLECTED
*
* ROBERT J. GROSS & GALE M. MARTINEZ
* Initial Input - 10/18/91
*
.....
*
* Nodalization Parameters
*
*      NRAD NAXL NTLN NCVOL NLH NPNTOT
COR00000  4    19    1    5    2    1
*
* 4 Radial rings in the core - rings 2 and 4 contain heated rods (NRAD)
* 19 Axial levels in the core including 1 for lower plenum (NAXL)
* 1 Axial segment in the lower plenum (NTLN)
* 4 Fluid volumes in the core and lower plenum (NCVOL)
*   CV110, CV210, CV220, CV230, AND CV240
* 2 Axial nodes in the vessel lower head (NLH)
* 1 Lower head penetration (NPNTOT)
*
* Geometric Parameters
*
*      RFUEL RCLAD DRGAP PITCH DXCAN DXSS DZLH
COR00001  0.00455 0.005375 1.0E-4 0.0143 0.0012 0.0005 0.01
*
* TUNGSTEN RODS = 6.0 mm diameter
* FUEL      = 9.1 mm diameter / 0.00455 mm radius
* GAP       = between 9.1 mm and 9.3 mm for thickness of 0.1 mm
* CLAD      = 10.75 mm diameter / 0.005375 mm radius
*
* The shroud thickness = 1.2 mm (DXCAN)
* Stainless steel cladding thickness on the AIC Rods = 0.5 mm (DXSS)
* Gap between the fuel and cladding = 0.1 mm (DRGAP)
* Thickness of lower head obtained from Gale's ISP28 deck = 10 mm (DZLH)
*
* Reactor Type
*

```

- IRTYP MCRP

COR00002 BWR 'AG-IN-CD' 'URANIUM METAL'

-
- Reactor type - Boiling Water Reactor (IRTYP) - see p. COR-UG-23
- Control Rod poison material - AG-IN-CD (MCRP)
-
- Radiative Exchange Factors
-
- FCNCL FSSCN FCELR FCELA FLPUP

*COR00003 1.0 0.05 1.0 0.25 1.0

COR00003 0.25 0.25 1.0 0.25 1.0

-
- Heat Structures are getting too hot. Change 1.0 values
- to 0.25 - RJG - 1/2/92
- Refine view factors - RJG - 2/13/92
-
- All of these view factors are guesses for now
-
- Radiation from canister wall to cladding (FCNCL)
- Radiation from poison to canister (FSSCN)
- control rods cannot "see" shroud for the most part
- Radiation from cell boundary to next radially adjacent cell (FCELR)
- Radiation from cell boundary to next axially adjacent cell (FCELA)
- Radiation from pool to the core components (FLPUP)
-
- NTPCOR ICFFIS ICFGAP

COR00004 101 001 0

-
- IN TRANSFER PROCESS NUMBER IS 101 (NTPCOR)
- Fission power control function number (ICFFIS)
- Fission power is set to 0.0
- Fuel-cladding gap conductance control function number (ICFGAP)
- No additional gap resistance is calculated = 0
-

CF00100 'FISSION POWER' EQUALS 1 1.0 0.0

CF00101 0

CF00110 0.0 0.0 TIME

-
- HFRZUO HFRZZR HFRZSS HFRZZX HFRZSX HFRZCP

COR00005 1000 1000 1000 1000 1000 100000

-
- Refreezing heat transfer coefficients for refreezing
- Coefficient for UO2 = 1000 * Gale used value of 300
- Coefficient for Zircaloy = 1000 * Gale used value of 300
- Coefficient for Steel = 1000 * Gale used value of 300
- Coefficient for ZrO2 = 1000 * Gale used value of 300
- Coefficient for Steel oxide = 1000 * Gale used value of 300
- Coefficient for AG-IN-CD = 1000 * Gale used value of 300
-
- Change coefficient for AG-IN-CD to 10000. - rjg - 1/28/92
- Temperatures at bottom are too cool - change to 5000 - rjg - 2/7/92
- Temperatures at bottom are too hot - change to 100000 - rjg - 2/11/92
-
- Keep in mind for cells in front of windows
- These are guesses for now
-
- Candling Secondary Material Transport Parameters
-
- MTUOZR MTZXZR MTSXSS MTC PSS FUOZR FZXZR FXCSS FCPSS

COR00007 1 2 2 2 0.2 1.0 1.0 0.0

-
- Transport flag for UO2 in molten Zircaloy (MTUOZR)
- Transport flag for ZrO2 in molten Zircaloy (MTZXZR)
- Transport flag for steel oxide in molten steel (MTSXSS)
- Transport flag for AG-IN-CD in molten steel (MTC PSS)
- Transport parameter for UO2 in molten Zircaloy (FUOZR)

```

* Transport parameter for ZrO2 in molten Zircaloy (FZXZR)
* Transport parameter for steel oxide in molten steel (FXCSS)
* Transport parameter for AG-IN-CD in molten steel (FCPSS)
.
* Use all default for candler parameters
.
* Debris Formation Parameters
.
*   DRCLMN  DRSSMN
*COR00008  1.0E-7  1.0E-7
COR00008  0.0  1.0E-7
.
* If completely oxidize Zr or SS before the quench begins, we may want
* to change to 0.0  0.0, values which Gale is now using in the
* Phebus calculation.
* Change DRCLMN to 0 0 to prevent debris formation, recommended by
* Randy Summers 2/7/92
* Minimum thickness of unoxidized Zircaloy in cladding or canister (DRXCMN)
* Minimum thickness of unoxidized steel in AG-IN-CD (DRSSMN)
.
* Lower Head Failure Modeling Parameters
.
*   HDBPN  HDBLH  TPFAIL  CDISPN
COR00009  1000  1000  4000  1 0
.
* HT Coefficient from debris to penetration structures (HDBPN)
* HT Coefficient from debris to lower head (HDBLH)
* Failure temperature of penetrations and lower head (TPFAIL)
*   Set failure of lower head high so will not fail - 4000 K
* Discharge coefficient for ejection of debris (CDISPN)
.
* Core Steel Composition
.
*   XFE  XCR  XNI  XCAR
*COR00010  0.185  0.190  0.525  0.0004 * SPECIFICATION OF MATERIALS IN SS
.
*   * GALE'S INCONEL COMPOSITION - DO NOT USE
COR00010  0.740  0.180  0.080  0.000 * DEFAULT VALUES
.
*   ICB CD  MATBCD  DXBCD  CDFBCD
*COR00011  3  'ARGON'  1.0E-4  1.7E-3
COR00011  3  'ARGON'  1.0E-4  1.7E-3
.
* try smaller diffusivity - RJG - 1/2/92
* increase diffusivity again - RJG - 2/13/92
.
.....
.
* Axial Segment Input
.
*   LEVEL  DZ  PORIN  PORDP
.
CORZ0101 -0.489  0.189  0.99  0.1 * Assume debris can fall thru
CORZ0201 -0.300  0.100  0.99  0.1 * Assume debris can fall thru
CORZ0301 -0.200  0.100  0.99  0.1 * Assume debris can fall thru
CORZ0401 -0.100  0.100  0.99  0.1 * Assume debris can fall thru
CORZ0501  0.000  0.100  0.99  0.1
CORZ0601  0.100  0.100  0.99  0.1
CORZ0701  0.200  0.100  0.99  0.1
CORZ0801  0.300  0.100  0.99  0.1
CORZ0901  0.400  0.100  0.99  0.1
CORZ1001  0.500  0.100  0.99  0.1
CORZ1101  0.600  0.100  0.99  0.1
CORZ1201  0.700  0.100  0.99  0.1
CORZ1301  0.800  0.100  0.99  0.1
CORZ1401  0.900  0.100  0.99  0.1
CORZ1501  1.000  0.100  0.99  0.1

```

CORZ1601 1.100 0.100 0.99 0.1
 CORZ1701 1.200 0.100 0.99 0.1
 CORZ1801 1.300 0.100 0.99 0.1
 CORZ1901 1.400 0.047 0.99 0.1

- * There is no core plate that might hold up debris as there is in Phebus.
- * Lower Plenum should agree with CVH data !!!
- * Radial Boundary Heat Structure Specification
- * According to COR manual, each level must have its own unique HS assigned to it - RJG 1/10/92

HEAT STRUCTURE NO.

IHSA ISUP
 CORZ0102 11001 01
 CORZ0202 11002 01
 CORZ0302 21003 11

- * Do not let particulate debris below this level - RJG - 1/29/92

CORZ0402 21004 11
 CORZ0502 21005 11
 CORZ0602 21006 11
 CORZ0702 21007 11
 CORZ0802 21008 11
 CORZ0902 22009 11
 CORZ1002 22010 11
 CORZ1102 22011 11
 CORZ1202 22012 11
 CORZ1302 23013 11
 CORZ1402 23014 11

- * Always support debris up to tungsten - RJG - 2/11/92

CORZ1502 23015 01
 CORZ1602 23016 01
 CORZ1702 23017 01
 CORZ1802 23018 01
 CORZ1902 24019 01

- * ISPU parameter - If "tens" digit is one, then other structure will support particulate debris until the component reaches the structure failure temp
- * TSFAIL If "ones" digit is one, intact components in cell jj will remain in that cell until they melt or form particulate debris.

- * MIGHT NEED ISPU = 11 FOR LEVELS WITH GRID SPACERS!!!!!!!!!!!!!!

- * First three digits give CV that core is located; last two give the axial level for IHSA.

- * Axial Power Density Profile
- * These optional cards are not needed for this simulation

RELATIVE POWER DENSITY

*CORZ0103 XXXXX
 *CORZ0203 XXXXX
 *CORZ0303 XXXXX
 *CORZ0403 XXXXX
 *CORZ0503 XXXXX
 *CORZ0603 XXXXX
 *CORZ0703 XXXXX
 *CORZ0803 XXXXX
 *CORZ0903 XXXXX
 *CORZ1003 XXXXX
 *CORZ1103 XXXXX

```

*CORZ1203  XXXXX
*CORZ1303  XXXXX
*CORZ1403  XXXXX
*CORZ1503  XXXXX
*CORZ1603  XXXXX
*CORZ1703  XXXXX
*CORZ1803  XXXXX
.
* Structure failure temperatures at axial levels
* This optional card is not needed for this simulation
* Try raising temperature for structural failure for
* structures at and below the grid space - rjg - 11/2/92
.
CORZ0104  2500.
CORZ0204  2500.
CORZ0304  2500.
CORZ0404  2500.
CORZ0504  2500.
.
* Radial Ring Cross-Sectional Areas
.
*      CROSS-SECTIONAL AREA
.
CORR0101  1.606E-4
CORR0201  7.596E-4
CORR0301  1.636E-3
CORR0401  4.8438E-3 * Subtracted off area of four corners 11/8/91
*      * Revised area calc 11/20/91
.
* Upper Boundary Heat Structure and Lower Head Failure Control Function
.
*      HEAT STRUCTURE NO.
.
CORR0102  24019
CORR0202  24019
CORR0302  24019
CORR0402  24019
.
.
* Lower Head Failure Control Function not used
.
* Radial Power Density Profile
.
*      RELATIVE POWER
.
CORR0103  0.0
CORR0203  1.0
CORR0303  0.0
CORR0403  1.0
.
.....
.....
.
* Cell Specific Input
* Power only in the second and fourth rings
.
.....
.....
.
* Ring 1 contains 1 unheated rod with no tungsten
* Ring 1 contains only UO2 and Clad
*   There is no canister in Ring 1
*   There is no AG-IN-CD or Steel in Ring 1
*   There is no MOLY or TUNG in Ring 1
.
.....

```

```

.....
*
* LEVEL 1 IS THE LOWER PLENUM, -489 TO -300 mm
* REPRESENTS 189 MM OF COPPER
*
* IJ  IREFN  ICVHC  ICVHB
COR10101  -1    110    110          * Lower Plenum in CV110
*      XMFU  XMCL   XMSS  XMCP   XMCN  MOLY  TUNG
COR10102  0.0   0.0    0.0   0.0   0.0   0.0 * 0.0
*      TFU   TCLAD  TSS   TCAN
COR10103  593 15 593 15 593 15 593 15 * 320 C AT 3000 SEC
*      DHCLAD DHYSS  DHYDP  DHYCNC  DYNCNB
COR10104  1.0E-6 1.0E-6 0.025 1.0E-6 1.0E-6 * EQUIV DIAS
*
* ASCELR OF LOWER PLENUM SHOULD BE 1 89 TIMES THAT OF OTHER CELLS
* BECAUSE OF LARGER DZ
*
*      ASCELR  AFLOWC  AFLOWB
COR10105  8 4908E-3 1 606E-4 0.0          * FLOW AREAS
*
* TOTAL FLOW AREA FOR AFLOWC SINCE NO ROD HERE
*
*      ASFU   ASCL   ASSS  ASCN
COR10106  0.0   0.0    0.0   0.0          * SURFACE AREAS
*
.....
* RING 1, LEVEL 2, -300 TO -200 mm
* NO ROD YET IN THIS LEVEL FOR UNHEATED ROD
*
* IJ  IREFN  ICVHC  ICVHB
COR10201  -1    110    110
*      XMFU  XMCL   XMSS  XMCP   XMCN  MOLY  TUNG
COR10202  0.0   0.0    0.0   0.0   0.0   0.0 * 0.0
*      TFU   TCLAD  TSS   TCAN
COR10203  593 15 593 15 593 15 593 15 * 320 C AT 3000 SEC
*      DHCLAD DHYSS  DHYDP  DHYCNC  DYNCNB
COR10204  1.0E-6 1.0E-6 0.025 1.0E-6 1.0E-6 * EQUIV DIAS
*      ASCELR  AFLOWC  AFLOWB
COR10205  4.493E-3 1 606E-4 0.0          * FLOW AREAS
*      ASFU   ASCL   ASSS  ASCN
COR10206  0.0   0.0    0.0   0.0          * SURFACE AREAS
*
.....
* RING 1, LEVEL 3, -200 TO -100 mm
* FIRST LEVEL WITH FUEL ON AN UNHEATED ROD
*
* IJ  IREFN  ICVHC  ICVHB
COR10301  -1    210    210
*      XMFU  XMCL   XMSS  XMCP   XMCN  MOLY  TUNG
COR10302  0.0715427 0.0150701 0.0   0.0   0.0   0.0 * 0.0
*      TFU   TCLAD  TSS   TCAN
COR10303  593 15 593 15 593 15 593 15 * 320 C AT 3000 SEC
*COR10303  711   711    711   711          * try value 1 2 higher
*      DHCLAD DHYSS  DHYDP  DHYCNC  DYNCNB
COR10304  2.633E-3 1.0E-6 0.025 1.0E-6 1.0E-6 * EQUIV DIAS
*      ASCELR  AFLOWC  AFLOWB
COR10305  4.493E-3 6.98374E-5 0.0          * FLOW AREAS
*      ASFU   ASCL   ASSS  ASCN
COR10306  2.8588E-3 3.3772E-3 0.0   0.0          * SURFACE AREAS
*
.....
* RING 1, LEVEL 4, -100 to 0 mm
*
* IJ  IREFN  ICVHC  ICVHB
COR10401  103   210    210
*

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```

.....
* RING 1, LEVEL 5, 0 - 100 mm
*
* IJ  IREFN  ICVHC  ICVHB
COR10501  -1    210    210
*      XMFU   XMCL   XMSS  XMCP  XMCN  MOLY  TUNG
COR10502  0 0715427 0 0150701 0 00312 0 0 0 0 0 0 * 0 0
*      TFU    TCLAD  TSS   TCAN
COR10503  700 15  700 15  700 15  700 15      * 427 C AT 3000 SEC
*COR10503  840 15  840 15  840 15  840 15      * try value 1 2 higher
*      DHCYL  DHYSS  DHYDP  DHYCNC  DYN CNB
COR10504  2 633E-3 1 0E-6  0 025 1 0E-6  1 0E-6 * EQUIV DIAS
*      ASCELR AFLOWC AFLOWB
COR10505  4 493E-3 6 98374E-5 0 0      * FLOW AREAS
*      ASFU   ASCL   ASSS   ASCN
COR10506  2 8588E-3 3 3772E-3 1 6886E-3 0 0      * SURFACE AREAS
*

```

* added 0 00312 kg of Zr spacer 2/12/92

* make surface area of Clad 50% larger

```

.....
* RING 1, LEVEL 6, 100 - 200 mm
*
* IJ  IREFN  ICVHC  ICVHB
COR10601  105    210    210
*      XMFU   XMCL   XMSS  XMCP  XMCN  MOLY  TUNG
COR10602  0 0715427 0 0150701 0 0 0 0 0 0 0 0 * 0 0
*      TFU    TCLAD  TSS   TCAN
COR10603  708 15  708 15  708 15  708 15      * 435 C AT 3000 SEC
*COR10603  849 15  849 15  849 15  849 15      * try value 1 2 higher
*      ASFU   ASCL   ASSS   ASCN
COR10606  2 8588E-3 3 3772E-3 0 0 0 0      * SURFACE AREAS
*

```

```

.....
* RING 1, LEVEL 7, 200 - 300 mm
*
* IJ  IREFN  ICVHC  ICVHB
COR10701  106    210    210
*      TFU    TCLAD  TSS   TCAN
COR10703  704 15  704 15  704 15  704 15      * 431 C AT 3000 SEC
*COR10703  845 15  845 15  845 15  845 15      * try value 1 2 higher
*

```

```

.....
* RING 1, LEVEL 8, 300 - 400 mm
*
* IJ  IREFN  ICVHC  ICVHB
COR10801  106    210    210
*      TFU    TCLAD  TSS   TCAN
COR10803  699 15  699 15  699 15  699 15      * 426 C AT 3000 SEC
*COR10803  838 15  838 15  838 15  838 15      * try value 1 2 higher
*

```

* RING 1, LEVEL 9, 400 - 500 mm

* CHANGE IN CONTROL VOLUME NUMBERS

```

*
* IJ  IREFN  ICVHC  ICVHB
COR10901  106    220    220
*      TFU    TCLAD  TSS   TCAN
COR10903  694 15  694 15  694 15  694 15      * 423 C AT 3000 SEC
*COR10903  832 15  832 15  832 15  832 15      * try value 1 2 higher
*

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.....
* RING 1, LEVEL 10, 500 - 600 mm
*
* IJ  IREFN  ICVHC  ICVHB
COR11001  106    220    220
*      TFU    TCLAD  TSS   TCAN
COR11003  690 15  690 15  690 15  690 15      * 417 C AT 3000 SEC
*COR11003  828 15  828 15  828 15  828 15      * try value 1 2 higher
*

```

* RING 1, LEVEL 11, 600 - 700 mm

*
 * IJJ IREFN ICVHC ICVHB
 COR11101 106 220 220
 * TFU TCLAD TSS TCAN
 COR11103 687.15 687.15 687.15 687.15 * 414 C AT 3000 SEC
 *COR11103 824.15 824.15 824.15 824.15 * 414 C AT 3000 SEC

 * RING 1, LEVEL 12, 700 - 800 mm
 *
 * IJJ IREFN ICVHC ICVHB
 COR11201 106 220 220
 * TFU TCLAD TSS TCAN
 COR11203 683.15 683.15 683.15 683.15 * 410 C AT 3000 SEC
 *COR11203 819.15 819.15 819.15 819.15 * 410 C AT 3000 SEC

 * RING 1, LEVEL 13, 800 - 900 mm
 * CHANGE IN CONTROL VOLUME NUMBERS
 *
 * IJJ IREFN ICVHC ICVHB
 COR11301 106 230 230
 * XMFU XMCL XMSS XMCP XMCN MOLY TUNG
 COR11302 0.0715427 0.0181901 0.0 0.0 0.0 0.0 * 0.0
 * TFU TCLAD TSS TCAN
 COR11303 678.15 678.15 678.15 678.15 * 405 C AT 3000 SEC
 *COR11303 813.15 813.15 813.15 813.15 * 405 C AT 3000 SEC

 * add mass of Zr spacer 2/12/92

 * RING 1, LEVEL 14, 900 - 1000 mm
 *
 * IJJ IREFN ICVHC ICVHB
 COR11401 106 230 230
 * TFU TCLAD TSS TCAN
 COR11403 670.15 670.15 670.15 670.15 * 397 C AT 3000 SEC
 *COR11403 804.15 804.15 804.15 804.15 * 397 C AT 3000 SEC

 * RING 1, LEVEL 15, 1000 - 1100 mm
 *
 * IJJ IREFN ICVHC ICVHB
 COR11501 106 230 230
 * TFU TCLAD TSS TCAN
 COR11503 648.15 648.15 648.15 648.15 * 375 C AT 3000 SEC
 *COR11503 777.15 777.15 777.15 777.15 * 375 C AT 3000 SEC

 * RING 1, LEVEL 16, 1100 - 1200 mm
 *
 * IJJ IREFN ICVHC ICVHB
 COR11601 106 230 230
 * TFU TCLAD TSS TCAN
 COR11603 618.15 618.15 618.15 618.15 * 345 C AT 3000 SEC
 *COR11603 741.15 741.15 741.15 741.15 * 345 C AT 3000 SEC

 * RING 1, LEVEL 17, 1200 - 1300 mm
 *
 * IJJ IREFN ICVHC ICVHB
 COR11701 106 230 230
 * TFU TCLAD TSS TCAN
 COR11703 593.15 593.15 593.15 593.15 * 320 C AT 3000 SEC
 *COR11703 711.15 711.15 711.15 711.15 * 320 C AT 3000 SEC

 * RING 1, LEVEL 18, 1300 - 1400 mm
 * UNHEATED ROD ONLY GOES TO 1295 MM
 *
 * ASCELR IS 1.0 TIMES THAT OF NORMAL LEVEL TO REFLECT 147 MM
 * OF HEIGHT OF THIS LEVEL
 *

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* IJW  IREFN  ICVHC  ICVHB
COR11801 -1    230    230
*      XMFU  XMCL   XMSS  XMCP  XMCN  CU  TUNG
COR11802 0.0   0.0    0.0  0.0  0.0  0.0 * 0.0
*      TFU   TCLAD  TSS   TCAN
COR11803 570.15 570.15 570.15 570.15      * 297 C AT 3000 SEC
*      DHCYL DHYSS  DHYDP DHYCNC DYNCNB
COR11804 1.0E-6 1.0E-6 0.025 1.0E-6 1.0E-6 * EQUIV DIAS
*      ASCELR AFLOWC AFLOWB
COR11805 4.493E-3 1.606E-4 0.0      * FLOW AREAS
*      ASFU  ASCL   ASSS  ASCN
COR11806 0.0    0.0    0.0    0.0      * SURFACE AREAS
*
.....
* RING 1, LEVEL 19, 1400 - 1447 mm (MISSING 24 MM OF TUNGSTEN)
* THAT IS WHY DO NOT REACH BUNDLE FLANGE AT 1471 MM
* UNHEATED ROD ONLY GOES TO 1295 MM
*
* ASCELR IS 0.47 TIMES THAT OF NORMAL LEVEL TO REFLECT 147 MM
* OF HEIGHT OF THIS LEVEL
*
* IJW  IREFN  ICVHC  ICVHB
COR11901 -1    240    240
*      XMFU  XMCL   XMSS  XMCP  XMCN  CU  TUNG
COR11902 0.0   0.0    0.0  0.0  0.0  0.0 * 0.0
*      TFU   TCLAD  TSS   TCAN
COR11903 570.15 570.15 570.15 570.15      * 297 C AT 3000 SEC
*      DHCYL DHYSS  DHYDP DHYCNC DYNCNB
COR11904 1.0E-6 1.0E-6 0.025 1.0E-6 1.0E-6 * EQUIV DIAS
*      ASCELR AFLOWC AFLOWB
COR11905 2.112E-3 1.606E-4 0.0      * FLOW AREAS
*      ASFU  ASCL   ASSS  ASCN
COR11906 0.0    0.0    0.0    0.0      * SURFACE AREAS
*
.....
* RING 2 - 4 HEATED RODS
* RING 2 CONTAINS NO CANISTER, AG-IN-CD, OR STEEL
*
.....
* RING 2, LEVEL 1 IS THE LOWER PLENUM, -489 TO -300 mm
*
* IJW  IREFN  ICVHC  ICVHB
COR20101 -1    110    110
*      XMFU  XMCL   XMSS  XMCP  XMCN  MOLY  TUNG
COR20102 0.0   0.0    0.0  0.0  0.0  0.0 * 0.0
*      TFU   TCLAD  TSS   TCAN
COR20103 593.15 593.15 593.15 593.15      * 320 C AT 3000 SEC
*      DHCLAD DHYSS  DHYDP DHYCNC DYNCNB
COR20104 1.0E-6 1.0E-6 0.025 1.0E-6 1.0E-6 * EQUIV DIAS
*
* Actually, there is 0.17421 kg of Zircaloy clad in this cell, but since
* water is always (mostly) present, do not make it available for oxidation
*
* TOTAL FLOW AREA FOR AFLOWC SINCE THERE ARE HEATED RODS HERE
* ASCELR OF LOWER PLENUM SHOULD BE 1.89 TIMES THAT BECAUSE OF LARGER DZ
*
*      ASCELR AFLOWC AFLOWB
COR20105 2.032E-2 3.9655E-4 0.0      * FLOW AREAS
*      ASFU  ASCL   ASSS  ASCN
COR20106 0.0    0.0    0.0    0.0      * SURFACE AREAS
*
.....
* RING 2, LEVEL 2, -300 TO -200 mm
*

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```

* IJJ IREFN ICVHC ICVHB
COR20201 -1 110 110
* XMFU XMCL XMSS XMCP XMCN MOLY TUNG
COR20202 0.0 0.0602804 0.0 0.0 0.0 0.237 *0.0
* TFU TCLAD TSS TCAN
COR20203 593.15 593.15 593.15 593.15 * 320 C AT 3000 SEC
* DHCLAD DHYSS DHYDP DHCNC DYNCNB
COR20204 0.01174 1.0E-6 0.025 1.0E-6 1.0E-6 * EQUIV DIAS
* ASCELR AFLOWC AFLOWB
COR20205 0.01075 3.9655E-4 0.0 * FLOW AREAS
* ASFU ASCL ASSS ASCN
COR20206 0.01081 1.3509E-2 0.0 0.0 * SURFACE AREAS
* * 8.6mm dia for 0 1m
.
.....
* RING 2, LEVEL 3, -200 TO -100 mm
.
* IJJ IREFN ICVHC ICVHB
COR20301 -1 210 210
* XMFU XMCL XMSS XMCP XMCN MOLY TUNG
COR20302 0.0 0.0602804 0.0 0.0 0.0 0.237 *0.0
* TFU TCLAD TSS TCAN
COR20303 593.15 593.15 593.15 593.15 * 320 C AT 3000 SEC
* COR20303 711.15 711.15 711.15 711.15 * 320 C AT 3000 SEC
* DHCLAD DHYSS DHYDP DHCNC DYNCNB
COR20304 0.01174 1.0E-6 0.025 1.0E-6 1.0E-6 * EQUIV DIAS
* ASCELR AFLOWC AFLOWB
COR20305 0.01075 3.9655E-4 0.0 * FLOW AREAS
* ASFU ASCL ASSS ASCN
COR20306 0.01081 1.3509E-2 0.0 0.0 * SURFACE AREAS
* * 8.6mm dia for 0 1m
.
.....
* RING 2, LEVEL 4, -100 to 0 mm
.
* IJJ IREFN ICVHC ICVHB
COR20401 203 210 210
.
.....
* RING 2, LEVEL 5, 0 - 100 mm
* FIRST LEVEL WITH FUEL ON A HEATED ROD
* NOW HAVE TUNGSTEN INSTEAD OF MOLY
.
* IJJ IREFN ICVHC ICVHB
COR20501 -1 210 210
* XMFU XMCL XMSS XMCP XMCN TUNG MOLY
COR20502 0.1617636 0.0602804 0.01478 0.0 0.0 0.22167 *0.0
* TFU TCLAD TSS TCAN
COR20503 703.15 703.15 703.15 703.15 * 430 C AT 3000 SEC
* COR20503 843.15 843.15 843.15 843.15 * 430 C AT 3000 SEC
* DHCLAD DHYSS DHYDP DHCNC DYNCNB
COR20504 0.01174 1.0E-6 0.025 1.0E-6 1.0E-6 * EQUIV DIAS
* ASCELR AFLOWC AFLOWB
COR20505 0.01075 3.9655E-4 0.0 * FLOW AREAS
* ASFU ASCL ASSS ASCN
COR20506 0.0114354 1.3509E-2 0.675E-2 0.0 * SURFACE AREAS
.
* added 0.01478 kg of Zr spacer 2/12/92
* make surface area of Clad 50% larger
.....
* RING 2, LEVEL 6, 100 - 200 mm
.
* IJJ IREFN ICVHC ICVHB
COR20601 205 210 210
* XMFU XMCL XMSS XMCP XMCN TUNG MOLY

```

COR20602 0.1617636 0.0602804 0.0 0.0 0.0 0.22167 * 0.0
* TFU TCLAD TSS TCAN
COR20603 704.15 704.15 704.15 704.15 * 431 C AT 3000 SEC
* COR20603 844.15 844.15 844.15 844.15 * 431 C AT 3000 SEC
* ASFU ASCL ASSS ASCN
COR20606 0.0114354 1.3509E-2 0.0 0.0 * SURFACE AREAS
.....
* RING 2, LEVEL 7, 200 - 300 mm
*
* IJ IREFN ICVHC ICVHB
COR20701 206 210 210
* TFU TCLAD TSS TCAN
COR20703 706.15 706.15 706.15 706.15 * 433 C AT 3000 SEC
* COR20703 847.15 847.15 847.15 847.15 * 433 C AT 3000 SEC
.....
* RING 2, LEVEL 8, 300 - 400 mm
*
* IJ IREFN ICVHC ICVHB
COR20801 206 210 210
* TFU TCLAD TSS TCAN
COR20803 708.15 708.15 708.15 708.15 * 435 C AT 3000 SEC
* COR20803 849.15 849.15 849.15 849.15 * 435 C AT 3000 SEC
.....
* RING 2, LEVEL 9, 400 - 500 mm
* CHANGE IN CONTROL VOLUME NUMBERS
*
* IJ IREFN ICVHC ICVHB
COR20901 206 220 220
* TFU TCLAD TSS TCAN
COR20903 701.15 701.15 701.15 701.15 * 428 C AT 3000 SEC
* COR20903 841.15 841.15 841.15 841.15 * 428 C AT 3000 SEC
.....
* RING 2, LEVEL 10, 500 - 600 mm
*
* IJ IREFN ICVHC ICVHB
COR21001 206 220 220
* TFU TCLAD TSS TCAN
COR21003 693.15 693.15 693.15 693.15 * 420 C AT 3000 SEC
* COR21003 831.15 831.15 831.15 831.15 * 420 C AT 3000 SEC
.....
* RING 2, LEVEL 11, 600 - 700 mm
*
* IJ IREFN ICVHC ICVHB
COR21101 206 220 220
* TFU TCLAD TSS TCAN
COR21103 689.15 689.15 689.15 689.15 * 416 C AT 3000 SEC
* COR21103 826.15 826.15 826.15 826.15 * 416 C AT 3000 SEC
.....
* RING 2, LEVEL 12, 700 - 800 mm
*
* IJ IREFN ICVHC ICVHB
COR21201 206 220 220
* TFU TCLAD TSS TCAN
COR21203 683.15 683.15 683.15 683.15 * 410 C AT 3000 SEC
* COR21203 819.15 819.15 819.15 819.15 * 410 C AT 3000 SEC
.....
* RING 2, LEVEL 13, 800 - 900 mm
* CHANGE IN CONTROL VOLUME NUMBERS
*
* IJ IREFN ICVHC ICVHB
COR21301 206 230 230
* XMFU XMCL XMSS XMCP XMCN TUNG MOLY
COR21302 0.1617636 0.0750604 0.0 0.0 0.0 0.22167 * 0.0
* TFU TCLAD TSS TCAN
COR21303 675.15 675.15 675.15 675.15 * 402 C AT 3000 SEC
* COR21303 810.15 810.15 810.15 810.15 * 402 C AT 3000 SEC

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*
* added mass of Zr spacer 2/12/92
*
* RING 2, LEVEL 14, 900 - 1000 mm
*
* IJJ IREFN ICVHC ICVHB
COR21401 206 230 230
* TFU TCLAD TSS TCAN
COR21403 668.15 668.15 668.15 668.15 * 395 C AT 3000 SEC
* COR21403 801.15 801.15 801.15 801.15 * 395 C AT 3000 SEC
*
* RING 2, LEVEL 15, 1000 - 1100 mm
*
* IJJ IREFN ICVHC ICVHB
COR21501 206 230 230
* XMFU XMCL XMSS XMCP XMCN MOLY TUNG
COR21502 0.0 0.0602804 0.0 0.0 0.0 0.237 * 0.0
* TFU TCLAD TSS TCAN
COR21503 653.15 653.15 653.15 653.15 * 380 C AT 3000 SEC
* COR21503 783.15 783.15 783.15 783.15 * 380 C AT 3000 SEC
* ASFU ASCL ASSS ASCN
COR21506 0.01801 1.3509E-2 0.0 0.0 * SURFACE AREAS
* * 8.6mm dia for 0.1m
*
* RING 2, LEVEL 16, 1100 - 1200 mm
*
* IJJ IREFN ICVHC ICVHB
COR21601 215 230 230
* TFU TCLAD TSS TCAN
COR21603 633.15 633.15 633.15 633.15 * 360 C AT 3000 SEC
* COR21603 759.15 759.15 759.15 759.15 * 360 C AT 3000 SEC
*
* RING 2, LEVEL 17, 1200 - 1300 mm
*
* IJJ IREFN ICVHC ICVHB
COR21701 215 230 230
* TFU TCLAD TSS TCAN
COR21703 578.15 578.15 578.15 578.15 * 305 C AT 3000 SEC
* COR21703 693.15 693.15 693.15 578.15 * 305 C AT 3000 SEC
*
* RING 2, LEVEL 18, 1300 - 1400 mm
*
* IJJ IREFN ICVHC ICVHB
COR21801 215 230 230
* XMFU XMCL XMSS XMCP XMCN CU TUNG
COR21802 0.0 0.0602804 0.0 0.0 0.0 0.2081 * 0.0
* TFU TCLAD TSS TCAN
COR21803 513.15 513.15 513.15 513.15 * 240 C AT 3000 SEC
* COR21803 693.15 693.15 693.15 693.15 * try 1.2 times higher
* ASCELR AFLOWC AFLOWB
COR21805 0.01075 3.9655E-4 0.0 * FLOW AREAS
*
* RING 2, LEVEL 19, 1400 - 1447 mm
*
* IJJ IREFN ICVHC ICVHB
COR21901 205 240 240
* XMFU XMCL XMSS XMCP XMCN CU TUNG
COR21902 0.0 0.0283318 0.0 0.0 0.0 0.09781 * 0.0
* TFU TCLAD TSS TCAN
COR21903 513.15 513.15 513.15 513.15 * 240 C AT 3000 SEC
* COR21903 693.15 693.15 693.15 693.15 * try 1.2 times higher
* ASCELR AFLOWC AFLOWB
COR21905 0.00505 3.9655E-4 0.0 * FLOW AREAS

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```

*      ASFU  ASCL  ASSS  ASCN
COR21906  0.00846  6.3492E-3  0.0  0.0      * SURFACE AREAS
*
*      * 8.6mm dia for 0.1m
*
* ASCELR, ASFU, ASCL ARE 0.47 TIMES SMALLER TO REFLECT SMALLER LENGTH OF NODE
* COMPARED TO OTHER NODES
*
*.....
*.....
* RING 3 - 6 UNHEATED RODS AND 2 AG-IN-CD ABSORBER RODS
* UNHEATED RODS AND ABSORBER RODS ONLY EXTEND DOWN TO -200 mm
*
*.....
*.....
* RING 3, LEVEL 1 IS THE LOWER PLENUM, -489 TO -300 mm
*
* IJW  IREFN  ICVHC  ICVHB
COR30101  -1    110    110
*      XMFU  XMCL  XMSS  XMCP  XMCN  MOLY  TUNG
COR30102  0.0   0.0   0.0   0.0   0.0 * 0.0  0.0
*      TFU   TCLAD  TSS   TCAN
COR30103  593 15  593 15  593 15  593 15      * 320 C AT 3000 SEC
*      DHCYL  DHYSS  DHYDP  DHYCNC  DYNCNB
COR30104  1.0E-6  1.0E-6  0.025  1.0E-6  1.0E-6 * EQUIV DIAS
*
*
* TOTAL FLOW AREA FOR AFLOWC SINCE NO ROD HERE
* ASCELR OF LOWER PLENUM SHOULD BE 1.89 TIMES THAT BECAUSE OF LARGER DZ
*
*      ASCELR  AFLOWC  AFLOWB
COR30105  3.3873E-2  1.636E-3  0.0      * FLOW AREAS
*      ASFU   ASCL   ASSS   ASCN
COR30106  0.0   0.0   0.0   0.0      * SURFACE AREAS
*
*.....
* RING 3, LEVEL 2, -300 TO -200 mm
* UNHEATED ROD ONLY GOES DOWN TO -200 MM
*
* IJW  IREFN  ICVHC  ICVHB
COR30201  -1    110    110
*      XMFU  XMCL  XMSS  XMCP  XMCN  MOLY  TUNG
COR30202  0.0   0.0   0.0   0.0   0.0 * 0.0  0.0
*      TFU   TCLAD  TSS   TCAN
COR30203  593 15  593 15  593 15  593 15      * 320 C AT 3000 SEC
*      DHCLAD  DHYSS  DHYDP  DHYCNC  DYNCNB
COR30204  1.0E-6  1.0E-6  0.025  1.0E-6  1.0E-6 * EQUIV DIAS
*      ASCELR  AFLOWC  AFLOWB
COR30205  1.7922E-2  1.636E-3  0.0      * FLOW AREAS
*      ASFU   ASCL   ASSS   ASCN
COR30206  0.0   0.0   0.0   0.0      * SURFACE AREAS
*
*.....
* RING 3, LEVEL 3, -200 TO -100 mm
*
* IJW  IREFN  ICVHC  ICVHB
COR30301  -1    210    210
*      XMFU  XMCL  XMSS  XMCP  XMCN  MOLY  TUNG
COR30302  0.42924  0.13355  0.026892  0.15836  0.0  0.0 * 0.0
*      TFU   TCLAD  TSS   TCAN
COR30303  593 15  593 15  593 15  593 15      * 320 C AT 3000 SEC
* COR30303  711 15  711 15  711 15  711 15      * 320 C AT 3000 SEC
*      DHCLAD  DHYSS  DHYDP  DHYCNC  DYNCNB
COR30304  0.01095  0.01095  0.025  1.0E-6  1.0E-6 * EQUIV DIAS
*      ASCELR  AFLOWC  AFLOWB
COR30305  1.7922E-2  7.922E-4  0.0      * FLOW AREAS
*      ASFU   ASCL   ASSS   ASCN

```

COR30306 0.017153 0.028934 0.00704 0.0 * SURFACE AREAS

 * RING 3, LEVEL 4, -100 to 0 mm

 * IJJ IREFN ICVHC ICVHB
 COR30401 303 210 210

 * RING 3, LEVEL 5, 0 - 100 mm

 * IJJ IREFN ICVHC ICVHB
 COR30501 -1 210 210
 * XMFU XMCL XMSS XMCP XMCN MOLY TUNG
 COR30502 0.42924 0.13355 0.058732 0.15836 0.0 0.0 * 0.0
 * TFU TCLAD TSS TCAN
 COR30503 700.15 700.15 700.15 700.15 * 427 C AT 3000 SEC
 * COR30503 840.15 840.15 840.15 840.15 * 427 C AT 3000 SEC
 * DHCYL DHYSS DHYDP DHYCNC DYNCNB
 COR30504 0.01095 0.01095 0.025 1.0E-6 1.0E-6 * EQUIV DIAS
 * ASCELR AFLOWC AFLOWB
 COR30505 1.7922E-2 7.922E-4 0.0 * FLOW AREAS
 * ASFU ASCL ASSS ASCN
 COR30506 0.017153 0.043401 0.028 0.0 * SURFACE AREAS

 * added 0.03184 kg of Zr spacer 2/12/92
 * make surface area of Clad 50% larger

 * RING 3, LEVEL 6, 100 - 200 mm

 * IJJ IREFN ICVHC ICVHB
 COR30601 305 210 210
 * XMFU XMCL XMSS XMCP XMCN MOLY TUNG
 COR30602 0.42924 0.13355 0.026892 0.15836 0.0 0.0 * 0.0
 * TFU TCLAD TSS TCAN
 COR30603 708.15 708.15 718.15 708.15 * 435 C AT 3000 SEC
 * COR30603 849.15 849.15 849.15 849.15 * 435 C AT 3000 SEC
 * ASFU ASCL ASSS ASCN
 COR30606 0.017153 0.043401 0.00704 0.0 * SURFACE AREAS

 * RING 3, LEVEL 7, 200 - 300 mm

 * IJJ IREFN ICVHC ICVHB
 COR30701 306 210 210
 * TFU TCLAD TSS TCAN
 COR30703 704.15 704.15 713.15 704.15 * 431 C AT 3000 SEC
 * COR30703 845.15 845.15 845.15 845.15 * 431 C AT 3000 SEC

 * RING 3, LEVEL 8, 300 - 400 mm

 * IJJ IREFN ICVHC ICVHB
 COR30801 306 210 210
 * TFU TCLAD TSS TCAN
 COR30803 699.15 699.15 705.15 699.15 * 426 C AT 3000 SEC
 * COR30803 838.15 838.15 838.15 838.15 * 426 C AT 3000 SEC

 * RING 3, LEVEL 9, 400 - 500 mm
 * CHANGE IN CONTROL VOLUME NUMBERS

 * IJJ IREFN ICVHC ICVHB
 COR30901 306 220 220
 * TFU TCLAD TSS TCAN
 COR30903 694.15 694.15 699.15 694.15 * 423 C AT 3000 SEC
 * COR30903 832.15 832.15 832.15 832.15 * 423 C AT 3000 SEC

 * RING 3, LEVEL 10, 500 - 600 mm

```

*
* IJJ IREFN ICVHC ICVHB
COR31001 306 220 220
* TFU TCLAD TSS TCAN
COR31003 690.15 690.15 693.15 690.15 * 417 C AT 3000 SEC
*COR31003 828.15 828.15 828.15 828.15 * 417 C AT 3000 SEC
.....
* RING 3, LEVEL 11, 600 - 700 mm
*
* IJJ IREFN ICVHC ICVHB
COR31101 306 220 220
* TFU TCLAD TSS TCAN
COR31103 687.15 687.15 687.15 687.15 * 414 C AT 3000 SEC
*COR31103 824.15 824.15 824.15 824.15 * 414 C AT 3000 SEC
.....
* RING 3, LEVEL 12, 700 - 800 mm
*
* IJJ IREFN ICVHC ICVHB
COR31201 306 220 220
* TFU TCLAD TSS TCAN
COR31203 683.15 683.15 681.15 683.15 * 410 C AT 3000 SEC
*COR31203 819.15 819.15 819.15 819.15 * 410 C AT 3000 SEC
.....
* RING 3, LEVEL 13, 800 - 900 mm
* CHANGE IN CONTROL VOLUME NUMBERS
*
* IJJ IREFN ICVHC ICVHB
COR31301 306 230 230
* XMFU XMCL XMSS XMCP XMCN MOLY TUNG
COR31302 0.42924 0.16539 0.026892 0.15836 0.0 0.0 * 0.0
* TFU TCLAD TSS TCAN
COR31303 678.15 678.15 675.15 678.15 * 405 C AT 3000 SEC
*COR31303 813.15 813.15 813.15 813.15 * 405 C AT 3000 SEC
.....
* RING 3, LEVEL 14, 900 - 1000 mm
*
* IJJ IREFN ICVHC ICVHB
COR31401 306 230 230
* TFU TCLAD TSS TCAN
COR31403 670.15 670.15 668.15 670.15 * 397 C AT 3000 SEC
*COR31403 804.15 804.15 804.15 804.15 * 397 C AT 3000 SEC
.....
* RING 3, LEVEL 15, 1000 - 1100 mm
*
* IJJ IREFN ICVHC ICVHB
COR31501 306 230 230
* TFU TCLAD TSS TCAN
COR31503 648.15 648.15 653.15 648.15 * 375 C AT 3000 SEC
*COR31503 777.15 777.15 777.15 777.15 * 375 C AT 3000 SEC
.....
* RING 3, LEVEL 16, 1100 - 1200 mm
*
* IJJ IREFN ICVHC ICVHB
COR31601 306 230 230
* TFU TCLAD TSS TCAN
COR31603 618.15 618.15 633.15 618.15 * 345 C AT 3000 SEC
*COR31603 741.15 741.15 741.15 741.15 * 345 C AT 3000 SEC
.....
* RING 3, LEVEL 17, 1200 - 1300 mm
*
* IJJ IREFN ICVHC ICVHB
COR31701 306 230 230
* TFU TCLAD TSS TCAN
COR31703 593.15 593.15 578.15 593.15 * 320 C AT 3000 SEC
*COR31703 711.15 711.15 711.15 711.15 * 320 C AT 3000 SEC
.....

```


* RING 3, LEVEL 18, 1300 - 1400 mm
 * UNHEATED ROD ONLY GOES TO 1295 MM
 *

* ASCELR IS 1.47 TIMES THAT OF NORMAL LEVEL TO REFLECT 147 MM
 * OF HEIGHT OF THIS LEVEL
 *

* IJW IREFN ICVHC ICVHB
 COR31801 -1 230 230
 * XMFU XMCL XMSS XMCP XMCN CU TUNG
 COR31802 0.0 0.0 0.0 0.0 0.0 0.0 * 0.0
 * TFU TCLAD TSS TCAN
 COR31803 570.15 570.15 570.15 570.15 * 297 C AT 3000 SEC
 * DHCYL DHYSS DHYDP DHYCNC DYNCNB
 COR31804 1.0E-6 1.0E-6 0.025 1.0E-6 1.0E-6 * EQUIV DIAS
 * ASCELR AFLOWC AFLOWB
 COR31805 1.7922E-2 1.636E-3 0.0 * FLOW AREAS
 * ASFU ASCL ASSS ASCN
 COR31806 0.0 0.0 0.0 0.0 * SURFACE AREAS
 *

.....

* RING 3, LEVEL 19, 1400 - 1447 mm (MISSING 24 MM OF TUNGSTEN)
 * THAT IS WHY DO NOT REACH BUNDLE FLANGE AT 1471 MM
 * UNHEATED ROD ONLY GOES TO 1295 MM
 *

* ASCELR IS 0.47 TIMES THAT OF NORMAL LEVEL TO REFLECT 147 MM
 * OF HEIGHT OF THIS LEVEL
 *

* IJW IREFN ICVHC ICVHB
 COR31901 -1 240 240
 * XMFU XMCL XMSS XMCP XMCN CU TUNG
 COR31902 0.0 0.0 0.0 0.0 0.0 0.0 * 0.0
 * TFU TCLAD TSS TCAN
 COR31903 570.15 570.15 570.15 570.15 * 297 C AT 3000 SEC
 * DHCYL DHYSS DHYDP DHYCNC DYNCNB
 COR31904 1.0E-6 1.0E-6 0.025 1.0E-6 1.0E-6 * EQUIV DIAS
 * ASCELR AFLOWC AFLOWB
 COR31905 8.4232E-3 1.636E-3 0.0 * FLOW AREAS
 * ASFU ASCL ASSS ASCN
 COR31906 0.0 0.0 0.0 0.0 * SURFACE AREAS
 *

.....

* RING 4 - 12 HEATED RODS
 * RING 4 CONTAINS 12 HEATED RODS WITH TUNGSTEN CORES AND UO2 SLEEVES
 *

.....

* RING 4, LEVEL 1 IS THE LOWER PLENUM, -489 TO -300 mm
 *

* IJW IREFN ICVHC ICVHB
 COR40101 -1 110 110
 * XMFU XMCL XMSS XMCP XMCN MOLY TUNG
 COR40102 0.0 0.0 0.0 0.0 0.0 0.0 * 0.0
 * TFU TCLAD TSS TCAN
 COR40103 593.15 593.15 593.15 593.15 * 320 C AT 3000 SEC
 * DHCYL DHYSS DHYDP DHYCNC DYNCNB
 COR40104 1.0E-6 1.0E-6 0.025 1.0E-6 1.0E-6 * EQUIV DIAS
 *

* Actually, there is 0.52263 kg of Zircaloy clad in this cell, but since
 * water is always (mostly) present, do not make it available for oxidation
 *

* ASCELR OF LOWER PLENUM SHOULD BE 1.89 TIMES THAT BECAUSE OF LARGER DZ
 * AFLOWC REFLECTS LARGER AREA OF STEAM DISTRIBUTION TUBE MINUS THE TWELVE
 * HEATED RODS THAT EXTEND INTO THE LOWER PLENUM
 *

* ASCELR AFLOWC AFLOWB


```

* IJJ IREFN ICVHC ICVHB
COR40601 405 210 210
* XMFU XMCL XMSS XMCP XMCN TUNG MOLY
COR40602 0.48529 0.18084 0.0 0.0 0.2523 0.665 * 0.0
* TFU TCLAD TSS TCAN
COR40603 704.15 704.15 704.15 668.15 * 431 C AT 3000 SEC
*COR40603 844.15 844.15 844.15 801.15 * 431 C AT 3000 SEC
* ASFU ASCL ASSS ASCN
COR40606 0.034305 0.0405265 0.0 0.035 * SURFACE AREAS
.....
* RING 4, LEVEL 7, 200 - 300 mm
.
* IJJ IREFN ICVHC ICVHB
COR40701 406 210 210
* TFU TCLAD TSS TCAN
COR40703 706.15 706.15 706.15 661.15 * C AT 3000 SEC
*COR40703 847.15 847.15 847.15 793.15 * C AT 3000 SEC
.....
* RING 4, LEVEL 8, 300 - 400 mm
.
* IJJ IREFN ICVHC ICVHB
COR40801 406 210 210
* TFU TCLAD TSS TCAN
COR40803 708.15 708.15 708.15 656.15 * 433 C AT 3000 SEC
*COR40803 849.15 849.15 849.15 787.15 * 433 C AT 3000 SEC
.....
* RING 4, LEVEL 9, 400 - 500 mm
* CHANGE IN CONTROL VOLUME NUMBERS
.
* IJJ IREFN ICVHC ICVHB
COR40901 406 220 220
* TFU TCLAD TSS TCAN
COR40903 701.15 701.15 701.15 649.15 * 435 C AT 3000 SEC
*COR40903 841.15 841.15 841.15 778.15 * 435 C AT 3000 SEC
.....
* RING 4, LEVEL 10, 500 - 600 mm
.
* IJJ IREFN ICVHC ICVHB
COR41001 406 220 220
* TFU TCLAD TSS TCAN
COR41003 693.15 693.15 693.15 643.15 * 428 C AT 3000 SEC
*COR41003 831.15 831.15 831.15 771.15 * 428 C AT 3000 SEC
.....
* RING 4, LEVEL 11, 600 - 700 mm
.
* IJJ IREFN ICVHC ICVHB
COR41101 406 220 220
* TFU TCLAD TSS TCAN
COR41103 689.15 689.15 689.15 638.15 * 420 C AT 3000 SEC
*COR41103 826.15 826.15 826.15 765.15 * 420 C AT 3000 SEC
.....
* RING 4, LEVEL 12, 700 - 800 mm
.
* IJJ IREFN ICVHC ICVHB
COR41201 406 220 220
* TFU TCLAD TSS TCAN
COR41203 683.15 683.15 683.15 631.15 * 416 C AT 3000 SEC
*COR41203 819.15 819.15 819.15 757.15 * 416 C AT 3000 SEC
.....
* RING 4, LEVEL 13, 800 - 900 mm
* CHANGE IN CONTROL VOLUME NUMBERS
.
* IJJ IREFN ICVHC ICVHB
COR41301 406 230 230
* XMFU XMCL XMSS XMCP XMCN TUNG MOLY
COR41302 0.48529 0.2751 0.0 0.0 0.2523 0.665 * 0.0

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*      TFU   TCLAD   TSS   TCAN
COR41303  675.15  675.15  675.15  625.15      * 410 C AT 3000 SEC
*COR41303  810.15  810.15  810.15  750.15      * 410 C AT 3000 SEC
.....
* RING 4, LEVEL 14, 900 - 1000 mm
*
* IJ  IREFN  ICVHC  ICVHB
COR41401  406    230    230
*      TFU   TCLAD   TSS   TCAN
COR41403  668.15  668.15  668.15  618.15      * 402 C AT 3000 SEC
*COR41403  801.15  801.15  801.15  741.15      * 402 C AT 3000 SEC
.....
* RING 4, LEVEL 15, 1000 - 1100 mm
*
* IJ  IREFN  ICVHC  ICVHB
COR41501  406    230    230
*      XMFU  XMCL    XMSS  XMCP  XMCN  MOLY  TUNG
COR41502  0.0    0.18084  0.0    0.0  0.2523  0.711 * 0.0
*      TFU   TCLAD   TSS   TCAN
COR41503  653.15  653.15  653.15  578.15      * 395 C AT 3000 SEC
*COR41503  783.15  783.15  783.15  693.15      * 395 C AT 3000 SEC
*      DHCLAD DHYSS  DHYDP  DHYCNC  DYNCNB
COR41504  0.03706 1.0E-6  0.025  0.1002  0.1002 * EQUIV DIAS
*      ASFU  ASCL    ASSS  ASCN
COR41506  0.03242 0.0405265 0.0    0.035      * SURFACE AREAS
*
*      * 12 RODS 8.6MM DIA
.....
* RING 4, LEVEL 16, 1100 - 1200 mm
*
* IJ  IREFN  ICVHC  ICVHB
COR41601  415    230    230
*      TFU   TCLAD   TSS   TCAN
COR41603  633.15  633.15  633.15  538.15      * 380 C AT 3000 SEC
*COR41603  759.15  759.15  759.15  645.15      * 380 C AT 3000 SEC
.....
* RING 4, LEVEL 17, 1200 - 1300 mm
* ASSUME SHROUD ENDS AT 1200 mm
*
* IJ  IREFN  ICVHC  ICVHB
COR41701  415    230    230
*      XMFU  XMCL    XMSS  XMCP  XMCN  MOLY  TUNG
COR41702  0.0    0.18084  0.0    0.0  0.0    0.711 * 0.0
*      TFU   TCLAD   TSS   TCAN
COR41703  578.15  578.15  578.15  578.15      * 360 C AT 3000 SEC
*COR41703  693.15  693.15  693.15  693.15      * 360 C AT 3000 SEC
*      ASFU  ASCL    ASSS  ASCN
COR41706  0.03242 0.0405265 0.0    0.0      * SURFACE AREAS
*
.....
* RING 4, LEVEL 18, 1300 - 1400 mm
*
* IJ  IREFN  ICVHC  ICVHB
COR41801  415    230    230
*      XMFU  XMCL    XMSS  XMCP  XMCN  CU    TUNG
COR41802  0.0    0.18084  0.0    0.0  0.0    0.62416 * 0.0
*      TFU   TCLAD   TSS   TCAN
COR41803  513.15  513.15  513.15  513.15      * 305 C AT 3000 SEC
*COR41803  615.15  615.15  615.15  615.15      * 305 C AT 3000 SEC
*      ASCELR AFLOWC  AFLOWB
COR41805  0.02080 3.7988E-3 0.0      * FLOW AREAS
*      ASFU  ASCL    ASSS  ASCN
COR41806  0.03242 0.0405265 0.0    0.0      * SURFACE AREAS
*
.....
* RING 4, LEVEL 19, 1400 - 1447 mm

```



```

* SC1001 ZIRCALOY OXIDATION RATE CONSTANT COEFFICIENTS
.
SC10011 1001 29 6 1 * Low temp range constant coeff (default)
*SC10012 1001 16820 0 2 * Low temp range exponential coeff
*SC10013 1001 97 9 3 * High temp range constant coeff (default)
SC10013 1001 77 9 3 * High temp range constant coeff (default)
*SC10014 1001 16610 0 4 * High temp range exponential coeff
*SC10015 1001 1853 0 5 * Temp boundary between low and high range (default)
SC10015 1001 1750 0 5 * Temp boundary between low and high range
.
.
* SC1002 STEEL OXIDATION RATE CONSTANT COEFFICIENTS
.
SC10021 1002 1 0 1 * Temp range constant coeff
*SC10022 1002 42400 0 2 * Temp range exponential coeff
.
* SC1131 MOLTEN HOLDUP PARAMETERS
.
SC11311 1131 6.0E-5 1 * Min ZrO2 Thickness to hold up melt
*SC11312 1131 2750 0 2 * Max ZrO2 Temp to hold up melt - original calc
SC11312 1131 2500 0 2 * Max ZrO2 Temp to hold up melt
SC11313 1131 0 001 3 * Min SSOX to hold up melt
*SC11314 1131 1700 0 4 * Max SSOX Temp to hold up melt - original calc
SC11314 1131 2500 0 4 * Max SSOX Temp to hold up melt
.
* SC1151 CONGLOMERATE DEBRIS SURFACE AREA COEFFS
.
SC11511 1151 1 0 3 5 * FAMIN(CAN) = 1 0
SC11512 1151 0 0 3 6 * FBMAX(CAN) = 0 0
.
* SC1501 CANISTER MASS/SURFACE AREA SPLITS
.
SC15011 1501 0 0 1
SC15012 1501 0 0 2
SC15013 1501 0 0 3
SC15014 1501 1 0 4
SC15015 1501 0 0 5
.
* SC1502 MINIMUM COMPONENT MASSES
.
SC15021 1502 1.0E-6 1 * Min Total Mass of Component
SC15022 1502 0 001 2 * Min Mass Subject to Time Step
.
* SC1003 GASEIOUS DIFFUSION OXIDATION COEFFS
.
SC10031 1003 0 0027 1 * Zircaloy Oxidation Coeff
.
.....
* CORA 13, ISP31 CONTROL FUNCTION INPU
* ROBERT J. GROSS AND GALE M. MARTINEZ
* NOVEMBER 13, 1991
.....
.
.....
* CONSTANT CONTROL FUNCTION CONTAINING
* THE INITIAL TIME
* THIS CAN BE EITHER ZERO OR 3000 - CHANGE ACCORDINGLY !!!!!
* CF198
.....
.
CF19800 'TIME CONST' EQUALS 1 0 0 0 0
CF19810 0 0 3000 0 TIME
*CF19810 0 0 0 0 TIME
.
.....
* CONSTANT CONTROL FUNCTION CONTAINING

```

```

* ZERO VALUE
* CF199
.....
.
CF19900 'ZERO CONST' EQUALS 1 0.0 0.0
CF19910 0.0 0.0 TIME
.
.....
* TABLE 1 ENTRY 21-35 FLUID TEMPERATURE
* CF200 - CF304
.....
.
.....
* FLUID TEMPERATURE LEVEL 3
* -200 TO -100 mm
.....
.
CF20000 'LEVEL 3 VOL-T' ADD 4 1.0 0.0
CF20010 0.1 0.0 COR-AFLMIN.103.103 * FIRST NUMBER IS DZ
CF20011 0.1 0.0 COR-AFLMIN.203.203
CF20012 0.1 0.0 COR-AFLMIN.303.303
CF20013 0.1 0.0 COR-AFLMIN.403.403
.
CF20100 'VOL TEMP 103' MULTIPLY 2 1.0 0.0
CF20110 0.1 0.0 COR-AFLMIN.103.103 * FIRST NUMBER IS DZ
CF20111 1.0 0.0 COR-TSVC.103
.
CF20200 'VOL TEMP 203' MULTIPLY 2 1.0 0.0
CF20210 0.1 0.0 COR-AFLMIN.203.203 * FIRST NUMBER IS DZ
CF20211 1.0 0.0 COR-TSVC.203
.
CF20300 'VOL TEMP 303' MULTIPLY 2 1.0 0.0
CF20310 0.1 0.0 COR-AFLMIN.303.303 * FIRST NUMBER IS DZ
CF20311 1.0 0.0 COR-TSVC.303
.
CF20400 'VOL TEMP 403' MULTIPLY 2 1.0 0.0
CF20410 0.1 0.0 COR-AFLMIN.403.403 * FIRST NUMBER IS DZ
CF20411 1.0 0.0 COR-TSVC.403
.
CF20500 'SUM VOL T 3' ADD 4 1.0 0.0
CF20510 1.0 0.0 CFVALU.201
CF20511 1.0 0.0 CFVALU.202
CF20512 1.0 0.0 CFVALU.203
CF20513 1.0 0.0 CFVALU.204
.
CF20600 'FLUID TEMP LEV 3' DIVIDE 2 1.0 0.0
CF20610 1.0 0.0 CFVALU.200 * DEMONINATOR
CF20611 1.0 0.0 CFVALU.205 * NUMERATOR
.
.....
.
.....
* FLUID TEMPERATURE LEVEL 4
* -100 TO 0 mm
.....
.
CF20700 'LEVEL 4 VOL-T' ADD 4 1.0 0.0
CF20710 0.1 0.0 COR-AFLMIN.104.104 * FIRST NUMBER IS DZ
CF20711 0.1 0.0 COR-AFLMIN.204.204
CF20712 0.1 0.0 COR-AFLMIN.304.304
CF20713 0.1 0.0 COR-AFLMIN.404.404
.
CF20800 'VOL TEMP 104' MULTIPLY 2 1.0 0.0
CF20810 0.1 0.0 COR-AFLMIN.104.104 * FIRST NUMBER IS DZ
CF20811 1.0 0.0 COR-TSVC.104
.

```

```

CF20900 'VOL TEMP 204' MULTIPLY 2 1.0 0.0
CF20910 0.1 0.0 COR-AFLMIN.204.204 * FIRST NUMBER IS DZ
CF20911 1.0 0.0 COR-TSVC.204
.

CF21000 'VOL TEMP 304' MULTIPLY 2 1.0 0.0
CF21010 0.1 0.0 COR-AFLMIN.304.304 * FIRST NUMBER IS DZ
CF21011 1.0 0.0 COR-TSVC.304
.

CF21100 'VOL TEMP 404' MULTIPLY 2 1.0 0.0
CF21110 0.1 0.0 COR-AFLMIN.404.404 * FIRST NUMBER IS DZ
CF21111 1.0 0.0 COR-TSVC.404
.

CF21200 'SUM VOL T 4' ADD 4 1.0 0.0
CF21210 1.0 0.0 CFVALU.208
CF21211 1.0 0.0 CFVALU.209
CF21212 1.0 0.0 CFVALU.210
CF21213 1.0 0.0 CFVALU.211
.

CF21300 'FLUID TEMP LEV 4' DIVIDE 2 1.0 0.0
CF21310 1.0 0.0 CFVALU.207 * DEMONINATOR
CF21311 1.0 0.0 CFVALU.212 * NUMERATOR
.
.....
.
.....
* FLUID TEMPERATURE LEVEL 5
* 0 TO 100 mm
.....
.

CF21400 'LEVEL 5 VOL-T' ADD 4 1.0 0.0
CF21410 0.1 0.0 COR-AFLMIN.105.105 * FIRST NUMBER IS DZ
CF21411 0.1 0.0 COR-AFLMIN.205.205
CF21412 0.1 0.0 COR-AFLMIN.305.305
CF21413 0.1 0.0 COR-AFLMIN.405.405
.

CF21500 'VOL TEMP 105' MULTIPLY 2 1.0 0.0
CF21510 0.1 0.0 COR-AFLMIN.105.105 * FIRST NUMBER IS DZ
CF21511 1.0 0.0 COR-TSVC.105
.

CF21600 'VOL TEMP 205' MULTIPLY 2 1.0 0.0
CF21610 0.1 0.0 COR-AFLMIN.205.205 * FIRST NUMBER IS DZ
CF21611 1.0 0.0 COR-TSVC.205
.

CF21700 'VOL TEMP 305' MULTIPLY 2 1.0 0.0
CF21710 0.1 0.0 COR-AFLMIN.305.305 * FIRST NUMBER IS DZ
CF21711 1.0 0.0 COR-TSVC.305
.

CF21800 'VOL TEMP 405' MULTIPLY 2 1.0 0.0
CF21810 0.1 0.0 COR-AFLMIN.405.405 * FIRST NUMBER IS DZ
CF21811 1.0 0.0 COR-TSVC.405
.

CF21900 'SUM VOL T 5' ADD 4 1.0 0.0
CF21910 1.0 0.0 CFVALU.215
CF21911 1.0 0.0 CFVALU.216
CF21912 1.0 0.0 CFVALU.217
CF21913 1.0 0.0 CFVALU.218
.

CF22000 'FLUID TEMP LEV 5' DIVIDE 2 1.0 0.0
CF22010 1.0 0.0 CFVALU.214 * DEMONINATOR
CF22011 1.0 0.0 CFVALU.219 * NUMERATOR
.
.....
.
.....
* FLUID TEMPERATURE LEVEL 6
* 100 TO 200 mm

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.....
.
CF22100 'LEVEL 6 VOL-T' ADD 4 1.0 0.0
CF22110 0.1 0.0 COR-AFLMIN.106.106 * FIRST NUMBER IS DZ
CF22111 0.1 0.0 COR-AFLMIN.206.206
CF22112 0.1 0.0 COR-AFLMIN.306.306
CF22113 0.1 0.0 COR-AFLMIN.406.406
.
CF22200 'VOL TEMP 106' MULTIPLY 2 1.0 0.0
CF22210 0.1 0.0 COR-AFLMIN.106.106 * FIRST NUMBER IS DZ
CF22211 1.0 0.0 COR-TSVC.106
.
CF22300 'VOL TEMP 206' MULTIPLY 2 1.0 0.0
CF22310 0.1 0.0 COR-AFLMIN.206.206 * FIRST NUMBER IS DZ
CF22311 1.0 0.0 COR-TSVC.206
.
CF22400 'VOL TEMP 306' MULTIPLY 2 1.0 0.0
CF22410 0.1 0.0 COR-AFLMIN.306.306 * FIRST NUMBER IS DZ
CF22411 1.0 0.0 COR-TSVC.306
.
CF22500 'VOL TEMP 406' MULTIPLY 2 1.0 0.0
CF22510 0.1 0.0 COR-AFLMIN.406.406 * FIRST NUMBER IS DZ
CF22511 1.0 0.0 COR-TSVC.406
.
CF22600 'SUM VOL T 6' ADD 4 1.0 0.0
CF22610 1.0 0.0 CFVALU.222
CF22611 1.0 0.0 CFVALU.223
CF22612 1.0 0.0 CFVALU.224
CF22613 1.0 0.0 CFVALU.225
.
CF22700 'FLUID TEMP LEV 6' DIVIDE 2 1.0 0.0
CF22710 1.0 0.0 CFVALU.221 * DEMONINATOR
CF22711 1.0 0.0 CFVALU.226 * NUMERATOR
.
.....
.
.....
* FLUID TEMPERATURE LEVEL 7
* 200 TO 300 mm
.....
.
CF22800 'LEVEL 7 VOL-T' ADD 4 1.0 0.0
CF22810 0.1 0.0 COR-AFLMIN.107.107 * FIRST NUMBER IS DZ
CF22811 0.1 0.0 COR-AFLMIN.207.207
CF22812 0.1 0.0 COR-AFLMIN.307.307
CF22813 0.1 0.0 COR-AFLMIN.407.407
.
CF22900 'VOL TEMP 107' MULTIPLY 2 1.0 0.0
CF22910 0.1 0.0 COR-AFLMIN.107.107 * FIRST NUMBER IS DZ
CF22911 1.0 0.0 COR-TSVC.107
.
CF23000 'VOL TEMP 207' MULTIPLY 2 1.0 0.0
CF23010 0.1 0.0 COR-AFLMIN.207.207 * FIRST NUMBER IS DZ
CF23011 1.0 0.0 COR-TSVC.207
.
CF23100 'VOL TEMP 307' MULTIPLY 2 1.0 0.0
CF23110 0.1 0.0 COR-AFLMIN.307.307 * FIRST NUMBER IS DZ
CF23111 1.0 0.0 COR-TSVC.307
.
CF23200 'VOL TEMP 407' MULTIPLY 2 1.0 0.0
CF23210 0.1 0.0 COR-AFLMIN.407.407 * FIRST NUMBER IS DZ
CF23211 1.0 0.0 COR-TSVC.407
.
CF23300 'SUM VOL T 7' ADD 4 1.0 0.0
CF23310 1.0 0.0 CFVALU.229
CF23311 1.0 0.0 CFVALU.230

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CF23312 1.0 0.0      CFVALU.231
CF23313 1.0 0.0      CFVALU.232
.
CF23400 'FLUID TEMP LEV 7' DIVIDE 2 1.0 0.0
CF23410 1.0 0.0      CFVALU.228      * DEMONINATOR
CF23411 1.0 0.0      CFVALU.233      * NUMERATOR
.
.....
.
.....
* FLUID TEMPERATURE LEVEL 8
* 300 TO 400 mm
.....
.
CF23500 'LEVEL 8 VOL-T' ADD 4 1.0 0.0
CF23510 0.1 0.0      COR-AFLMIN.108.108 * FIRST NUMBER IS DZ
CF23511 0.1 0.0      COR-AFLMIN.208.208
CF23512 0.1 0.0      COR-AFLMIN.308.308
CF23513 0.1 0.0      COR-AFLMIN.408.408
.
CF23600 'VOL TEMP 108' MULTIPLY 2 1.0 0.0
CF23610 0.1 0.0      COR-AFLMIN.108.108 * FIRST NUMBER IS DZ
CF23611 1.0 0.0      COR-TSVC.108
.
CF23700 'VOL TEMP 208' MULTIPLY 2 1.0 0.0
CF23710 0.1 0.0      COR-AFLMIN.208.208 * FIRST NUMBER IS DZ
CF23711 1.0 0.0      COR-TSVC.208
.
CF23800 'VOL TEMP 308' MULTIPLY 2 1.0 0.0
CF23810 0.1 0.0      COR-AFLMIN.308.308 * FIRST NUMBER IS DZ
CF23811 1.0 0.0      COR-TSVC.308
.
CF23900 'VOL TEMP 408' MULTIPLY 2 1.0 0.0
CF23910 0.1 0.0      COR-AFLMIN.408.408 * FIRST NUMBER IS DZ
CF23911 1.0 0.0      COR-TSVC.408
.
CF24000 'SUM VOL T 8' ADD 4 1.0 0.0
CF24010 1.0 0.0      CFVALU.236
CF24011 1.0 0.0      CFVALU.237
CF24012 1.0 0.0      CFVALU.238
CF24013 1.0 0.0      CFVALU.239
.
CF24100 'FLUID TEMP LEV 8' DIVIDE 2 1.0 0.0
CF24110 1.0 0.0      CFVALU.235      * DEMONINATOR
CF24111 1.0 0.0      CFVALU.240      * NUMERATOR
.
.....
.
.....
* FLUID TEMPERATURE LEVEL 9
* 400 TO 500 mm
.....
.
CF24200 'LEVEL 9 VOL-T' ADD 4 1.0 0.0
CF24210 0.1 0.0      COR-AFLMIN.109.109 * FIRST NUMBER IS DZ
CF24211 0.1 0.0      COR-AFLMIN.209.209
CF24212 0.1 0.0      COR-AFLMIN.309.309
CF24213 0.1 0.0      COR-AFLMIN.409.409
.
CF24300 'VOL TEMP 109' MULTIPLY 2 1.0 0.0
CF24310 0.1 0.0      COR-AFLMIN.109.109 * FIRST NUMBER IS DZ
CF24311 1.0 0.0      COR-TSVC.109
.
CF24400 'VOL TEMP 209' MULTIPLY 2 1.0 0.0
CF24410 0.1 0.0      COR-AFLMIN.209.209 * FIRST NUMBER IS DZ
CF24411 1.0 0.0      COR-TSVC.209

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*
CF24500 'VOL TEMP 309' MULTIPLY 2 1.0 0.0
CF24510 0.1 0.0 COR-AFLMIN.309.309 * FIRST NUMBER IS DZ
CF24511 1.0 0.0 COR-TSVC.309
*
CF24600 'VOL TEMP 409' MULTIPLY 2 1.0 0.0
CF24610 0.1 0.0 COR-AFLMIN.409.409 * FIRST NUMBER IS DZ
CF24611 1.0 0.0 COR-TSVC.409
*
CF24700 'SUM VOL T 9' ADD 4 1.0 0.0
CF24710 1.0 0.0 CFVALU.243
CF24711 1.0 0.0 CFVALU.244
CF24712 1.0 0.0 CFVALU.245
CF24713 1.0 0.0 CFVALU.246
*
CF24800 'FLUID TEMP LEV 9' DIVIDE 2 1.0 0.0
CF24810 1.0 0.0 CFVALU.242 * DEMONINATOR
CF24811 1.0 0.0 CFVALU.247 * NUMERATOR
*
.....
*
.....
* FLUID TEMPERATURE LEVEL 10
* 500 TO 600 mm
.....
*
CF24900 'LEVEL10 VOL T' ADD 4 1.0 0.0
CF24910 0.1 0.0 COR-AFLMIN.110.110 * FIRST NUMBER IS DZ
CF24911 0.1 0.0 COR-AFLMIN.210.210
CF24912 0.1 0.0 COR-AFLMIN.310.310
CF24913 0.1 0.0 COR-AFLMIN.410.410
*
CF25000 'VOL TEMP 110' MULTIPLY 2 1.0 0.0
CF25010 0.1 0.0 COR-AFLMIN.110.110 * FIRST NUMBER IS DZ
CF25011 1.0 0.0 COR-TSVC.110
*
CF25100 'VOL TEMP 210' MULTIPLY 2 1.0 0.0
CF25110 0.1 0.0 COR-AFLMIN.210.210 * FIRST NUMBER IS DZ
CF25111 1.0 0.0 COR-TSVC.210
*
CF25200 'VOL TEMP 310' MULTIPLY 2 1.0 0.0
CF25210 0.1 0.0 COR-AFLMIN.310.310 * FIRST NUMBER IS DZ
CF25211 1.0 0.0 COR-TSVC.310
*
CF25300 'VOL TEMP 410' MULTIPLY 2 1.0 0.0
CF25310 0.1 0.0 COR-AFLMIN.410.410 * FIRST NUMBER IS DZ
CF25311 1.0 0.0 COR-TSVC.410
*
CF25400 'SUM VOL T 10' ADD 4 1.0 0.0
CF25410 1.0 0.0 CFVALU.250
CF25411 1.0 0.0 CFVALU.251
CF25412 1.0 0.0 CFVALU.252
CF25413 1.0 0.0 CFVALU.253
*
CF25500 'FLUID TEMP LEV10' DIVIDE 2 1.0 0.0
CF25510 1.0 0.0 CFVALU.249 * DEMONINATOR
CF25511 1.0 0.0 CFVALU.254 * NUMERATOR
*
.....
*
.....
* FLUID TEMPERATURE LEVEL 11
* 600 TO 700 mm
.....
*
CF25600 'LEVEL 11 VOL-T' ADD 4 1.0 0.0

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CF25610 0.1 0.0 COR-AFLMIN.111.111 * FIRST NUMBER IS DZ
 CF25611 0.1 0.0 COR-AFLMIN.211.211
 CF25612 0.1 0.0 COR-AFLMIN.311.311
 CF25613 0.1 0.0 COR-AFLMIN.411.411
 .
 CF25700 'VOL TEMP 111' MULTIPLY 2 1.0 0.0
 CF25710 0.1 0.0 COR-AFLMIN.111.111 * FIRST NUMBER IS DZ
 CF25711 1.0 0.0 COR-TSVC.111
 .
 CF25800 'VOL TEMP 211' MULTIPLY 2 1.0 0.0
 CF25810 0.1 0.0 COR-AFLMIN.211.211 * FIRST NUMBER IS DZ
 CF25811 1.0 0.0 COR-TSVC.211
 .
 CF25900 'VOL TEMP 311' MULTIPLY 2 1.0 0.0
 CF25910 0.1 0.0 COR-AFLMIN.311.311 * FIRST NUMBER IS DZ
 CF25911 1.0 0.0 COR-TSVC.311
 .
 CF26000 'VOL TEMP 411' MULTIPLY 2 1.0 0.0
 CF26010 0.1 0.0 COR-AFLMIN.411.411 * FIRST NUMBER IS DZ
 CF26011 1.0 0.0 COR-TSVC.411
 .
 CF26100 'SUM VOL T 11' ADD 4 1.0 0.0
 CF26110 1.0 0.0 CFVALU.257
 CF26111 1.0 0.0 CFVALU.258
 CF26112 1.0 0.0 CFVALU.259
 CF26113 1.0 0.0 CFVALU.260
 .
 CF26200 'FLUID TEMP LEV11' DIVIDE 2 1.0 0.0
 CF26210 1.0 0.0 CFVALU.256 * DEMONINATOR
 CF26211 1.0 0.0 CFVALU.261 * NUMERATOR
 .

 .

 * FLUID TEMPERATURE LEVEL 12
 * 700 TO 800 mm

 .
 CF26300 'LEVEL 12 VOL-T' ADD 4 1.0 0.0
 CF26310 0.1 0.0 COR-AFLMIN.112.112 * FIRST NUMBER IS DZ
 CF26311 0.1 0.0 COR-AFLMIN.212.212
 CF26312 0.1 0.0 COR-AFLMIN.312.312
 CF26313 0.1 0.0 COR-AFLMIN.412.412
 .
 CF26400 'VOL TEMP 112' MULTIPLY 2 1.0 0.0
 CF26410 0.1 0.0 COR-AFLMIN.112.112 * FIRST NUMBER IS DZ
 CF26411 1.0 0.0 COR-TSVC.112
 .
 CF26500 'VOL TEMP 212' MULTIPLY 2 1.0 0.0
 CF26510 0.1 0.0 COR-AFLMIN.212.212 * FIRST NUMBER IS DZ
 CF26511 1.0 0.0 COR-TSVC.212
 .
 CF26600 'VOL TEMP 312' MULTIPLY 2 1.0 0.0
 CF26610 0.1 0.0 COR-AFLMIN.312.312 * FIRST NUMBER IS DZ
 CF26611 1.0 0.0 COR-TSVC.312
 .
 CF26700 'VOL TEMP 412' MULTIPLY 2 1.0 0.0
 CF26710 0.1 0.0 COR-AFLMIN.412.412 * FIRST NUMBER IS DZ
 CF26711 1.0 0.0 COR-TSVC.412
 .
 CF26800 'SUM VOL T 12' ADD 4 1.0 0.0
 CF26810 1.0 0.0 CFVALU.264
 CF26811 1.0 0.0 CFVALU.265
 CF26812 1.0 0.0 CFVALU.266
 CF26813 1.0 0.0 CFVALU.267
 .

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CF26900 'FLUID TEMP LEV12' DIVIDE 2 1.0 0.0
CF26910 1.0 0.0    CFVALU.263    * DEMONINATOR
CF26911 1.0 0.0    CFVALU.268    * NUMERATOR
.
.....
.
.....
* FLUID TEMPERATURE LEVEL 13
* 800 TO 900 mm
.....
.
CF27000 'LEVEL 13 VOL-T' ADD 4 1.0 0.0
CF27010 0.1 0.0    COR-AFLMIN.113.113 * FIRST NUMBER IS DZ
CF27011 0.1 0.0    COR-AFLMIN.213.213
CF27012 0.1 0.0    COR-AFLMIN.313.313
CF27013 0.1 0.0    COR-AFLMIN.413.413
.
CF27100 'VOL TEMP 113' MULTIPLY 2 1.0 0.0
CF27110 0.1 0.0    COR-AFLMIN 113 113 * FIRST NUMBER IS DZ
CF27111 1.0 0.0    COR-TSVC.113
.
CF27200 'VOL TEMP 213' MULTIPLY 2 1.0 0.0
CF27210 0.1 0.0    COR-AFLMIN 213.213 * FIRST NUMBER IS DZ
CF27211 1.0 0.0    COR-TSVC 213
.
CF27300 'VOL TEMP 313' MULTIPLY 2 1.0 0.0
CF27310 0.1 0.0    COR-AFLMIN 313 313 * FIRST NUMBER IS DZ
CF27311 1.0 0.0    COR-TSVC 313
.
CF27400 'VOL TEMP 413' MULTIPLY 2 1.0 0.0
CF27410 0.1 0.0    COR-AFLMIN 413 413 * FIRST NUMBER IS DZ
CF27411 1.0 0.0    COR-TSVC 413
.
CF27500 'SUM VOL T 13' ADD 4 1.0 0.0
CF27510 1.0 0.0    CFVALU.271
CF27511 1.0 0.0    CFVALU.272
CF27512 1.0 0.0    CFVALU.273
CF27513 1.0 0.0    CFVALU.274
.
CF27600 'FLUID TEMP LEV13' DIVIDE 2 1.0 0.0
CF27610 1.0 0.0    CFVALU.270    * DEMONINATOR
CF27611 1.0 0.0    CFVALU.275    * NUMERATOR
.
.....
.
.....
* FLUID TEMPERATURE LEVEL 14
* 900 TO 1000 mm
.....
.
CF27700 'LEVEL 14 VOL-T' ADD 4 1.0 0.0
CF27710 0.1 0.0    COR-AFLMIN.114.114 * FIRST NUMBER IS DZ
CF27711 0.1 0.0    COR-AFLMIN.214.214
CF27712 0.1 0.0    COR-AFLMIN.314.314
CF27713 0.1 0.0    COR-AFLMIN.414.414
.
CF27800 'VOL TEMP 114' MULTIPLY 2 1.0 0.0
CF27810 0.1 0.0    COR-AFLMIN.114.114 * FIRST NUMBER IS DZ
CF27811 1.0 0.0    COR-TSVC 114
.
CF27900 'VOL TEMP 214' MULTIPLY 2 1.0 0.0
CF27910 0.1 0.0    COR-AFLMIN 214 214 * FIRST NUMBER IS DZ
CF27911 1.0 0.0    COR-TSVC 214
.
CF28000 'VOL TEMP 314' MULTIPLY 2 1.0 0.0
CF28010 0.1 0.0    COR-AFLMIN.314.314 * FIRST NUMBER IS DZ

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CF28011 1.0 0.0 COR-TSVC.314
.
CF28100 'VOL TEMP 414' MULTIPLY 2 1.0 0.0
CF28110 0.1 0.0 COR-AFLMIN.414.414 * FIRST NUMBER IS DZ
CF28111 1.0 0.0 COR-TSVC.414
.
CF28200 'SUM VOL T 14' ADD 4 1.0 0.0
CF28210 1.0 0.0 CFVALU.278
CF28211 1.0 0.0 CFVALU.279
CF28212 1.0 0.0 CFVALU.280
CF28213 1.0 0.0 CFVALU.281
.
CF28300 'FLUID TEMP LEV14' DIVIDE 2 1.0 0.0
CF28310 1.0 0.0 CFVALU.277 * DEMONINATOR
CF28311 1.0 0.0 CFVALU.282 * NUMERATOR
.
.....
.
.....
* FLUID TEMPERATURE LEVEL 15
* 1000 TO 1100 mm
.....
.
CF28400 'LEVEL 15 VOL-T' ADD 4 1.0 0.0
CF28410 0.1 0.0 COR-AFLMIN.115.115 * FIRST NUMBER IS DZ
CF28411 0.1 0.0 COR-AFLMIN.215.215
CF28412 0.1 0.0 COR-AFLMIN.315.315
CF28413 0.1 0.0 COR-AFLMIN.415.415
.
CF28500 'VOL TEMP 115' MULTIPLY 2 1.0 0.0
CF28510 0.1 0.0 COR-AFLMIN.115.115 * FIRST NUMBER IS DZ
CF28511 1.0 0.0 COR-TSVC.115
.
CF28600 'VOL TEMP 215' MULTIPLY 2 1.0 0.0
CF28610 0.1 0.0 COR-AFLMIN.215.215 * FIRST NUMBER IS DZ
CF28611 1.0 0.0 COR-TSVC.215
.
CF28700 'VOL TEMP 315' MULTIPLY 2 1.0 0.0
CF28710 0.1 0.0 COR-AFLMIN.315.315 * FIRST NUMBER IS DZ
CF28711 1.0 0.0 COR-TSVC.315
.
CF28800 'VOL TEMP 415' MULTIPLY 2 1.0 0.0
CF28810 0.1 0.0 COR-AFLMIN.415.415 * FIRST NUMBER IS DZ
CF28811 1.0 0.0 COR-TSVC.415
.
CF28900 'SUM VOL T 15' ADD 4 1.0 0.0
CF28910 1.0 0.0 CFVALU.285
CF28911 1.0 0.0 CFVALU.286
CF28912 1.0 0.0 CFVALU.287
CF28913 1.0 0.0 CFVALU.288
.
CF29000 'FLUID TEMP LEV15' DIVIDE 2 1.0 0.0
CF29010 1.0 0.0 CFVALU.284 * DEMONINATOR
CF29011 1.0 0.0 CFVALU.289 * NUMERATOR
.
.....
.
.....
* FLUID TEMPERATURE LEVEL 16
* 1100 TO 1200 mm
.....
.
CF29100 'LEVEL 16 VOL-T' ADD 4 1.0 0.0
CF29110 0.1 0.0 COR-AFLMIN.116.116 * FIRST NUMBER IS DZ
CF29111 0.1 0.0 COR-AFLMIN.216.216
CF29112 0.1 0.0 COR-AFLMIN.316.316

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CF29113 0.1 0.0    COR-AFLMIN.416.416
.
CF29200 'VOL TEMP 116' MULTIPLY 2 1.0 0.0
CF29210 0.1 0.0    COR-AFLMIN.116.116    * FIRST NUMBER IS DZ
CF29211 1.0 0.0    COR-TSVC.116
.
CF29300 'VOL TEMP 216' MULTIPLY 2 1.0 0.0
CF29310 0.1 0.0    COR-AFLMIN.216.216    * FIRST NUMBER IS DZ
CF29311 1.0 0.0    COR-TSVC.216
.
CF29400 'VOL TEMP 316' MULTIPLY 2 1.0 0.0
CF29410 0.1 0.0    COR-AFLMIN.316.316    * FIRST NUMBER IS DZ
CF29411 1.0 0.0    COR-TSVC.316
.
CF29500 'VOL TEMP 416' MULTIPLY 2 1.0 0.0
CF29510 0.1 0.0    COR-AFLMIN.416.416    * FIRST NUMBER IS DZ
CF29511 1.0 0.0    COR-TSVC.416
.
CF29600 'SUM VOL T 16'  ADD 4 1.0 0.0
CF29610 1.0 0.0    CFVALU.292
CF29611 1.0 0.0    CFVALU.293
CF29612 1.0 0.0    CFVALU.294
CF29613 1.0 0.0    CFVALU.295
.
CF29700 'FLUID TEMP LEV16' DIVIDE 2 1.0 0.0
CF29710 1.0 0.0    CFVALU.291    * DEMONINATOR
CF29711 1.0 0.0    CFVALU.296    * NUMERATOR
.
.....
.
.....
* FLUID TEMPERATURE LEVEL 17
* 1200 TO 1300 mm
.....
.
CF29800 'LEVEL 17 VOL-T' ADD 4 1.0 0.0
CF29810 0.047 0.0    COR-AFLMIN.117.117    * FIRST NUMBER IS DZ
CF29811 0.047 0.0    COR-AFLMIN.217.217
CF29812 0.047 0.0    COR-AFLMIN.317.317
CF29813 0.047 0.0    COR-AFLMIN.417.417
.
CF29900 'VOL TEMP 117' MULTIPLY 2 1.0 0.0
CF29910 0.047 0.0    COR-AFLMIN.117.117    * FIRST NUMBER IS DZ
CF29911 1.0 0.0    COR-TSVC.117
.
CF30000 'VOL TEMP 217' MULTIPLY 2 1.0 0.0
CF30010 0.047 0.0    COR-AFLMIN.217.217    * FIRST NUMBER IS DZ
CF30011 1.0 0.0    COR-TSVC.217
.
CF30100 'VOL TEMP 317' MULTIPLY 2 1.0 0.0
CF30110 0.047 0.0    COR-AFLMIN.317.317    * FIRST NUMBER IS DZ
CF30111 1.0 0.0    COR-TSVC.317
.
CF30200 'VOL TEMP 417' MULTIPLY 2 1.0 0.0
CF30210 0.047 0.0    COR-AFLMIN.417.417    * FIRST NUMBER IS DZ
CF30211 1.0 0.0    COR-TSVC.417
.
CF30300 'SUM VOL T 17'  ADD 4 1.0 0.0
CF30310 1.0 0.0    CFVALU.299
CF30311 1.0 0.0    CFVALU.300
CF30312 1.0 0.0    CFVALU.301
CF30313 1.0 0.0    CFVALU.302
.
CF30400 'FLUID TEMP LEV17' DIVIDE 2 1.0 0.0
CF30410 1.0 0.0    CFVALU.298    * DEMONINATOR
CF30411 1.0 0.0    CFVALU.303    * NUMERATOR

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*.....
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*.....
* TABLE 2 ENTRY 1-15 ZR OXIDIZED RING 1
* CF305 - CF319
*.....
*
CF30500 'ZR OXID 103' EQUALS 1 4912 4366 0.0
CF30510 1.0 0.0 COR-MZRO2-CL 103
*
CF30600 'ZR OXID 104' EQUALS 1 4912 4366 0.0
CF30610 1.0 0.0 COR-MZRO2-CL 104
*
CF30700 'ZR OXID 105' EQUALS 1 4912 4366 0.0
CF30710 1.0 0.0 COR-MZRO2-CL 105
*
CF30800 'ZR OXID 106' EQUALS 1 4912 4366 0.0
CF30810 1.0 0.0 COR-MZRO2-CL 106
*
CF30900 'ZR OXID 107' EQUALS 1 4912 4366 0.0
CF30910 1.0 0.0 COR-MZRO2-CL 107
*
CF31000 'ZR OXID 108' EQUALS 1 4912 4366 0.0
CF31010 1.0 0.0 COR-MZRO2-CL 108
*
CF31100 'ZR OXID 109' EQUALS 1 4912 4366 0.0
CF31110 1.0 0.0 COR-MZRO2-CL 109
*
CF31200 'ZR OXID 110' EQUALS 1 4912 4366 0.0
CF31210 1.0 0.0 COR-MZRO2-CL 110
*
CF31300 'ZR OXID 111' EQUALS 1 4912 4366 0.0
CF31310 1.0 0.0 COR-MZRO2-CL 111
*
CF31400 'ZR OXID 112' EQUALS 1 4912 4366 0.0
CF31410 1.0 0.0 COR-MZRO2-CL 112
*
* NEXT LEVEL HAS MASS OF ZR SPACER IN IT
CF31500 'ZR OXID 113' EQUALS 1 4069 8074 0.0
CF31510 1.0 0.0 COR-MZRO2-CL 113
*
CF31600 'ZR OXID 114' EQUALS 1 4912 4366 0.0
CF31610 1.0 0.0 COR-MZRO2-CL 114
*
CF31700 'ZR OXID 115' EQUALS 1 4912 4366 0.0
CF31710 1.0 0.0 COR-MZRO2-CL 115
*
CF31800 'ZR OXID 116' EQUALS 1 4912 4366 0.0
CF31810 1.0 0.0 COR-MZRO2-CL 116
*
CF31900 'ZR OXID 117' EQUALS 1 4912 4366 0.0
CF31910 1.0 0.0 COR-MZRO2-CL 117
*
*.....
* TABLE 2 ENTRY 16-30 ZR OXIDIZED RING 2
* CF320 - CF334
*.....
*
CF32000 'ZR OXID 203' EQUALS 1 1228 1035 0.0
CF32010 1.0 0.0 COR-MZRO2-CL 203
*
CF32100 'ZR OXID 204' EQUALS 1 1228 1035 0.0
CF32110 1.0 0.0 COR-MZRO2-CL 204
*
CF32200 'ZR OXID 205' EQUALS 1 1228 1035 0.0

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CF32210 1 0 0 0 COR-MZRO2-CL 205
.
CF32300 'ZR OXID 206' EQUALS 1 1228 1035 0 0
CF32310 1 0 0 0 COR-MZRO2-CL 206
.
CF32400 'ZR OXID 207' EQUALS 1 1228 1035 0 0
CF32410 1 0 0 0 COR-MZRO2-CL 207
.
CF32500 'ZR OXID 208' EQUALS 1 1228 1035 0 0
CF32510 1 0 0 0 COR-MZRO2-CL 208
.
CF32600 'ZR OXID 209' EQUALS 1 1228 1035 0 0
CF32610 1 0 0 0 COR-MZRO2-CL 209
.
CF32700 'ZR OXID 210' EQUALS 1 1228 1035 0 0
CF32710 1 0 0 0 COR-MZRO2-CL 210
.
CF32800 'ZR OXID 211' EQUALS 1 1228 1035 0 0
CF32810 1 0 0 0 COR-MZRO2-CL 211
.
CF32900 'ZR OXID 212' EQUALS 1 1228 1035 0 0
CF32910 1 0 0 0 COR-MZRO2-CL 212
.
* NEXT LEVEL HAS MASS OF ZR SPACER IN IT
CF33000 'ZR OXID 213' EQUALS 1 986 2751 0 0
CF33010 1 0 0 0 COR-MZRO2-CL 213
.
CF33100 'ZR OXID 214' EQUALS 1 1228 1035 0 0
CF33110 1 0 0 0 COR-MZRO2-CL 214
.
CF33200 'ZR OXID 215' EQUALS 1 1228 1035 0 0
CF33210 1 0 0 0 COR-MZRO2-CL 215
.
CF33300 'ZR OXID 216' EQUALS 1 1228 1035 0 0
CF33310 1 0 0 0 COR-MZRO2-CL 216
.
CF33400 'ZR OXID 217' EQUALS 1 1228 1035 0 0
CF33410 1 0 0 0 COR-MZRO2-CL 217
.
.....
* TABLE 2 ENTRY 31-45 ZR OXIDIZED RING 3
* CF335 - CF349
.....
.
CF33500 'ZR OXID 303' EQUALS 1 554 3258 0 0
CF33510 1 0 0 0 COR-MZRO2-CL 303
.
CF33600 'ZR OXID 304' EQUALS 1 554 3258 0 0
CF33610 1 0 0 0 COR-MZRO2-CL 304
.
CF33700 'ZR OXID 305' EQUALS 1 554 3258 0 0
CF33710 1 0 0 0 COR-MZRO2-CL 305
.
CF33800 'ZR OXID 306' EQUALS 1 554 3258 0 0
CF33810 1 0 0 0 COR-MZRO2-CL 306
.
CF33900 'ZR OXID 307' EQUALS 1 554 3258 0 0
CF33910 1 0 0 0 COR-MZRO2-CL 307
.
CF34000 'ZR OXID 308' EQUALS 1 554 3258 0 0
CF34010 1 0 0 0 COR-MZRO2-CL 308
.
CF34100 'ZR OXID 309' EQUALS 1 554 3258 0 0
CF34110 1 0 0 0 COR-MZRO2-CL 309
.
CF34200 'ZR OXID 310' EQUALS 1 554 3258 0 0

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CF34210 1.0 0.0 COR-MZRO2-CL.310
.
CF34300 'ZR OXID 311' EQUALS 1 554.3258 0.0
CF34310 1.0 0.0 COR-MZRO2-CL.311
.
CF34400 'ZR OXID 312' EQUALS 1 554.3258 0.0
CF34410 1.0 0.0 COR-MZRO2-CL.312
.
* NEXT LEVEL HAS MASS OF ZR SPACER IN IT
CF34500 'ZR OXID 313' EQUALS 1 447.6099 0.0
CF34510 1.0 0.0 COR-MZRO2-CL.313
.
CF34600 'ZR OXID 314' EQUALS 1 554.3258 0.0
CF34610 1.0 0.0 COR-MZRO2-CL.314
.
CF34700 'ZR OXID 315' EQUALS 1 554.3258 0.0
CF34710 1.0 0.0 COR-MZRO2-CL.315
.
CF34800 'ZR OXID 316' EQUALS 1 554.3258 0.0
CF34810 1.0 0.0 COR-MZRO2-CL.316
.
CF34900 'ZR OXID 317' EQUALS 1 554.3258 0.0
CF34910 1.0 0.0 COR-MZRO2-CL.317
.
.....
* TABLE 2 ENTRY 46-60 ZR OXIDIZED RING 4
* CF350 - CF364
.....
.
CF35000 'ZR OXID 403' EQUALS 1 409.3685 0.0
CF35010 1.0 0.0 COR-MZRO2-CL.403
.
CF35100 'ZR OXID 404' EQUALS 1 409.3685 0.0
CF35110 1.0 0.0 COR-MZRO2-CL.404
.
CF35200 'ZR OXID 405' EQUALS 1 409.3685 0.0
CF35210 1.0 0.0 COR-MZRO2-CL.405
.
CF35300 'ZR OXID 406' EQUALS 1 409.3685 0.0
CF35310 1.0 0.0 COR-MZRO2-CL.406
.
CF35400 'ZR OXID 407' EQUALS 1 409.3685 0.0
CF35410 1.0 0.0 COR-MZRO2-CL.407
.
CF35500 'ZR OXID 408' EQUALS 1 409.3685 0.0
CF35510 1.0 0.0 COR-MZRO2-CL.408
.
CF35600 'ZR OXID 409' EQUALS 1 409.3685 0.0
CF35610 1.0 0.0 COR-MZRO2-CL.409
.
CF35700 'ZR OXID 410' EQUALS 1 409.3685 0.0
CF35710 1.0 0.0 COR-MZRO2-CL.410
.
CF35800 'ZR OXID 411' EQUALS 1 409.3685 0.0
CF35810 1.0 0.0 COR-MZRO2-CL.411
.
CF35900 'ZR OXID 412' EQUALS 1 409.3685 0.0
CF35910 1.0 0.0 COR-MZRO2-CL.412
.
CF36000 'ZR OXID 413' EQUALS 1 409.3685 0.0
CF36010 1.0 0.0 COR-MZRO2-CL.413
.
* NEXT LEVEL HAS MASS OF ZR SPACER IN IT
CF36100 'ZR OXID 414' EQUALS 1 269.1029 0.0
CF36110 1.0 0.0 COR-MZRO2-CL.414
.

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CF36200 'ZR OXID 415' EQUALS 1 409.3685 0.0
CF36210 1.0 0.0 COR-MZRO2-CL 415
.
CF36300 'ZR OXID 416' EQUALS 1 409.3685 0.0
CF36310 1.0 0.0 COR-MZRO2-CL 416
.
CF36400 'ZR OXID 417' EQUALS 1 409.3685 0.0
CF36410 1.0 0.0 COR-MZRO2-CL 417
.
.....
* TABLE 2 ENTRY 61-75 ZR OXIDIZED SHROUD
* CF365 - CF379
.....
.
CF36500 'ZR OXID CAN3' EQUALS 1 0.0 0.0
CF36510 1.0 0.0 COR-MZRO2-CN 403
.
CF36600 'ZR OXID CAN4' EQUALS 1 0.0 0.0
CF36610 1.0 0.0 COR-MZRO2-CN 404
.
CF36700 'ZR OXID CAN5' EQUALS 1 293.4213 0.0
CF36710 1.0 0.0 COR-MZRO2-CN 405
.
CF36800 'ZR OXID CAN6' EQUALS 1 293.4213 0.0
CF36810 1.0 0.0 COR-MZRO2-CN 406
.
CF36900 'ZR OXID CAN7' EQUALS 1 293.4213 0.0
CF36910 1.0 0.0 COR-MZRO2-CN 407
.
CF37000 'ZR OXID CAN8' EQUALS 1 293.4213 0.0
CF37010 1.0 0.0 COR-MZRO2-CN 408
.
CF37100 'ZR OXID CAN9' EQUALS 1 293.4213 0.0
CF37110 1.0 0.0 COR-MZRO2-CN 409
.
CF37200 'ZR OXIDCAN10' EQUALS 1 293.4213 0.0
CF37210 1.0 0.0 COR-MZRO2-CN 410
.
CF37300 'ZR OXIDCAN11' EQUALS 1 293.4213 0.0
CF37310 1.0 0.0 COR-MZRO2-CN 411
.
CF37400 'ZR OXIDCAN12' EQUALS 1 293.4213 0.0
CF37410 1.0 0.0 COR-MZRO2-CN 412
.
CF37500 'ZR OXIDCAN13' EQUALS 1 293.4213 0.0
CF37510 1.0 0.0 COR-MZRO2-CN 413
.
CF37600 'ZR OXIDCAN14' EQUALS 1 293.4213 0.0
CF37610 1.0 0.0 COR-MZRO2-CN 414
.
CF37700 'ZR OXIDCAN15' EQUALS 1 293.4213 0.0
CF37710 1.0 0.0 COR-MZRO2-CN 415
.
CF37800 'ZR OXIDCAN16' EQUALS 1 293.4213 0.0
CF37810 1.0 0.0 COR-MZRO2-CN 416
.
CF37900 'ZR OXIDCAN17' EQUALS 1 0.0 0.0
CF37910 1.0 0.0 COR-MZRO2-CN 417
.
.....
.
.....
* TABLE 2 ENTRY 361-375 INTACT UO2 TOTAL MASS
* CF380 - CF394
.....
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.....
* INTACT UO2 MASS LEVEL 3
* -200 TO -100 mm
.....
.
CF38000 'INTACT FU LEV 3' ADD 4 199.6874 0.0
CF38010 1.0 0.0 COR-MUO2-FU.103
CF38011 1.0 0.0 COR-MUO2-FU.203
CF38012 1.0 0.0 COR-MUO2-FU.303
CF38013 1.0 0.0 COR-MUO2-FU.403
.
.....
* INTACT UO2 MASS LEVEL 4
* -100 TO 0 mm
.....
.
CF38100 'INTACT FU LEV 4' ADD 4 199.6874 0.0
CF38110 1.0 0.0 COR-MUO2-FU.104
CF38111 1.0 0.0 COR-MUO2-FU.204
CF38112 1.0 0.0 COR-MUO2-FU.304
CF38113 1.0 0.0 COR-MUO2-FU.404
.
.....
* INTACT UO2 MASS LEVEL 5
* 0 TO 100 mm
.....
.
CF38200 'INTACT FU LEV 5' ADD 4 87.1204 0.0
CF38210 1.0 0.0 COR-MUO2-FU.105
CF38211 1.0 0.0 COR-MUO2-FU.205
CF38212 1.0 0.0 COR-MUO2-FU.305
CF38213 1.0 0.0 COR-MUO2-FU.405
.
.....
* INTACT UO2 MASS LEVEL 6
* 100 TO 200 mm
.....
.
CF38300 'INTACT FU LEV 6' ADD 4 87.1204 0.0
CF38310 1.0 0.0 COR-MUO2-FU.106
CF38311 1.0 0.0 COR-MUO2-FU.206
CF38312 1.0 0.0 COR-MUO2-FU.306
CF38313 1.0 0.0 COR-MUO2-FU.406
.
.....
* INTACT UO2 MASS LEVEL 7
* 200 TO 300 mm
.....
.
CF38400 'INTACT FU LEV 7' ADD 4 87.1204 0.0
CF38410 1.0 0.0 COR-MUO2-FU.107
CF38411 1.0 0.0 COR-MUO2-FU.207
CF38412 1.0 0.0 COR-MUO2-FU.307
CF38413 1.0 0.0 COR-MUO2-FU.407
.
.....
* INTACT UO2 MASS LEVEL 8
* 300 TO 400 mm
.....
.
CF38500 'INTACT FU LEV 8' ADD 4 87.1204 0.0
CF38510 1.0 0.0 COR-MUO2-FU.108
CF38511 1.0 0.0 COR-MUO2-FU.208
CF38512 1.0 0.0 COR-MUO2-FU.308
CF38513 1.0 0.0 COR-MUO2-FU.408
.

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.....
* INTACT UO2 MASS LEVEL 9
* 400 TO 500 mm
.....
.
CF38600 'INTACT FU LEV 9' ADD 4 87.1204 0.0
CF38610 1.0 0.0 COR-MUO2-FU.109
CF38611 1.0 0.0 COR-MUO2-FU.209
CF38612 1.0 0.0 COR-MUO2-FU.309
CF38613 1.0 0.0 COR-MUO2-FU.409
.
.....
* INTACT UO2 MASS LEVEL 10
* 500 TO 600 mm
.....
.
CF38700 'INTACT FU LEV10' ADD 4 87.1204 0.0
CF38710 1.0 0.0 COR-MUO2-FU.110
CF38711 1.0 0.0 COR-MUO2-FU.210
CF38712 1.0 0.0 COR-MUO2-FU.310
CF38713 1.0 0.0 COR-MUO2-FU.410
.
.....
* INTACT UO2 MASS LEVEL 11
* 600 TO 700 mm
.....
.
CF38800 'INTACT FU LEV11' ADD 4 87.1204 0.0
CF38810 1.0 0.0 COR-MUO2-FU.111
CF38811 1.0 0.0 COR-MUO2-FU.211
CF38812 1.0 0.0 COR-MUO2-FU.311
CF38813 1.0 0.0 COR-MUO2-FU.411
.
.....
* INTACT UO2 MASS LEVEL 12
* 700 TO 800 mm
.....
.
CF38900 'INTACT FU LEV12' ADD 4 87.1204 0.0
CF38910 1.0 0.0 COR-MUO2-FU.112
CF38911 1.0 0.0 COR-MUO2-FU.212
CF38912 1.0 0.0 COR-MUO2-FU.312
CF38913 1.0 0.0 COR-MUO2-FU.412
.
.....
* INTACT UO2 MASS LEVEL 13
* 800 TO 900 mm
.....
.
CF39000 'INTACT FU LEV13' ADD 4 87.1204 0.0
CF39010 1.0 0.0 COR-MUO2-FU.113
CF39011 1.0 0.0 COR-MUO2-FU.213
CF39012 1.0 0.0 COR-MUO2-FU.313
CF39013 1.0 0.0 COR-MUO2-FU.413
.
.....
* INTACT UO2 MASS LEVEL14
* 900 TO 1000 mm
.....
.
CF39100 'INTACT FU LEV14' ADD 4 87.1204 0.0
CF39110 1.0 0.0 COR-MUO2-FU.114
CF39111 1.0 0.0 COR-MUO2-FU.214
CF39112 1.0 0.0 COR-MUO2-FU.314
CF39113 1.0 0.0 COR-MUO2-FU.414
.

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.....
* INTACT UO2 MASS LEVEL15
* 1000 TO 1100 mm
.....
.
CF39200 'INTACT FU LEV15' ADD 4 199.6874 0.0
CF39210 1.0 0.0 COR-MUO2-FU.115
CF39211 1.0 0.0 COR-MUO2-FU.215
CF39212 1.0 0.0 COR-MUO2-FU.315
CF39213 1.0 0.0 COR-MUO2-FU.415
.
.....
* INTACT UO2 MASS LEVEL 16
* 1100 TO 1200 mm
.....
.
CF39300 'INTACT FU LEV16' ADD 4 199.6874 0.0
CF39310 1.0 0.0 COR-MUO2-FU.116
CF39311 1.0 0.0 COR-MUO2-FU.216
CF39312 1.0 0.0 COR-MUO2-FU.316
CF39313 1.0 0.0 COR-MUO2-FU.416
.
.....
* INTACT UO2 MASS LEVEL 17
* 1200 TO 1300 mm
.....
.
CF39400 'INTACT FU LEV17' ADD 4 199.6874 0.0
CF39410 1.0 0.0 COR-MUO2-FU.117
CF39411 1.0 0.0 COR-MUO2-FU.217
CF39412 1.0 0.0 COR-MUO2-FU.317
CF39413 1.0 0.0 COR-MUO2-FU.417
.
.....
.
.....
* TABLE 2 ENTRY 376-390 INTACT ZrO2 TOTAL MASS
* CF395 - CF409
.....
.
.....
* INTACT ZRO2 MASS LEVEL 3
* -200 TO -100 mm
.....
.
CF39500 '% ZRO2 LEV 3' ADD 5 190.0602 0.0
CF39510 1.0 0.0 COR-MZRO2-CL 103
CF39511 1.0 0.0 COR-MZRO2-CL.203
CF39512 1.0 0.0 COR-MZRO2-CL 303
CF39513 1.0 0.0 COR-MZRO2-CL 403
CF39514 1.0 0.0 COR-MZRO2-CN 403
.
.....
* INTACT ZRO2 MASS LEVEL 4
* -100 TO 0 mm
.....
.
CF39600 '% ZRO2 LEV 4' ADD 5 190.0602 0.0
CF39610 1.0 0.0 COR-MZRO2-CL 104
CF39611 1.0 0.0 COR-MZRO2-CL.204
CF39612 1.0 0.0 COR-MZRO2-CL 304
CF39613 1.0 0.0 COR-MZRO2-CL 404
CF39614 1.0 0.0 COR-MZRO2-CN 404
.
.....
* INTACT ZRO2 MASS LEVEL 5

```

* 0 TO 100 mm

.....

.

CF39700 '% ZRO2 LEV 5' ADD 5 115.3730 0.0

CF39710 1.0 0.0 COR-MZRO2-CL.105

CF39711 1.0 0.0 COR-MZRO2-CL.205

CF39712 1.0 0.0 COR-MZRO2-CL.305

CF39713 1.0 0.0 COR-MZRO2-CL.405

CF39714 1.0 0.0 COR-MZRO2-CN.405

.

.....

* INTACT ZRO2 MASS LEVEL 6

* 100 TO 200 mm

.....

.

CF39800 '% ZRO2 LEV 6' ADD 5 115.3730 0.0

CF39810 1.0 0.0 COR-MZRO2-CL.106

CF39811 1.0 0.0 COR-MZRO2-CL.206

CF39812 1.0 0.0 COR-MZRO2-CL.306

CF39813 1.0 0.0 COR-MZRO2-CL.406

CF39814 1.0 0.0 COR-MZRO2-CN.406

.

.....

* INTACT ZRO2 MASS LEVEL 7

* 200 TO 300 mm

.....

.

CF39900 '% ZRO2 LEV 7' ADD 5 115.3730 0.0

CF39910 1.0 0.0 COR-MZRO2-CL.107

CF39911 1.0 0.0 COR-MZRO2-CL.207

CF39912 1.0 0.0 COR-MZRO2-CL.307

CF39913 1.0 0.0 COR-MZRO2-CL.407

CF39914 1.0 0.0 COR-MZRO2-CN.407

.

.....

* INTACT ZRO2 MASS LEVEL 8

* 300 TO 400 mm

.....

.

CF40000 '% ZRO2 LEV 8' ADD 5 115.3730 0.0

CF40010 1.0 0.0 COR-MZRO2-CL.108

CF40011 1.0 0.0 COR-MZRO2-CL.208

CF40012 1.0 0.0 COR-MZRO2-CL.308

CF40013 1.0 0.0 COR-MZRO2-CL.408

CF40014 1.0 0.0 COR-MZRO2-CN.408

.

.....

* INTACT ZRO2 MASS LEVEL 9

* 400 TO 500 mm

.....

.

CF40100 '% ZRO2 LEV 9' ADD 5 115.3730 0.0

CF40110 1.0 0.0 COR-MZRO2-CL.109

CF40111 1.0 0.0 COR-MZRO2-CL.209

CF40112 1.0 0.0 COR-MZRO2-CL.309

CF40113 1.0 0.0 COR-MZRO2-CL.409

CF40114 1.0 0.0 COR-MZRO2-CN.409

.

.....

* INTACT ZRO2 MASS LEVEL 10

* 500 TO 600 mm

.....

.

CF40200 '% ZRO2 LEV10' ADD 5 115.3730 0.0

CF40210 1.0 0.0 COR-MZRO2-CL.110

CF40211 1.0 0.0 COR-MZRO2-CL.210

```

CF40212 1.0 0.0 COR-MZRO2-CL 310
CF40213 1.0 0.0 COR-MZRO2-CL 410
CF40214 1.0 0.0 COR-MZRO2-CN 410
.
.....
* INTACT ZRO2 MASS LEVEL 11
* 600 TO 700 mm
.....
.
CF40300 '% ZRO2 LEV11' ADD 5 115.3730 0.0
CF40310 1.0 0.0 COR-MZRO2-CL.111
CF40311 1.0 0.0 COR-MZRO2-CL.211
CF40312 1.0 0.0 COR-MZRO2-CL 311
CF40313 1.0 0.0 COR-MZRO2-CL 411
CF40314 1.0 0.0 COR-MZRO2-CN 411
.
.....
* INTACT ZRO2 MASS LEVEL 12
* 700 TO 800 mm
.....
.
CF40400 '% ZRO2 LEV12' ADD 5 115.3730 0.0
CF40410 1.0 0.0 COR-MZRO2-CL 112
CF40411 1.0 0.0 COR-MZRO2-CL 212
CF40412 1.0 0.0 COR-MZRO2-CL 312
CF40413 1.0 0.0 COR-MZRO2-CL 412
CF40414 1.0 0.0 COR-MZRO2-CN 412
.
.....
* INTACT ZRO2 MASS LEVEL 13
* 800 TO 900 mm
.....
.
CF40500 '% ZRO2 LEV13' ADD 5 94.2370 0.0
CF40510 1.0 0.0 COR-MZRO2-CL 113
CF40511 1.0 0.0 COR-MZRO2-CL 213
CF40512 1.0 0.0 COR-MZRO2-CL 313
CF40513 1.0 0.0 COR-MZRO2-CL 413
CF40514 1.0 0.0 COR-MZRO2-CN 413
.
.....
* INTACT ZRO2 MASS LEVEL14
* 900 TO 1000 mm
.....
.
CF40600 '% ZRO2 LEV14' ADD 5 115.3730 0.0
CF40610 1.0 0.0 COR-MZRO2-CL 114
CF40611 1.0 0.0 COR-MZRO2-CL 214
CF40612 1.0 0.0 COR-MZRO2-CL 314
CF40613 1.0 0.0 COR-MZRO2-CL 414
CF40614 1.0 0.0 COR-MZRO2-CN 414
.
.....
* INTACT ZRO2 MASS LEVEL15
* 1000 TO 1100 mm
.....
.
CF40700 '% ZRO2 LEV15' ADD 5 115.3730 0.0
CF40710 1.0 0.0 COR-MZRO2-CL.115
CF40711 1.0 0.0 COR-MZRO2-CL.215
CF40712 1.0 0.0 COR-MZRO2-CL 315
CF40713 1.0 0.0 COR-MZRO2-CL 415
CF40714 1.0 0.0 COR-MZRO2-CN 415
.
.....
* INTACT ZRO2 MASS LEVEL 16

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* 1100 TO 1200 mm

.....

.

CF40800 '% ZRO2 LEV16' ADD 5 115.3730 0.0

CF40810 1.0 0.0 COR-MZRO2-CL.116

CF40811 1.0 0.0 COR-MZRO2-CL.216

CF40812 1.0 0.0 COR-MZRO2-CL.316

CF40813 1.0 0.0 COR-MZRO2-CL.416

CF40814 1.0 0.0 COR-MZRO2-CN.416

.

.....

* INTACT ZRO2 MASS LEVEL 17

* 1200 TO 1300 mm

.....

.

CF40900 '% ZRO2 LEV17' ADD 5 190.0602 0.0

CF40910 1.0 0.0 COR-MZRO2-CL.117

CF40911 1.0 0.0 COR-MZRO2-CL.217

CF40912 1.0 0.0 COR-MZRO2-CL.317

CF40913 1.0 0.0 COR-MZRO2-CL.417

CF40914 1.0 0.0 COR-MZRO2-CN.417

.

.....

.

.....

* TABLE 2 ENTRY 391-405 INTACT Zr TOTAL MASS

* CF410 - CF424

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.....

* INTACT ZR MASS LEVEL 3

* -200 TO -100 mm

.....

.

CF41000 '% ZR LEV 3' ADD 5 256.5813 0.0

CF41010 1.0 0.0 COR-MZR-CL.103

CF41011 1.0 0.0 COR-MZR-CL.203

CF41012 1.0 0.0 COR-MZR-CL.303

CF41013 1.0 0.0 COR-MZR-CL.403

CF41014 1.0 0.0 COR-MZR-CN.403

.

.....

* INTACT ZR MASS LEVEL 4

* -100 TO 0 mm

.....

.

CF41100 '% ZR LEV 4' ADD 5 256.5813 0.0

CF41110 1.0 0.0 COR-MZR-CL.104

CF41111 1.0 0.0 COR-MZR-CL.204

CF41112 1.0 0.0 COR-MZR-CL.304

CF41113 1.0 0.0 COR-MZR-CL.404

CF41114 1.0 0.0 COR-MZR-CN.404

.

.....

* INTACT ZR MASS LEVEL 5

* 0 TO 100 mm

.....

.

CF41200 '% ZR LEV 5' ADD 5 156.1914 0.0

CF41210 1.0 0.0 COR-MZR-CL.105

CF41211 1.0 0.0 COR-MZR-CL.205

CF41212 1.0 0.0 COR-MZR-CL.305

CF41213 1.0 0.0 COR-MZR-CL.405

CF41214 1.0 0.0 COR-MZR-CN.405

.

.....

* INTACT ZR MASS LEVEL 6

* 100 TO 200 mm

.....

.

CF41300 '% ZR LEV 6' ADD 5 156.1914 0.0

CF41310 1.0 0.0 COR-MZR-CL.106

CF41311 1.0 0.0 COR-MZR-CL.206

CF41312 1.0 0.0 COR-MZR-CL.306

CF41313 1.0 0.0 COR-MZR-CL.406

CF41314 1.0 0.0 COR-MZR-CN.406

.

.....

* INTACT ZR MASS LEVEL 7

* 200 TO 300 mm

.....

.

CF41400 '% ZR LEV 7' ADD 5 156.1914 0.0

CF41410 1.0 0.0 COR-MZR-CL.107

CF41411 1.0 0.0 COR-MZR-CL.207

CF41412 1.0 0.0 COR-MZR-CL.307

CF41413 1.0 0.0 COR-MZR-CL.407

CF41414 1.0 0.0 COR-MZR-CN.407

.

.....

* INTACT ZR MASS LEVEL 8

* 300 TO 400 mm

.....

.

CF41500 '% ZR LEV 8' ADD 5 156.1914 0.0

CF41510 1.0 0.0 COR-MZR-CL.108

CF41511 1.0 0.0 COR-MZR-CL.208

CF41512 1.0 0.0 COR-MZR-CL.308

CF41513 1.0 0.0 COR-MZR-CL.408

CF41514 1.0 0.0 COR-MZR-CN.408

.

.....

* INTACT ZR MASS LEVEL 9

* 400 TO 500 mm

.....

.

CF41600 '% ZR LEV 9' ADD 5 156.1914 0.0

CF41610 1.0 0.0 COR-MZR-CL.109

CF41611 1.0 0.0 COR-MZR-CL.209

CF41612 1.0 0.0 COR-MZR-CL.309

CF41613 1.0 0.0 COR-MZR-CL.409

CF41614 1.0 0.0 COR-MZR-CN.409

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.....

* INTACT ZR MASS LEVEL 10

* 500 TO 600 mm

.....

.

CF41700 '% ZR LEV10' ADD 5 156.1914 0.0

CF41710 1.0 0.0 COR-MZR-CL.110

CF41711 1.0 0.0 COR-MZR-CL.210

CF41712 1.0 0.0 COR-MZR-CL.310

CF41713 1.0 0.0 COR-MZR-CL.410

CF41714 1.0 0.0 COR-MZR-CN.410

.

.....

* INTACT ZR MASS LEVEL 11

* 600 TO 700 mm

.....

.

CF41800 '% ZR LEV11' ADD 5 156.1914 0.0

CF41810 1.0 0.0 COR-MZR-CL.111

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CF41811 1.0 0.0 COR-MZR-CL.211
CF41812 1.0 0.0 COR-MZR-CL.311
CF41813 1.0 0.0 COR-MZR-CL.411
CF41814 1.0 0.0 COR-MZR-CN.411
.
.....
* INTACT ZR MASS LEVEL 12
* 700 TO 800 mm
.....
.
CF41900 '% ZR LEV12' ADD 5 156.1914 0.0
CF41910 1.0 0.0 COR-MZR-CL.112
CF41911 1.0 0.0 COR-MZR-CL.212
CF41912 1.0 0.0 COR-MZR-CL.312
CF41913 1.0 0.0 COR-MZR-CL.412
CF41914 1.0 0.0 COR-MZR-CN.412
.
.....
* INTACT ZR MASS LEVEL 13
* 800 TO 900 mm
.....
.
CF42000 '% ZR LEV13' ADD 5 127.2200 0.0
CF42010 1.0 0.0 COR-MZR-CL.113
CF42011 1.0 0.0 COR-MZR-CL.213
CF42012 1.0 0.0 COR-MZR-CL.313
CF42013 1.0 0.0 COR-MZR-CL.413
CF42014 1.0 0.0 COR-MZR-CN.413
.
.....
* INTACT ZR MASS LEVEL14
* 900 TO 1000 mm
.....
.
CF42100 '% ZR LEV14' ADD 5 156.1914 0.0
CF42110 1.0 0.0 COR-MZR-CL.114
CF42111 1.0 0.0 COR-MZR-CL.214
CF42112 1.0 0.0 COR-MZR-CL.314
CF42113 1.0 0.0 COR-MZR-CL.414
CF42114 1.0 0.0 COR-MZR-CN.414
.
.....
* INTACT ZR MASS LEVEL15
* 1000 TO 1100 mm
.....
.
CF42200 '% ZR LEV15' ADD 5 156.1914 0.0
CF42210 1.0 0.0 COR-MZR-CL.115
CF42211 1.0 0.0 COR-MZR-CL.215
CF42212 1.0 0.0 COR-MZR-CL.315
CF42213 1.0 0.0 COR-MZR-CL.415
CF42214 1.0 0.0 COR-MZR-CN.415
.
.....
* INTACT ZR MASS LEVEL 16
* 1100 TO 1200 mm
.....
.
CF42300 '% ZR LEV16' ADD 5 156.1914 0.0
CF42310 1.0 0.0 COR-MZR-CL.116
CF42311 1.0 0.0 COR-MZR-CL.216
CF42312 1.0 0.0 COR-MZR-CL.316
CF42313 1.0 0.0 COR-MZR-CL.416
CF42314 1.0 0.0 COR-MZR-CN.416
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* INTACT ZR MASS LEVEL 17
* 1200 TO 1300 mm
.....
*
CF42400 '% ZR LEV17' ADD 5 256.5813 0.0
CF42410 1.0 0.0 COR-MZR-CL.117
CF42411 1.0 0.0 COR-MZR-CL.217
CF42412 1.0 0.0 COR-MZR-CL.317
CF42413 1.0 0.0 COR-MZR-CL.417
CF42414 1.0 0.0 COR-MZR-CN.417
*
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*
.....
* TABLE 2 ENTRY 406-420 INTACT AIC TOTAL MASS
* CF425 - CF439
.....
*
.....
* INTACT AIC MASS LEVEL 3
* -200 TO -100 mm
.....
*
CF42500 '% AIC LEV 3' EQUALS 1 631.4726 0.0
CF42510 1.0 0.0 COR-MCRP-OS.303
*
.....
* INTACT AIC MASS LEVEL 4
* -100 TO 0 mm
.....
*
CF42600 '% AIC LEV 4' EQUALS 1 631.4726 0.0
CF42610 1.0 0.0 COR-MCRP-OS.304
*
.....
* INTACT AIC MASS LEVEL 5
* 0 TO 100 mm
.....
*
CF42700 '% AIC LEV 5' EQUALS 1 631.4726 0.0
CF42710 1.0 0.0 COR-MCRP-OS.305
*
.....
* INTACT AIC MASS LEVEL 6
* 100 TO 200 mm
.....
*
CF42800 '% AIC LEV 6' EQUALS 1 631.4726 0.0
CF42810 1.0 0.0 COR-MCRP-OS.306
*
.....
* INTACT AIC MASS LEVEL 7
* 200 TO 300 mm
.....
*
CF42900 '% AIC LEV 7' EQUALS 1 631.4726 0.0
CF42910 1.0 0.0 COR-MCRP-OS.307
*
.....
* INTACT AIC MASS LEVEL 8
* 300 TO 400 mm
.....
*
CF43000 '% AIC LEV 8' EQUALS 1 631.4726 0.0
CF43010 1.0 0.0 COR-MCRP-OS.308
*

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.....
* INTACT AIC MASS LEVEL 9
* 400 TO 500 mm
.....
.
CF43100 '% AIC LEV 9' EQUALS 1 631.4726 0.0
CF43110 1.0 0.0 COR-MCRP-OS.309
.
.....
* INTACT AIC MASS LEVEL 10
* 500 TO 600 mm
.....
.
CF43200 '% AIC LEV10' EQUALS 1 631.4726 0.0
CF43210 1.0 0.0 COR-MCRP-OS.310
.
.....
* INTACT AIC MASS LEVEL 11
* 600 TO 700 mm
.....
.
CF43300 '% AIC LEV 11' EQUALS 1 631.4726 0.0
CF43310 1.0 0.0 COR-MCRP-OS.311
.
.....
* INTACT AIC MASS LEVEL 12
* 700 TO 800 mm
.....
.
CF43400 '% AIC LEV 12' EQUALS 1 631.4726 0.0
CF43410 1.0 0.0 COR-MCRP-OS.312
.
.....
* INTACT AIC MASS LEVEL 13
* 800 TO 900 mm
.....
.
CF43500 '% AIC LEV 13' EQUALS 1 631.4726 0.0
CF43510 1.0 0.0 COR-MCRP-OS.313
.
.....
* INTACT AIC MASS LEVEL14
* 900 TO 1000 mm
.....
.
CF43600 '% AIC LEV 14' EQUALS 1 631.4726 0.0
CF43610 1.0 0.0 COR-MCRP-OS.314
.
.....
* INTACT AIC MASS LEVEL15
* 1000 TO 1100 mm
.....
.
CF43700 '% AIC LEV 15' EQUALS 1 631.4726 0.0
CF43710 1.0 0.0 COR-MCRP-OS.315
.
.....
* INTACT AIC MASS LEVEL 16
* 1100 TO 1200 mm
.....
.
CF43800 '% AIC LEV 16' EQUALS 1 631.4726 0.0
CF43810 1.0 0.0 COR-MCRP-OS.316
.
.....
* INTACT AIC MASS LEVEL 17

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* 1200 TO 1300 mm

.....

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CF43900 '% AIC LEV 17' EQUALS 1 631.4726 0.0

CF43910 1.0 0.0 COR-MCRP-OS.317

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* TABLE 2 ENTRY 421-435 TOTAL U-Z-O-AIC MASS RELOCATED

* CF440 - CF454

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* UO2/ZR/AIC/ZRO2 TOTAL MASS LEVEL 3

* -200 TO -100 mm

.....

•

CF44000 '% TOTAL LEV 3' ADD 31 63.47836 0.0

CF44010 1.0 0.0 COR-MZR-CL.103

CF44011 1.0 0.0 COR-MZR-CL.203

CF44012 1.0 0.0 COR-MZR-CL.303

CF44013 1.0 0.0 COR-MZR-CL.403

CF44014 1.0 0.0 COR-MZR-CN.403

CF44015 1.0 0.0 COR-MUO2-FU.103

CF44016 1.0 0.0 COR-MUO2-FU.203

CF44017 1.0 0.0 COR-MUO2-FU.303

CF44018 1.0 0.0 COR-MUO2-FU.403

CF44019 1.0 0.0 COR-MZRO2-CL.103

CF44020 1.0 0.0 COR-MZRO2-CL.203

CF44021 1.0 0.0 COR-MZRO2-CL.303

CF44022 1.0 0.0 COR-MZRO2-CL.403

CF44023 1.0 0.0 COR-MZRO2-CN.403

CF44024 1.0 0.0 COR-MCRP-OS.303

CF44025 1.0 0.0 COR-MUO2-DB.103

CF44026 1.0 0.0 COR-MUO2-DB.203

CF44027 1.0 0.0 COR-MUO2-DB.303

CF44028 1.0 0.0 COR-MUO2-DB.403

CF44029 1.0 0.0 COR-MZR-DB.103

CF44030 1.0 0.0 COR-MZR-DB.203

CF44031 1.0 0.0 COR-MZR-DB.303

CF44032 1.0 0.0 COR-MZR-DB.403

CF44033 1.0 0.0 COR-MZRO2-DB.103

CF44034 1.0 0.0 COR-MZRO2-DB.203

CF44035 1.0 0.0 COR-MZRO2-DB.303

CF44036 1.0 0.0 COR-MZRO2-DB.403

CF44037 1.0 0.0 COR-MCRP-DB.103

CF44038 1.0 0.0 COR-MCRP-DB.203

CF44039 1.0 0.0 COR-MCRP-DB.303

CF44040 1.0 0.0 COR-MCRP-DB.403

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.....

* UO2/ZR/AIC/ZRO2 TOTAL MASS LEVEL 4

* -100 TO 0 mm

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•

CF44100 '% TOTAL LEV 4' ADD 31 63.37836 0.0

CF44110 1.0 0.0 COR-MZR-CL.104

CF44111 1.0 0.0 COR-MZR-CL.204

CF44112 1.0 0.0 COR-MZR-CL.304

CF44113 1.0 0.0 COR-MZR-CL.404

CF44114 1.0 0.0 COR-MZR-CN.404

CF44115 1.0 0.0 COR-MUO2-FU.104

CF44116 1.0 0.0 COR-MUO2-FU.204

CF44117 1.0 0.0 COR-MUO2-FU.304

CF44118 1.0 0.0 COR-MUO2-FU.404

CF44119	1.0	0.0	COR-MZRO2-CL.104
CF44120	1.0	0.0	COR-MZRO2-CL.204
CF44121	1.0	0.0	COR-MZRO2-CL.304
CF44122	1.0	0.0	COR-MZRO2-CL.404
CF44123	1.0	0.0	COR-MZRO2-CN.404
CF44124	1.0	0.0	COR-MCRP-OS.304
CF44125	1.0	0.0	COR-MUO2-DB.104
CF44126	1.0	0.0	COR-MUO2-DB.204
CF44127	1.0	0.0	COR-MUO2-DB.304
CF44128	1.0	0.0	COR-MUO2-DB.404
CF44129	1.0	0.0	COR-MZR-DB.104
CF44130	1.0	0.0	COR-MZR-DB.204
CF44131	1.0	0.0	COR-MZR-DB.304
CF44132	1.0	0.0	COR-MZR-DB.404
CF44133	1.0	0.0	COR-MZRO2-DB.104
CF44134	1.0	0.0	COR-MZRO2-DB.204
CF44135	1.0	0.0	COR-MZRO2-DB.304
CF44136	1.0	0.0	COR-MZRO2-DB.404
CF44137	1.0	0.0	COR-MCRP-DB.104
CF44138	1.0	0.0	COR-MCRP-DB.204
CF44139	1.0	0.0	COR-MCRP-DB.304
CF44140	1.0	0.0	COR-MCRP-DB.404

.....
 * UO2/ZR/AIC/ZRO2 TOTAL MASS LEVEL 5
 * 0 TO 100 mm

CF44200 '% TOTAL LEV 5' ADD 31 35.5776 0 0

CF44210	1.0	0.0	COR-MZR-CL.105
CF44211	1.0	0.0	COR-MZR-CL.205
CF44212	1.0	0.0	COR-MZR-CL.305
CF44213	1.0	0.0	COR-MZR-CL.405
CF44214	1.0	0.0	COR-MZR-CN.405
CF44215	1.0	0.0	COR-MUO2-FU.105
CF44216	1.0	0.0	COR-MUO2-FU.205
CF44217	1.0	0.0	COR-MUO2-FU.305
CF44218	1.0	0.0	COR-MUO2-FU.405
CF44219	1.0	0.0	COR-MZRO2-CL.105
CF44220	1.0	0.0	COR-MZRO2-CL.205
CF44221	1.0	0.0	COR-MZRO2-CL.305
CF44222	1.0	0.0	COR-MZRO2-CL.405
CF44223	1.0	0.0	COR-MZRO2-CN.405
CF44224	1.0	0.0	COR-MCRP-OS.305
CF44225	1.0	0.0	COR-MUO2-DB.105
CF44226	1.0	0.0	COR-MUO2-DB.205
CF44227	1.0	0.0	COR-MUO2-DB.305
CF44228	1.0	0.0	COR-MUO2-DB.405
CF44229	1.0	0.0	COR-MZR-DB.105
CF44230	1.0	0.0	COR-MZR-DB.205
CF44231	1.0	0.0	COR-MZR-DB.305
CF44232	1.0	0.0	COR-MZR-DB.405
CF44233	1.0	0.0	COR-MZRO2-DB.105
CF44234	1.0	0.0	COR-MZRO2-DB.205
CF44235	1.0	0.0	COR-MZRO2-DB.305
CF44236	1.0	0.0	COR-MZRO2-DB.405
CF44237	1.0	0.0	COR-MCRP-DB.105
CF44238	1.0	0.0	COR-MCRP-DB.205
CF44239	1.0	0.0	COR-MCRP-DB.305
CF44240	1.0	0.0	COR-MCRP-DB.405

.....
 * UO2/ZR/AIC/ZRO2 TOTAL MASS LEVEL 6
 * 100 TO 200 mm

CF44300 '% TOTAL LEV 6' ADD 31 35.5776 0.0
 CF44310 1.0 0.0 COR-MZR-CL.106
 CF44311 1.0 0.0 COR-MZR-CL.206
 CF44312 1.0 0.0 COR-MZR-CL.306
 CF44313 1.0 0.0 COR-MZR-CL.406
 CF44314 1.0 0.0 COR-MZR-CN.406
 CF44315 1.0 0.0 COR-MUO2-FU.106
 CF44316 1.0 0.0 COR-MUO2-FU.206
 CF44317 1.0 0.0 COR-MUO2-FU.306
 CF44318 1.0 0.0 COR-MUO2-FU.406
 CF44319 1.0 0.0 COR-MZRO2-CL.106
 CF44320 1.0 0.0 COR-MZRO2-CL.206
 CF44321 1.0 0.0 COR-MZRO2-CL.306
 CF44322 1.0 0.0 COR-MZRO2-CL.406
 CF44323 1.0 0.0 COR-MZRO2-CN.406
 CF44324 1.0 0.0 COR-MCRP-OS.306
 CF44325 1.0 0.0 COR-MUO2-DB.106
 CF44326 1.0 0.0 COR-MUO2-DB.206
 CF44327 1.0 0.0 COR-MUO2-DB.306
 CF44328 1.0 0.0 COR-MUO2-DB.406
 CF44329 1.0 0.0 COR-MZR-DB.106
 CF44330 1.0 0.0 COR-MZR-DB.206
 CF44331 1.0 0.0 COR-MZR-DB.306
 CF44332 1.0 0.0 COR-MZR-DB.406
 CF44333 1.0 0.0 COR-MZRO2-DB.106
 CF44334 1.0 0.0 COR-MZRO2-DB.206
 CF44335 1.0 0.0 COR-MZRO2-DB.306
 CF44336 1.0 0.0 COR-MZRO2-DB.406
 CF44337 1.0 0.0 COR-MCRP-DB.106
 CF44338 1.0 0.0 COR-MCRP-DB.206
 CF44339 1.0 0.0 COR-MCRP-DB.306
 CF44340 1.0 0.0 COR-MCRP-DB.406

.....
 * UO2/ZR/AIC/ZRO2 TOTAL MASS LEVEL 7
 * 200 TO 300 mm

CF44400 '% TOTAL LEV 7' ADD 31 35.5776 0.0
 CF44410 1.0 0.0 COR-MZR-CL.107
 CF44411 1.0 0.0 COR-MZR-CL.207
 CF44412 1.0 0.0 COR-MZR-CL.307
 CF44413 1.0 0.0 COR-MZR-CL.407
 CF44414 1.0 0.0 COR-MZR-CN.407
 CF44415 1.0 0.0 COR-MUO2-FU.107
 CF44416 1.0 0.0 COR-MUO2-FU.207
 CF44417 1.0 0.0 COR-MUO2-FU.307
 CF44418 1.0 0.0 COR-MUO2-FU.407
 CF44419 1.0 0.0 COR-MZRO2-CL.107
 CF44420 1.0 0.0 COR-MZRO2-CL.207
 CF44421 1.0 0.0 COR-MZRO2-CL.307
 CF44422 1.0 0.0 COR-MZRO2-CL.407
 CF44423 1.0 0.0 COR-MZRO2-CN.407
 CF44424 1.0 0.0 COR-MCRP-OS.307
 CF44425 1.0 0.0 COR-MUO2-DB.107
 CF44426 1.0 0.0 COR-MUO2-DB.207
 CF44427 1.0 0.0 COR-MUO2-DB.307
 CF44428 1.0 0.0 COR-MUO2-DB.407
 CF44429 1.0 0.0 COR-MZR-DB.107
 CF44430 1.0 0.0 COR-MZR-DB.207
 CF44431 1.0 0.0 COR-MZR-DB.307
 CF44432 1.0 0.0 COR-MZR-DB.407
 CF44433 1.0 0.0 COR-MZRO2-DB.107
 CF44434 1.0 0.0 COR-MZRO2-DB.207
 CF44435 1.0 0.0 COR-MZRO2-DB.307
 CF44436 1.0 0.0 COR-MZRO2-DB.407

CF44437	1.0	0.0	COR-MCRP-DB.107
CF44438	1.0	0.0	COR-MCRP-DB.207
CF44439	1.0	0.0	COR-MCRP-DB.307
CF44440	1.0	0.0	COR-MCRP-DB.407
.			

* UO2/ZR/AIC/ZRO2 TOTAL MASS LEVEL 8			
* 300 TO 400 mm			

.			
CF44500	% TOTAL LEV 8' ADD 31 35.5776 0.0		
CF44510	1.0	0.0	COR-MZR-CL.108
CF44511	1.0	0.0	COR-MZR-CL.208
CF44512	1.0	0.0	COR-MZR-CL.308
CF44513	1.0	0.0	COR-MZR-CL.408
CF44514	1.0	0.0	COR-MZR-CN.408
CF44515	1.0	0.0	COR-MUO2-FU.108
CF44516	1.0	0.0	COR-MUO2-FU.208
CF44517	1.0	0.0	COR-MUO2-FU.308
CF44518	1.0	0.0	COR-MUO2-FU.408
CF44519	1.0	0.0	COR-MZRO2-CL.108
CF44520	1.0	0.0	COR-MZRO2-CL.208
CF44521	1.0	0.0	COR-MZRO2-CL.308
CF44522	1.0	0.0	COR-MZRO2-CL.408
CF44523	1.0	0.0	COR-MZRO2-CN.408
CF44524	1.0	0.0	COR-MCRP-OS.308
CF44525	1.0	0.0	COR-MUO2-DB.108
CF44526	1.0	0.0	COR-MUO2-DB.208
CF44527	1.0	0.0	COR-MUO2-DB.308
CF44528	1.0	0.0	COR-MUO2-DB.408
CF44529	1.0	0.0	COR-MZR-DB.108
CF44530	1.0	0.0	COR-MZR-DB.208
CF44531	1.0	0.0	COR-MZR-DB.308
CF44532	1.0	0.0	COR-MZR-DB.408
CF44533	1.0	0.0	COR-MZRO2-DB.108
CF44534	1.0	0.0	COR-MZRO2-DB.208
CF44535	1.0	0.0	COR-MZRO2-DB.308
CF44536	1.0	0.0	COR-MZRO2-DB.408
CF44537	1.0	0.0	COR-MCRP-DB.108
CF44538	1.0	0.0	COR-MCRP-DB.208
CF44539	1.0	0.0	COR-MCRP-DB.308
CF44540	1.0	0.0	COR-MCRP-DB.408
.			

* UO2/ZR/AIC/ZRO2 TOTAL MASS LEVEL 9			
* 400 TO 500 mm			

.			
CF44600	% TOTAL LEV 9' ADD 31 35.5776 0.0		
CF44610	1.0	0.0	COR-MZR-CL.109
CF44611	1.0	0.0	COR-MZR-CL.209
CF44612	1.0	0.0	COR-MZR-CL.309
CF44613	1.0	0.0	COR-MZR-CL.409
CF44614	1.0	0.0	COR-MZR-CN.409
CF44615	1.0	0.0	COR-MUO2-FU.109
CF44616	1.0	0.0	COR-MUO2-FU.209
CF44617	1.0	0.0	COR-MUO2-FU.309
CF44618	1.0	0.0	COR-MUO2-FU.409
CF44619	1.0	0.0	COR-MZRO2-CL.109
CF44620	1.0	0.0	COR-MZRO2-CL.209
CF44621	1.0	0.0	COR-MZRO2-CL.309
CF44622	1.0	0.0	COR-MZRO2-CL.409
CF44623	1.0	0.0	COR-MZRO2-CN.409
CF44624	1.0	0.0	COR-MCRP-OS.309
CF44625	1.0	0.0	COR-MUO2-DB.109
CF44626	1.0	0.0	COR-MUO2-DB.209

CF44627	1.0	0.0	COR-MUO2-DB.309
CF44628	1.0	0.0	COR-MUO2-DB.409
CF44629	1.0	0.0	COR-MZR-DB.109
CF44630	1.0	0.0	COR-MZR-DB.209
CF44631	1.0	0.0	COR-MZR-DB.309
CF44632	1.0	0.0	COR-MZR-DB.409
CF44633	1.0	0.0	COR-MZRO2-DB.109
CF44634	1.0	0.0	COR-MZRO2-DB.209
CF44635	1.0	0.0	COR-MZRO2-DB.309
CF44636	1.0	0.0	COR-MZRO2-DB.409
CF44637	1.0	0.0	COR-MCRP-DB.109
CF44638	1.0	0.0	COR-MCRP-DB.209
CF44639	1.0	0.0	COR-MCRP-DB.309
CF44640	1.0	0.0	COR-MCRP-DB.409

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* UO2/ZR/AIC/ZRO2 TOTAL MASS LEVEL 10

* 500 TO 600 mm

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CF44700	'% TOTAL LEV10'	ADD	31	35.5776	0.0
CF44710	1.0	0.0			COR-MZR-CL.110
CF44711	1.0	0.0			COR-MZR-CL.210
CF44712	1.0	0.0			COR-MZR-CL.310
CF44713	1.0	0.0			COR-MZR-CL.410
CF44714	1.0	0.0			COR-MZR-CN.410
CF44715	1.0	0.0			COR-MUO2-FU.110
CF44716	1.0	0.0			COR-MUO2-FU.210
CF44717	1.0	0.0			COR-MUO2-FU.310
CF44718	1.0	0.0			COR-MUO2-FU.410
CF44719	1.0	0.0			COR-MZRO2-CL.110
CF44720	1.0	0.0			COR-MZRO2-CL.210
CF44721	1.0	0.0			COR-MZRO2-CL.310
CF44722	1.0	0.0			COR-MZRO2-CL.410
CF44723	1.0	0.0			COR-MZRO2-CN.410
CF44724	1.0	0.0			COR-MCRP-OS.310
CF44725	1.0	0.0			COR-MUO2-DB.110
CF44726	1.0	0.0			COR-MUO2-DB.210
CF44727	1.0	0.0			COR-MUO2-DB.310
CF44728	1.0	0.0			COR-MUO2-DB.410
CF44729	1.0	0.0			COR-MZR-DB.110
CF44730	1.0	0.0			COR-MZR-DB.210
CF44731	1.0	0.0			COR-MZR-DB.310
CF44732	1.0	0.0			COR-MZR-DB.410
CF44733	1.0	0.0			COR-MZRO2-DB.110
CF44734	1.0	0.0			COR-MZRO2-DB.210
CF44735	1.0	0.0			COR-MZRO2-DB.310
CF44736	1.0	0.0			COR-MZRO2-DB.410
CF44737	1.0	0.0			COR-MCRP-DB.110
CF44738	1.0	0.0			COR-MCRP-DB.210
CF44739	1.0	0.0			COR-MCRP-DB.310
CF44740	1.0	0.0			COR-MCRP-DB.410

.....

* UO2/ZR/AIC/ZRO2 TOTAL MASS LEVEL 11

* 600 TO 700 mm

.....

CF44800	'% TOTAL LEV11'	ADD	31	35.5776	0.0
CF44810	1.0	0.0			COR-MZR-CL.111
CF44811	1.0	0.0			COR-MZR-CL.211
CF44812	1.0	0.0			COR-MZR-CL.311
CF44813	1.0	0.0			COR-MZR-CL.411
CF44814	1.0	0.0			COR-MZR-CN.411
CF44815	1.0	0.0			COR-MUO2-FU.111
CF44816	1.0	0.0			COR-MUO2-FU.211

CF44817	1.0	0.0	COR-MUO2-FU.311
CF44818	1.0	0.0	COR-MUO2-FU.411
CF44819	1.0	0.0	COR-MZRO2-CL.111
CF44820	1.0	0.0	COR-MZRO2-CL.211
CF44821	1.0	0.0	COR-MZRO2-CL.311
CF44822	1.0	0.0	COR-MZRO2-CL.411
CF44823	1.0	0.0	COR-MZRO2-CN.411
CF44824	1.0	0.0	COR-MCRP-OS.311
CF44825	1.0	0.0	COR-MUO2-DB.111
CF44826	1.0	0.0	COR-MUO2-DB.211
CF44827	1.0	0.0	COR-MUO2-DB.311
CF44828	1.0	0.0	COR-MUO2-DB.411
CF44829	1.0	0.0	COR-MZR-DB.111
CF44830	1.0	0.0	COR-MZR-DB.211
CF44831	1.0	0.0	COR-MZR-DB.311
CF44832	1.0	0.0	COR-MZR-DB.411
CF44833	1.0	0.0	COR-MZRO2-DB.111
CF44834	1.0	0.0	COR-MZRO2-DB.211
CF44835	1.0	0.0	COR-MZRO2-DB.311
CF44836	1.0	0.0	COR-MZRO2-DB.411
CF44837	1.0	0.0	COR-MCRP-DB.111
CF44838	1.0	0.0	COR-MCRP-DB.211
CF44839	1.0	0.0	COR-MCRP-DB.311
CF44840	1.0	0.0	COR-MCRP-DB.411

.....

* UO2/ZR/AIC/ZRO2 TOTAL MASS LEVEL 12

* 700 TO 800 mm

.....

.

CF44900 '% TOTAL LEV12' ADD 31 35 5776 0.0

CF44910	1.0	0.0	COR-MZR-CL.112
CF44911	1.0	0.0	COR-MZR-CL.212
CF44912	1.0	0.0	COR-MZR-CL.312
CF44913	1.0	0.0	COR-MZR-CL.412
CF44914	1.0	0.0	COR-MZR-CN.412
CF44915	1.0	0.0	COR-MUO2-FU.112
CF44916	1.0	0.0	COR-MUO2-FU.212
CF44917	1.0	0.0	COR-MUO2-FU.312
CF44918	1.0	0.0	COR-MUO2-FU.412
CF44919	1.0	0.0	COR-MZRO2-CL.112
CF44920	1.0	0.0	COR-MZRO2-CL.212
CF44921	1.0	0.0	COR-MZRO2-CL.312
CF44922	1.0	0.0	COR-MZRO2-CL.412
CF44923	1.0	0.0	COR-MZRO2-CN.412
CF44924	1.0	0.0	COR-MCRP-OS.312
CF44925	1.0	0.0	COR-MUO2-DB.112
CF44926	1.0	0.0	COR-MUO2-DB.212
CF44927	1.0	0.0	COR-MUO2-DB.312
CF44928	1.0	0.0	COR-MUO2-DB.412
CF44929	1.0	0.0	COR-MZR-DB.112
CF44930	1.0	0.0	COR-MZR-DB.212
CF44931	1.0	0.0	COR-MZR-DB.312
CF44932	1.0	0.0	COR-MZR-DB.412
CF44933	1.0	0.0	COR-MZRO2-DB.112
CF44934	1.0	0.0	COR-MZRO2-DB.212
CF44935	1.0	0.0	COR-MZRO2-DB.312
CF44936	1.0	0.0	COR-MZRO2-DB.412
CF44937	1.0	0.0	COR-MCRP-DB.112
CF44938	1.0	0.0	COR-MCRP-DB.212
CF44939	1.0	0.0	COR-MCRP-DB.312
CF44940	1.0	0.0	COR-MCRP-DB.412

.....

* UO2/ZR/AIC/ZRO2 TOTAL MASS LEVEL 13

* 800 TO 900 mm

.....

.

CF45000 '% TOTAL LEV13' ADD 31 31.7119 0.0

CF45010	1.0	0.0	COR-MZR-CL.113
CF45011	1.0	0.0	COR-MZR-CL.213
CF45012	1.0	0.0	COR-MZR-CL.313
CF45013	1.0	0.0	COR-MZR-CL.413
CF45014	1.0	0.0	COR-MZR-CN.413
CF45015	1.0	0.0	COR-MUO2-FU.113
CF45016	1.0	0.0	COR-MUO2-FU.213
CF45017	1.0	0.0	COR-MUO2-FU.313
CF45018	1.0	0.0	COR-MUO2-FU.413
CF45019	1.0	0.0	COR-MZRO2-CL.113
CF45020	1.0	0.0	COR-MZRO2-CL.213
CF45021	1.0	0.0	COR-MZRO2-CL.313
CF45022	1.0	0.0	COR-MZRO2-CL.413
CF45023	1.0	0.0	COR-MZRO2-CN.413
CF45024	1.0	0.0	COR-MCRP-OS.313
CF45025	1.0	0.0	COR-MUO2-DB.113
CF45026	1.0	0.0	COR-MUO2-DB.213
CF45027	1.0	0.0	COR-MUO2-DB.313
CF45028	1.0	0.0	COR-MUO2-DB.413
CF45029	1.0	0.0	COR-MZR-DB.113
CF45030	1.0	0.0	COR-MZR-DB.213
CF45031	1.0	0.0	COR-MZR-DB.313
CF45032	1.0	0.0	COR-MZR-DB.413
CF45033	1.0	0.0	COR-MZRO2-DB.113
CF45034	1.0	0.0	COR-MZRO2-DB.213
CF45035	1.0	0.0	COR-MZRO2-DB.313
CF45036	1.0	0.0	COR-MZRO2-DB.413
CF45037	1.0	0.0	COR-MCRP-DB.113
CF45038	1.0	0.0	COR-MCRP-DB.213
CF45039	1.0	0.0	COR-MCRP-DB.313
CF45040	1.0	0.0	COR-MCRP-DB.413

.

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* UO2/ZR/AIC/ZRO2 TOTAL MASS LEVEL 14

* 900 TO 1000 mm

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.

CF45100 '% TOTAL LEV14' ADD 31 35.5776 0.0

CF45110	1.0	0.0	COR-MZR-CL.114
CF45111	1.0	0.0	COR-MZR-CL.214
CF45112	1.0	0.0	COR-MZR-CL.314
CF45113	1.0	0.0	COR-MZR-CL.414
CF45114	1.0	0.0	COR-MZR-CN.414
CF45115	1.0	0.0	COR-MUO2-FU.114
CF45116	1.0	0.0	COR-MUO2-FU.214
CF45117	1.0	0.0	COR-MUO2-FU.314
CF45118	1.0	0.0	COR-MUO2-FU.414
CF45119	1.0	0.0	COR-MZRO2-CL.114
CF45120	1.0	0.0	COR-MZRO2-CL.214
CF45121	1.0	0.0	COR-MZRO2-CL.314
CF45122	1.0	0.0	COR-MZRO2-CL.414
CF45123	1.0	0.0	COR-MZRO2-CN.414
CF45124	1.0	0.0	COR-MCRP-OS.314
CF45125	1.0	0.0	COR-MUO2-DB.114
CF45126	1.0	0.0	COR-MUO2-DB.214
CF45127	1.0	0.0	COR-MUO2-DB.314
CF45128	1.0	0.0	COR-MUO2-DB.414
CF45129	1.0	0.0	COR-MZR-DB.114
CF45130	1.0	0.0	COR-MZR-DB.214
CF45131	1.0	0.0	COR-MZR-DB.314
CF45132	1.0	0.0	COR-MZR-DB.414
CF45133	1.0	0.0	COR-MZRO2-DB.114
CF45134	1.0	0.0	COR-MZRO2-DB.214

CF45135	1.0	0.0	COR-MZRO2-DB.314
CF45136	1.0	0.0	COR-MZRO2-DB.414
CF45137	1.0	0.0	COR-MCRP-DB.114
CF45138	1.0	0.0	COR-MCRP-DB.214
CF45139	1.0	0.0	COR-MCRP-DB.314
CF45140	1.0	0.0	COR-MCRP-DB.414

.....

* UO2/ZR/AIC/ZRO2 TOTAL MASS LEVEL 15

* 1000 TO 1100 mm

.....

.

CF45200 '% TOTAL LEV15' ADD 31 46.2171 0.0

CF45210	1.0	0.0	COR-MZR-CL.115
CF45211	1.0	0.0	COR-MZR-CL.215
CF45212	1.0	0.0	COR-MZR-CL.315
CF45213	1.0	0.0	COR-MZR-CL.415
CF45214	1.0	0.0	COR-MZR-CN.415
CF45215	1.0	0.0	COR-MUO2-FU.115
CF45216	1.0	0.0	COR-MUO2-FU.215
CF45217	1.0	0.0	COR-MUO2-FU.315
CF45218	1.0	0.0	COR-MUO2-FU.415
CF45219	1.0	0.0	COR-MZRO2-CL.115
CF45220	1.0	0.0	COR-MZRO2-CL.215
CF45221	1.0	0.0	COR-MZRO2-CL.315
CF45222	1.0	0.0	COR-MZRO2-CL.415
CF45223	1.0	0.0	COR-MZRO2-CN.415
CF45224	1.0	0.0	COR-MCRP-OS.315
CF45225	1.0	0.0	COR-MUO2-DB.115
CF45226	1.0	0.0	COR-MUO2-DB.215
CF45227	1.0	0.0	COR-MUO2-DB.315
CF45228	1.0	0.0	COR-MUO2-DB.415
CF45229	1.0	0.0	COR-MZR-DB.115
CF45230	1.0	0.0	COR-MZR-DB.215
CF45231	1.0	0.0	COR-MZR-DB.315
CF45232	1.0	0.0	COR-MZR-DB.415
CF45233	1.0	0.0	COR-MZRO2-DB.115
CF45234	1.0	0.0	COR-MZRO2-DB.215
CF45235	1.0	0.0	COR-MZRO2-DB.315
CF45236	1.0	0.0	COR-MZRO2-DB.415
CF45237	1.0	0.0	COR-MCRP-DB.115
CF45238	1.0	0.0	COR-MCRP-DB.215
CF45239	1.0	0.0	COR-MCRP-DB.315
CF45240	1.0	0.0	COR-MCRP-DB.415

.

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* UO2/ZR/AIC/ZRO2 TOTAL MASS LEVEL 16

* 1100 TO 1200 mm

.....

.

CF45300 '% TOTAL LEV16' ADD 31 46.2171 0.0

CF45310	1.0	0.0	COR-MZR-CL.116
CF45311	1.0	0.0	COR-MZR-CL.216
CF45312	1.0	0.0	COR-MZR-CL.316
CF45313	1.0	0.0	COR-MZR-CL.416
CF45314	1.0	0.0	COR-MZR-CN.416
CF45315	1.0	0.0	COR-MUO2-FU.116
CF45316	1.0	0.0	COR-MUO2-FU.216
CF45317	1.0	0.0	COR-MUO2-FU.316
CF45318	1.0	0.0	COR-MUO2-FU.416
CF45319	1.0	0.0	COR-MZRO2-CL.116
CF45320	1.0	0.0	COR-MZRO2-CL.216
CF45321	1.0	0.0	COR-MZRO2-CL.316
CF45322	1.0	0.0	COR-MZRO2-CL.416
CF45323	1.0	0.0	COR-MZRO2-CN.416
CF45324	1.0	0.0	COR-MCRP-OS.316

CF45325	1.0	0.0	COR-MUO2-DB.116
CF45326	1.0	0.0	COR-MUO2-DB.216
CF45327	1.0	0.0	COR-MUO2-DB.316
CF45328	1.0	0.0	COR-MUO2-DB.416
CF45329	1.0	0.0	COR-MZR-DB.116
CF45330	1.0	0.0	COR-MZR-DB.216
CF45331	1.0	0.0	COR-MZR-DB.316
CF45332	1.0	0.0	COR-MZR-DB.416
CF45333	1.0	0.0	COR-MZRO2-DB.116
CF45334	1.0	0.0	COR-MZRO2-DB.216
CF45335	1.0	0.0	COR-MZRO2-DB.316
CF45336	1.0	0.0	COR-MZRO2-DB.416
CF45337	1.0	0.0	COR-MCRP-DB.116
CF45338	1.0	0.0	COR-MCRP-DB.216
CF45339	1.0	0.0	COR-MCRP-DB.316
CF45340	1.0	0.0	COR-MCRP-DB.416

.....
 * UO2/ZR/AIC/ZRO2 TOTAL MASS LEVEL 17
 * 1200 TO 1300 mm

CF45400	'% TOTAL LEV17' ADD 31 63 47836 0.0		
CF45410	1.0	0.0	COR-MZR-CL.117
CF45411	1.0	0.0	COR-MZR-CL.217
CF45412	1.0	0.0	COR-MZR-CL.317
CF45413	1.0	0.0	COR-MZR-CL.417
CF45414	1.0	0.0	COR-MZR-CN.417
CF45415	1.0	0.0	COR-MUO2-FU.117
CF45416	1.0	0.0	COR-MUO2-FU.217
CF45417	1.0	0.0	COR-MUO2-FU.317
CF45418	1.0	0.0	COR-MUO2-FU.417
CF45419	1.0	0.0	COR-MZRO2-CL.117
CF45420	1.0	0.0	COR-MZRO2-CL.217
CF45421	1.0	0.0	COR-MZRO2-CL.317
CF45422	1.0	0.0	COR-MZRO2-CL.417
CF45423	1.0	0.0	COR-MZRO2-CN.417
CF45424	1.0	0.0	COR-MCRP-OS.317
CF45425	1.0	0.0	COR-MUO2-DB.117
CF45426	1.0	0.0	COR-MUO2-DB.217
CF45427	1.0	0.0	COR-MUO2-DB.317
CF45428	1.0	0.0	COR-MUO2-DB.417
CF45429	1.0	0.0	COR-MZR-DB.117
CF45430	1.0	0.0	COR-MZR-DB.217
CF45431	1.0	0.0	COR-MZR-DB.317
CF45432	1.0	0.0	COR-MZR-DB.417
CF45433	1.0	0.0	COR-MZRO2-DB.117
CF45434	1.0	0.0	COR-MZRO2-DB.217
CF45435	1.0	0.0	COR-MZRO2-DB.317
CF45436	1.0	0.0	COR-MZRO2-DB.417
CF45437	1.0	0.0	COR-MCRP-DB.117
CF45438	1.0	0.0	COR-MCRP-DB.217
CF45439	1.0	0.0	COR-MCRP-DB.317
CF45440	1.0	0.0	COR-MCRP-DB.417

.....
 *

 * TABLE 2 ENTRY 436-450 % CORE BLOCKAGE
 * CF455 - CF514

 *

 * CORE BLOCKAGE LEVEL 3
 * -200 TO -100 mm

3 of 3


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*
CF45500 'FREZ-AREA 3' EQUALS 1 1.0 0.0
CF45501 1.0
CF45510 1.0 0.0 CFVALU 456
*
CF45600 'COM AREA 3' L-A-IFTE 3 1.0 0.0
CF45601 1.0
CF45610 1.0 0.0 CFVALU 457 * IF TEST
CF45611 1.0 0.0 CFVALU 455 * TRUE
CF45612 1.0 0.0 CFVALU 200 * FALSE
*
CF45700 'LEV 3 TEST' L-GT 2 1.0 0.0
CF45701 FALSE
CF45705 'LATCH'
CF45710 1.0 0.0 TIME
CF45711 0.0 2.5 TIME
*
CF45800 'CORE BLK LEV 3' DIVIDE 2 100.0 100.0
CF45810 1.0 0.0 CFVALU 455
CF45811 -1.0 0.0 CFVALU 200
*
*****
* CORE BLOCKAGE LEVEL 4
* -100 TO 0 mm
*****
*
CF45900 'FREZ-AREA 4' EQUALS 1 1.0 0.0
CF45901 1.0
CF45910 1.0 0.0 CFVALU 460
*
CF46000 'COM AREA 4' L-A-IFTE 3 1.0 0.0
CF46001 1.0
CF46010 1.0 0.0 CFVALU 461 * IF TEST
CF46011 1.0 0.0 CFVALU 459 * TRUE
CF46012 1.0 0.0 CFVALU 207 * FALSE
*
CF46100 'LEV 4 TEST' L-GT 2 1.0 0.0
CF46101 FALSE
CF46105 'LATCH'
CF46110 1.0 0.0 TIME
CF46111 0.0 2.5 TIME
*
CF46200 'CORE BLK LEV 4' DIVIDE 2 100.0 100.0
CF46210 1.0 0.0 CFVALU 459
CF46211 -1.0 0.0 CFVALU 207
*
*****
* CORE BLOCKAGE LEVEL 5
* 0 TO 100 mm
*****
*
CF46300 'FREZ-AREA 5' EQUALS 1 1.0 0.0
CF46301 1.0
CF46310 1.0 0.0 CFVALU 464
*
CF46400 'COM AREA 5' L-A-IFTE 3 1.0 0.0
CF46401 1.0
CF46410 1.0 0.0 CFVALU 465 * IF TEST
CF46411 1.0 0.0 CFVALU 463 * TRUE
CF46412 1.0 0.0 CFVALU 214 * FALSE
*
CF46500 'LEV 5 TEST' L-GT 2 1.0 0.0
CF46501 FALSE
CF46505 'LATCH'
CF46510 1.0 0.0 TIME
CF46511 0.0 2.5 TIME

```

```

*
CF46600 'CORE BLK LEV 5' DIVIDE 2 100.0 100.0
CF46610 1.0 0.0 CFVALU 463
CF46611 -1.0 0.0 CFVALU 214
*
*****
* CORE BLOCKAGE LEVEL 6
* 100 TO 200 mm
*****
*
CF46700 'FREZ-AREA 6' EQUALS 1 1.0 0.0
CF46701 1.0
CF46710 1.0 0.0 CFVALU 468
*
CF46800 'COM AREA 6' L-A-IFTE 3 1.0 0.0
CF46801 1.0
CF46810 1.0 0.0 CFVALU 469 * IF TEST
CF46811 1.0 0.0 CFVALU 467 * TRUE
CF46812 1.0 0.0 CFVALU 221 * FALSE
*
CF46900 'LEV 6 TEST' L-GT 2 1.0 0.0
CF46901 FALSE
CF46905 'LATCH'
CF46910 1.0 0.0 TIME
CF46911 0.0 2.5 TIME
*
CF47000 'CORE BLK LEV 6' DIVIDE 2 100.0 100.0
CF47010 1.0 0.0 CFVALU 467
CF47011 -1.0 0.0 CFVALU 221
*
*****
* CORE BLOCKAGE LEVEL 7
* 200 TO 300 mm
*****
*
CF47100 'FREZ-AREA 7' EQUALS 1 1.0 0.0
CF47101 1.0
CF47110 1.0 0.0 CFVALU 472
*
CF47200 'COM AREA 7' L-A-IFTE 3 1.0 0.0
CF47201 1.0
CF47210 1.0 0.0 CFVALU 473 * IF TEST
CF47211 1.0 0.0 CFVALU 471 * TRUE
CF47212 1.0 0.0 CFVALU 228 * FALSE
*
CF47300 'LEV 7 TEST' L-GT 2 1.0 0.0
CF47301 FALSE
CF47305 'LATCH'
CF47310 1.0 0.0 TIME
CF47311 0.0 2.5 TIME
*
CF47400 'CORE BLK LEV 7' DIVIDE 2 100.0 100.0
CF47410 1.0 0.0 CFVALU 471
CF47411 -1.0 0.0 CFVALU 228
*
*****
* CORE BLOCKAGE LEVEL 8
* 300 TO 400 mm
*****
*
CF47500 'FREZ-AREA 8' EQUALS 1 1.0 0.0
CF47501 1.0
CF47510 1.0 0.0 CFVALU 476
*
CF47600 'COM AREA 8' L-A-IFTE 3 1.0 0.0
CF47601 1.0

```

```

CF47610 1.0 0.0 CFVALU.477      * IF TEST
CF47611 1.0 0.0 CFVALU.475      * TRUE
CF47612 1.0 0.0 CFVALU.235      * FALSE
.

CF47700 'LEV 8 TEST' L-GT  2 1.0 0.0
CF47701 FALSE
CF47705 'LATCH'
CF47710 1.0 0.0  TIME
CF47711 0.0 2.5  TIME
.

CF47800 'CORE BLK LEV 8' DIVIDE 2 100.0 100.0
CF47810 1.0 0.0 CFVALU.475
CF47811 -1.0 0.0 CFVALU.235
.
.....
* CORE BLOCKAGE LEVEL 9
* 400 TO 500 mm
.....
.

CF47900 'FREZ-AREA 9' EQUALS 1 1.0 0.0
CF47901 1.0
CF47910 1.0 0.0 CFVALU.480
.

CF48000 'COM AREA 9' L-A-IFTE 3 1.0 0.0
CF48001 1.0
CF48010 1.0 0.0 CFVALU.481      * IF TEST
CF48011 1.0 0.0 CFVALU.479      * TRUE
CF48012 1.0 0.0 CFVALU.242      * FALSE
.

CF48100 'LEV 9 TEST' L-GT  2 1.0 0.0
CF48101 FALSE
CF48105 'LATCH'
CF48110 1.0 0.0  TIME
CF48111 0.0 2.5  TIME
.

CF48200 'CORE BLK LEV 9' DIVIDE 2 100.0 100.0
CF48210 1.0 0.0 CFVALU.479
CF48211 -1.0 0.0 CFVALU.242
.
.....
* CORE BLOCKAGE LEVEL 10
* 500 TO 600 mm
.....
.

CF48300 'FREZ-AREA10' EQUALS 1 1.0 0.0
CF48301 1.0
CF48310 1.0 0.0 CFVALU.484
.

CF48400 'COM AREA10' L-A-IFTE 3 1.0 0.0
CF48401 1.0
CF48410 1.0 0.0 CFVALU.485      * IF TEST
CF48411 1.0 0.0 CFVALU.483      * TRUE
CF48412 1.0 0.0 CFVALU.249      * FALSE
.

CF48500 'LEV10 TEST' L-GT  2 1.0 0.0
CF48501 FALSE
CF48505 'LATCH'
CF48510 1.0 0.0  TIME
CF48511 0.0 2.5  TIME
.

CF48600 'CORE BLK LEV10' DIVIDE 2 100.0 100.0
CF48610 1.0 0.0 CFVALU.483
CF48611 -1.0 0.0 CFVALU.249
.
.....
* CORE BLOCKAGE LEVEL 11

```

```

* 600 TO 700 mm
*****
.
CF48700 'FREZ-AREA11' EQUALS 1 1.0 0.0
CF48701 1.0
CF48710 1.0 0.0 CFVALU.488
.
CF48800 'COM AREA11' L-A-IFTE 3 1.0 0.0
CF48801 1.0
CF48810 1.0 0.0 CFVALU.489 *IF TEST
CF48811 1.0 0.0 CFVALU.487 *TRUE
CF48812 1.0 0.0 CFVALU.256 *FALSE
.
CF48900 'LEV11 TEST' L-GT 2 1.0 0.0
CF48901 .FALSE
CF48905 'LATCH'
CF48910 1.0 0.0 TIME
CF48911 0.0 2.5 TIME
.
CF49000 'CORE BLK LEV11' DIVIDE 2 100.0 100.0
CF49010 1.0 0.0 CFVALU.487
CF49011 -1.0 0.0 CFVALU.256
.
*****
* CORE BLOCKAGE LEVEL 12
* 700 TO 800 mm
*****
.
CF49100 'FREZ-AREA12' EQUALS 1 1.0 0.0
CF49101 1.0
CF49110 1.0 0.0 CFVALU.492
.
CF49200 'COM AREA12' L-A-IFTE 3 1.0 0.0
CF49201 1.0
CF49210 1.0 0.0 CFVALU.493 *IF TEST
CF49211 1.0 0.0 CFVALU.491 *TRUE
CF49212 1.0 0.0 CFVALU.263 *FALSE
.
CF49300 'LEV12 TEST' L-GT 2 1.0 0.0
CF49301 .FALSE
CF49305 'LATCH'
CF49310 1.0 0.0 TIME
CF49311 0.0 2.5 TIME
.
CF49400 'CORE BLK LEV12' DIVIDE 2 100.0 100.0
CF49410 1.0 0.0 CFVALU.491
CF49411 -1.0 0.0 CFVALU.263
.
*****
* CORE BLOCKAGE LEVEL 13
* 800 TO 900 mm
*****
.
CF49500 'FREZ-AREA13' EQUALS 1 1.0 0.0
CF49501 1.0
CF49510 1.0 0.0 CFVALU.496
.
CF49600 'COM AREA13' L-A-IFTE 3 1.0 0.0
CF49601 1.0
CF49610 1.0 0.0 CFVALU.497 *IF TEST
CF49611 1.0 0.0 CFVALU.495 *TRUE
CF49612 1.0 0.0 CFVALU.270 *FALSE
.
CF49700 'LEV13 TEST' L-GT 2 1.0 0.0
CF49701 .FALSE
CF49705 'LATCH'

```

```

CF49710 1.0 0.0 TIME
CF49711 0.0 2.5 TIME
.
CF49800 'CORE BLK LEV13' DIVIDE 2 100.0 100.0
CF49810 1.0 0.0 CFVALU 495
CF49811 -1.0 0.0 CFVALU 270
.
.....
* CORE BLOCKAGE LEVEL14
* 900 TO 1000 mm
.....
.
CF49900 'FREZ-AREA14' EQUALS 1 1.0 0.0
CF49901 1.0
CF49910 1.0 0.0 CFVALU.500
.
CF50000 'COM AREA14' L-A-IFTE 3 1.0 0.0
CF50001 1.0
CF50010 1.0 0.0 CFVALU.501 * IF TEST
CF50011 1.0 0.0 CFVALU.499 * TRUE
CF50012 1.0 0.0 CFVALU.277 * FALSE
.
CF50100 'LEV14 TEST' L-GT 2 1.0 0.0
CF50101 .FALSE
CF50105 'LATCH'
CF50110 1.0 0.0 TIME
CF50111 0.0 2.5 TIME
.
CF50200 'CORE BLK LEV14' DIVIDE 2 100.0 100.0
CF50210 1.0 0.0 CFVALU 499
CF50211 -1.0 0.0 CFVALU 277
.
.....
* CORE BLOCKAGE LEVEL15
* 1000 TO 1100 mm
.....
.
CF50300 'FREZ-AREA15' EQUALS 1 1.0 0.0
CF50301 1.0
CF50310 1.0 0.0 CFVALU.504
.
CF50400 'COM AREA15' L-A-IFTE 3 1.0 0.0
CF50401 1.0
CF50410 1.0 0.0 CFVALU.505 * IF TEST
CF50411 1.0 0.0 CFVALU.503 * TRUE
CF50412 1.0 0.0 CFVALU 284 * FALSE
.
CF50500 'LEV15 TEST' L-GT 2 1.0 0.0
CF50501 .FALSE
CF50505 'LATCH'
CF50510 1.0 0.0 TIME
CF50511 0.0 2.5 TIME
.
CF50600 'CORE BLK LEV15' DIVIDE 2 100.0 100.0
CF50610 1.0 0.0 CFVALU 503
CF50611 -1.0 0.0 CFVALU 284
.
.....
* CORE BLOCKAGE LEVEL 16
* 1100 TO 1200 mm
.....
.
CF50700 'FREZ-AREA16' EQUALS 1 1.0 0.0
CF50701 1.0
CF50710 1.0 0.0 CFVALU 508
.

```

```

CF50800 'COM AREA16' L-A-IFTE 3 1.0 0.0
CF50801 1.0
CF50810 1.0 0.0 CFVALU.509 * IF TEST
CF50811 1.0 0.0 CFVALU.507 * TRUE
CF50812 1.0 0.0 CFVALU.291 * FALSE
.

CF50900 'LEV16 TEST' L-GT 2 1.0 0.0
CF50901 .FALSE
CF50905 'LATCH'
CF50910 1.0 0.0 TIME
CF50911 0.0 2.5 TIME
.

CF51000 'CORE BLK LEV16' DIVIDE 2 100.0 100.0
CF51010 1.0 0.0 CFVALU.507
CF51011 -1.0 0.0 CFVALU.291
.

.....
* CORE BLOCKAGE LEVEL 17
* 1200 TO 1300 mm
.....
.

CF51100 'FREZ-AREA17' EQUALS 1 1.0 0.0
CF51101 1.0
CF51110 1.0 0.0 CFVALU.512
.

CF51200 'COM AREA17' L-A-IFTE 3 1.0 0.0
CF51201 1.0
CF51210 1.0 0.0 CFVALU.513 * IF TEST
CF51211 1.0 0.0 CFVALU.511 * TRUE
CF51212 1.0 0.0 CFVALU.298 * FALSE
.

CF51300 'LEV17 TEST' L-GT 2 1.0 0.0
CF51301 .FALSE
CF51305 'LATCH'
CF51310 1.0 0.0 TIME
CF51311 0.0 2.5 TIME
.

CF51400 'CORE BLK LEV17' DIVIDE 2 100.0 100.0
CF51410 1.0 0.0 CFVALU.511
CF51411 -1.0 0.0 CFVALU.298
.

.....
.

.....
* TABLE 1 ENTRIES 17 - 20 HYDROGEN PRODUCTION
* #17 - HYDROGEN GENERATION RATE (BUNDLE) Kg/s
* #18 - HYDROGEN GENERATION RATE (SHROUD) Kg/s
* #19 - ACCUMU HYDROGEN GENERATION (BUNDLE) Kg
* #20 - ACCUMU HYDROGEN GENERATION (SHROUD) Kg
* CF515 - CF488
.....
.

.....
* #20 ACCUMU H2 IN THE SHROUD (KG)
* CF515
.....
.

CF51500 'H2 MASS SHR' ADD 15 0.0327223 0.0
CF51510 1.0 0.0 COR-MZRO2-CN 403
CF51511 1.0 0.0 COR-MZRO2-CN 404
CF51512 1.0 0.0 COR-MZRO2-CN 405
CF51513 1.0 0.0 COR-MZRO2-CN 406
CF51514 1.0 0.0 COR-MZRO2-CN 407
CF51515 1.0 0.0 COR-MZRO2-CN 408
CF51516 1.0 0.0 COR-MZRO2-CN 409
CF51517 1.0 0.0 COR-MZRO2-CN 410

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CF51518 1.0 0.0 COR-MZRO2-CN 411
CF51519 1.0 0.0 COR-MZRO2-CN 412
CF51520 1.0 0.0 COR-MZRO2-CN 413
CF51521 1.0 0.0 COR-MZRO2-CN 414
CF51522 1.0 0.0 COR-MZRO2-CN 415
CF51523 1.0 0.0 COR-MZRO2-CN 416
CF51524 1.0 0.0 COR-MZRO2-CN 417
.
.....
* #18 H2 GENERATION IN THE SHROUD (KG/S)
* CF516
.....
.
CF51600 'H2 RATE SHR' DER-F 2 1.0 0.0
CF51610 1.0 0.0 CFVALU.515
CF51611 1.0 0.0 TIME
.
.....
* #19 ACCUMU H2 IN THE BUNDLE (KG)
* CF517
.....
.
CF51700 'H2 MASS BUN' ADD 2 1.0 0.0
CF51710 1.0 0.0 FL-I-MFLOW 4.240
CF51711 -1.0 0.0 CFVALU.515
.
.....
* #17 H2 GENERATION IN THE BUNDLE (KG/S)
* CF518
.....
.
CF51800 'H2 RATE BUN' ADD 2 1.0 0.0
CF51810 1.0 0.0 FL-MFLOW 4.240
CF51811 -1.0 0.0 CFVALU.516
.
.....
.
.....
* TABLE 1 ENTRY 3 SYSTEM PRESSURE (MPA)
* CF519
.....
.
CF51900 'SYSTEM PRESS' EQUALS 1 1.0 0.0
CF51910 1.0E-6 0.0 CVH-P.220
.
.....
* TABLE 1 ENTRY 4 STEAM INLET FLOW (KG/S)
* CF520
.....
.
CF52000 'STEAM INLET FL' TAB-FUN 1 1.0 0.0
CF52003 030
CF52010 1.0 0.0 TIME
.
.....
* TABLE 1 ENTRY 5 ARGON INLET FLOW (KG/S)
* CF521
.....
.
CF52100 'ARGON INLET FL' TAB-FUN 1 1.0 0.0
CF52103 010
CF52110 1.0 0.0 TIME
.
.....
* TABLE 1 ENTRY 6 WATER INLET FLOW (KG/S)
* CF522

```

```

.....
*
CF52200 'WATER INLET FL' TAB-FUN 1 1.0 0.0 * SOURCE INTO CV110
CF52203 050
CF52210 1.0 0.0 TIME
*
.....
* TABLE 1 ENTRY 9 TEMPERATURE AT BUNDLE TOP (K)
* CF523
.....
*
CF52300 'BUND TOP TEMP' EQUALS 1 1.0 0.0
CF52310 0.0 393.0 TIME
*
.....
* CONTROL FUNCTIONS NECESSARY FOR PLOTTING CORE
* VARIABLES
*
* CF524 - CF561 PLOT INTACT CLADDING ZRO2 MASS IN A CELL
*
CF52400 'MZRO2-CL-201' EQUALS 1 1.0 0.0
CF52410 1.0 0.0 COR-MZRO2-CL 201
CF52500 'MZRO2-CL-202' EQUALS 1 1.0 0.0
CF52510 1.0 0.0 COR-MZRO2-CL 202
CF52600 'MZRO2-CL-203' EQUALS 1 1.0 0.0
CF52610 1.0 0.0 COR-MZRO2-CL 203
CF52700 'MZRO2-CL-204' EQUALS 1 1.0 0.0
CF52710 1.0 0.0 COR-MZRO2-CL 204
CF52800 'MZRO2-CL-205' EQUALS 1 1.0 0.0
CF52810 1.0 0.0 COR-MZRO2-CL 205
CF52900 'MZRO2-CL-206' EQUALS 1 1.0 0.0
CF52910 1.0 0.0 COR-MZRO2-CL 206
CF53000 'MZRO2-CL-207' EQUALS 1 1.0 0.0
CF53010 1.0 0.0 COR-MZRO2-CL 207
CF53100 'MZRO2-CL-208' EQUALS 1 1.0 0.0
CF53110 1.0 0.0 COR-MZRO2-CL 208
CF53200 'MZRO2-CL-209' EQUALS 1 1.0 0.0
CF53210 1.0 0.0 COR-MZRO2-CL 209
CF53300 'MZRO2-CL-210' EQUALS 1 1.0 0.0
CF53310 1.0 0.0 COR-MZRO2-CL 210
CF53400 'MZRO2-CL-211' EQUALS 1 1.0 0.0
CF53410 1.0 0.0 COR-MZRO2-CL 211
CF53500 'MZRO2-CL-212' EQUALS 1 1.0 0.0
CF53510 1.0 0.0 COR-MZRO2-CL 212
CF53600 'MZRO2-CL-213' EQUALS 1 1.0 0.0
CF53610 1.0 0.0 COR-MZRO2-CL 213
CF53700 'MZRO2-CL-214' EQUALS 1 1.0 0.0
CF53710 1.0 0.0 COR-MZRO2-CL 214
CF53800 'MZRO2-CL-215' EQUALS 1 1.0 0.0
CF53810 1.0 0.0 COR-MZRO2-CL 215
CF53900 'MZRO2-CL-216' EQUALS 1 1.0 0.0
CF53910 1.0 0.0 COR-MZRO2-CL 216
CF54000 'MZRO2-CL-217' EQUALS 1 1.0 0.0
CF54010 1.0 0.0 COR-MZRO2-CL 217
CF54100 'MZRO2-CL-218' EQUALS 1 1.0 0.0
CF54110 1.0 0.0 COR-MZRO2-CL 218
CF54200 'MZRO2-CL-219' EQUALS 1 1.0 0.0
CF54210 1.0 0.0 COR-MZRO2-CL 219
CF54300 'MZRO2-CL-401' EQUALS 1 1.0 0.0
CF54310 1.0 0.0 COR-MZRO2-CL 401
CF54400 'MZRO2-CL-402' EQUALS 1 1.0 0.0
CF54410 1.0 0.0 COR-MZRO2-CL 402
CF54500 'MZRO2-CL-403' EQUALS 1 1.0 0.0
CF54510 1.0 0.0 COR-MZRO2-CL 403
CF54600 'MZRO2-CL-404' EQUALS 1 1.0 0.0
CF54610 1.0 0.0 COR-MZRO2-CL 404

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CF54700 'MZRO2-CL-405' EQUALS 1 1.0 0.0
 CF54710 1.0 0.0 COR-MZRO2-CL 405
 CF54800 'MZRO2-CL-406' EQUALS 1 1.0 0.0
 CF54810 1.0 0.0 COR-MZRO2-CL 406
 CF54900 'MZRO2-CL-407' EQUALS 1 1.0 0.0
 CF54910 1.0 0.0 COR-MZRO2-CL 407
 CF55000 'MZRO2-CL-408' EQUALS 1 1.0 0.0
 CF55010 1.0 0.0 COR-MZRO2-CL 408
 CF55100 'MZRO2-CL-409' EQUALS 1 1.0 0.0
 CF55110 1.0 0.0 COR-MZRO2-CL 409
 CF55200 'MZRO2-CL-410' EQUALS 1 1.0 0.0
 CF55210 1.0 0.0 COR-MZRO2-CL 410
 CF55300 'MZRO2-CL-411' EQUALS 1 1.0 0.0
 CF55310 1.0 0.0 COR-MZRO2-CL 411
 CF55400 'MZRO2-CL-412' EQUALS 1 1.0 0.0
 CF55410 1.0 0.0 COR-MZRO2-CL 412
 CF55500 'MZRO2-CL-413' EQUALS 1 1.0 0.0
 CF55510 1.0 0.0 COR-MZRO2-CL 413
 CF55600 'MZRO2-CL-414' EQUALS 1 1.0 0.0
 CF55610 1.0 0.0 COR-MZRO2-CL 414
 CF55700 'MZRO2-CL-415' EQUALS 1 1.0 0.0
 CF55710 1.0 0.0 COR-MZRO2-CL 415
 CF55800 'MZRO2-CL-416' EQUALS 1 1.0 0.0
 CF55810 1.0 0.0 COR-MZRO2-CL 416
 CF55900 'MZRO2-CL-417' EQUALS 1 1.0 0.0
 CF55910 1.0 0.0 COR-MZRO2-CL 417
 CF56000 'MZRO2-CL-418' EQUALS 1 1.0 0.0
 CF56010 1.0 0.0 COR-MZRO2-CL 418
 CF56100 'MZRO2-CL-419' EQUALS 1 1.0 0.0
 CF56110 1.0 0.0 COR-MZRO2-CL 419

* CF562 - CF580 PLOT INTACT OTHER STRUCTURE CONTROL
 * POISON MASS IN A CELL

CF56200 'MCRP-OS-301' EQUALS 1 1.0 0.0
 CF56210 1.0 0.0 COR-MCRP-OS 301
 CF56300 'MCRP-OS-302' EQUALS 1 1.0 0.0
 CF56310 1.0 0.0 COR-MCRP-OS 302
 CF56400 'MCRP-OS-303' EQUALS 1 1.0 0.0
 CF56410 1.0 0.0 COR-MCRP-OS 303
 CF56500 'MCRP-OS-304' EQUALS 1 1.0 0.0
 CF56510 1.0 0.0 COR-MCRP-OS 304
 CF56600 'MCRP-OS-305' EQUALS 1 1.0 0.0
 CF56610 1.0 0.0 COR-MCRP-OS 305
 CF56700 'MCRP-OS-306' EQUALS 1 1.0 0.0
 CF56710 1.0 0.0 COR-MCRP-OS 306
 CF56800 'MCRP-OS-307' EQUALS 1 1.0 0.0
 CF56810 1.0 0.0 COR-MCRP-OS 307
 CF56900 'MCRP-OS-308' EQUALS 1 1.0 0.0
 CF56910 1.0 0.0 COR-MCRP-OS 308
 CF57000 'MCRP-OS-309' EQUALS 1 1.0 0.0
 CF57010 1.0 0.0 COR-MCRP-OS 309
 CF57100 'MCRP-OS-310' EQUALS 1 1.0 0.0
 CF57110 1.0 0.0 COR-MCRP-OS 310
 CF57200 'MCRP-OS-311' EQUALS 1 1.0 0.0
 CF57210 1.0 0.0 COR-MCRP-OS 311
 CF57300 'MCRP-OS-312' EQUALS 1 1.0 0.0
 CF57310 1.0 0.0 COR-MCRP-OS 312
 CF57400 'MCRP-OS-313' EQUALS 1 1.0 0.0
 CF57410 1.0 0.0 COR-MCRP-OS 313
 CF57500 'MCRP-OS-314' EQUALS 1 1.0 0.0
 CF57510 1.0 0.0 COR-MCRP-OS 314
 CF57600 'MCRP-OS-315' EQUALS 1 1.0 0.0
 CF57610 1.0 0.0 COR-MCRP-OS 315
 CF57700 'MCRP-OS-316' EQUALS 1 1.0 0.0
 CF57710 1.0 0.0 COR-MCRP-OS 316

```

CF57800 'MCRP-OS-317' EQUALS 1 1.0 0.0
CF57810 1.0 0.0 COR-MCRP-OS 317
CF57900 'MCRP-OS-318' EQUALS 1 1.0 0.0
CF57910 1.0 0.0 COR-MCRP-OS 318
CF58000 'MCRP-OS-319' EQUALS 1 1.0 0.0
CF58010 1.0 0.0 COR-MCRP-OS 319
.
* CF581 - CF588 PLOT MELT FRACTION OF POISON IN
* OTHER STRUCTURE (COMP 6) IN CELLS 310 (500-600MM)
* TO 317 (1200-1300MM)
.
CF58100 'MELT POISON-310' EQUALS 1 100.0 0.0
CF58110 1.0 0.0 COR-MLTFR 310.6.5
CF58200 'MELT POISON-311' EQUALS 1 100.0 0.0
CF58210 1.0 0.0 COR-MLTFR 311.6.5
CF58300 'MELT POISON-312' EQUALS 1 100.0 0.0
CF58310 1.0 0.0 COR-MLTFR 312.6.5
CF58400 'MELT POISON-313' EQUALS 1 100.0 0.0
CF58410 1.0 0.0 COR-MLTFR 313.6.5
CF58500 'MELT POISON-314' EQUALS 1 100.0 0.0
CF58510 1.0 0.0 COR-MLTFR 314.6.5
CF58600 'MELT POISON-315' EQUALS 1 100.0 0.0
CF58610 1.0 0.0 COR-MLTFR 315.6.5
CF58700 'MELT POISON-316' EQUALS 1 100.0 0.0
CF58710 1.0 0.0 COR-MLTFR 316.6.5
CF58800 'MELT POISON-317' EQUALS 1 100.0 0.0
CF58810 1.0 0.0 COR-MLTFR 317.6.5
.
* CF589 - CF595 PLOT MELT FRACTION OF POISON IN
* OTHER STRUCTURE (COMP 6) IN CELLS 3 (-200 TO -100MM)
* TO 309 (400-500MM)
.
CF58900 'MELT POISON-303' EQUALS 1 100.0 0.0
CF58910 1.0 0.0 COR-MLTFR 303.6.5
CF59000 'MELT POISON-304' EQUALS 1 100.0 0.0
CF59010 1.0 0.0 COR-MLTFR 304.6.5
CF59100 'MELT POISON-305' EQUALS 1 100.0 0.0
CF59110 1.0 0.0 COR-MLTFR 305.6.5
CF59200 'MELT POISON-306' EQUALS 1 100.0 0.0
CF59210 1.0 0.0 COR-MLTFR 306.6.5
CF59300 'MELT POISON-307' EQUALS 1 100.0 0.0
CF59310 1.0 0.0 COR-MLTFR 307.6.5
CF59400 'MELT POISON-308' EQUALS 1 100.0 0.0
CF59410 1.0 0.0 COR-MLTFR 308.6.5
CF59500 'MELT POISON-309' EQUALS 1 100.0 0.0
CF59510 1.0 0.0 COR-MLTFR 309.6.5
.
.....
* TABLE 1 ENTRY 10 HEAT FLUX TO THE SHROUD (kW)
* APPROXIMATE BY USING CONDUCTION HEAT TRANSFER
* THROUGH THE SHROUD INSULATION
* CF596 to CF606
.
CF59600 'TDIFF 21005' ADD 2 0.00148 0.0
CF59610 1.0 0.0 HS-TEMP.2100501
CF59611 -1.0 0.0 HS-TEMP.2100502
.
CF59700 'TDIFF 21006' ADD 2 0.00148 0.0
CF59710 1.0 0.0 HS-TEMP.2100601
CF59711 -1.0 0.0 HS-TEMP.2100602
.
CF59800 'TDIFF 21007' ADD 2 0.00148 0.0
CF59810 1.0 0.0 HS-TEMP.2100701
CF59811 -1.0 0.0 HS-TEMP.2100702
.
CF59900 'TDIFF 21008' ADD 2 0.00148 0.0

```

```

CF59910  1.0  0.0  HS-TEMP 2100801
CF59911 -1.0  0.0  HS-TEMP 2100802
.

CF60000  'TDIFF 22009' ADD  2  0.00148  0.0
CF60010  1.0  0.0  HS-TEMP.2200901
CF60011 -1.0  0.0  HS-TEMP.2200902
.

CF60100  'TDIFF 22010' ADD  2  0.00148  0.0
CF60110  1.0  0.0  HS-TEMP.2201001
CF60111 -1.0  0.0  HS-TEMP.2201002
.

CF60200  'TDIFF 22011' ADD  2  0.00148  0.0
CF60210  1.0  0.0  HS-TEMP.2201101
CF60211 -1.0  0.0  HS-TEMP.2201102
.

CF60300  'TDIFF 22012' ADD  2  0.00148  0.0
CF60310  1.0  0.0  HS-TEMP.2201201
CF60311 -1.0  0.0  HS-TEMP.2201202
.

CF60400  'TDIFF 23013' ADD  2  0.00148  0.0
CF60410  1.0  0.0  HS-TEMP.2301301
CF60411 -1.0  0.0  HS-TEMP.2301302
.

CF60500  'TDIFF 23014' ADD  2  0.00148  0.0
CF60510  1.0  0.0  HS-TEMP 2301401
CF60511 -1.0  0.0  HS-TEMP 2301402
.

CF60600  'SHROUD HF'  ADD  10  1.0  0.0
CF60610  1.0  0.0  CFVALU 596
CF60611  1.0  0.0  CFVALU 597
CF60612  1.0  0.0  CFVALU 598
CF60613  1.0  0.0  CFVALU 599
CF60614  1.0  0.0  CFVALU 600
CF60615  1.0  0.0  CFVALU 601
CF60616  1.0  0.0  CFVALU 602
CF60617  1.0  0.0  CFVALU 603
CF60618  1.0  0.0  CFVALU 604
CF60619  1.0  0.0  CFVALU 605
.

.....
* TABLE 1 ENTRY 11 HEAT FLUX INTO FLUID (kW)
* APPROXIMATE BY USING COR-QCNV VARIABLE
* CF607 to CF606
.

.....
*CF60700  'FLUID HF'  ADD  5  0.001  0.0
*CF60710  1.0  0.0  COR-QCNV.110
*CF60711  1.0  0.0  COR-QCNV.210
*CF60712  1.0  0.0  COR-QCNV.220
*CF60713  1.0  0.0  COR-QCNV.230
*CF60714  1.0  0.0  COR-QCNV.240
.

.....
* TABLE 1 ENTRY 12 HEAT STORED IN BUNDLE (kW)
* APPROXIMATE BY TAKING DERIVATIVE OF COR-ENERGY-TOT
* CF608
.

.....
*CF60800  'FLUID HF'  DER-F  2  0.001  0.0
*CF60810  1.0  0.0  COR-ENERGY-TOT
*CF60811  1.0  0.0  TIME
.

.....
* TABLE 1 ENTRY 15 POWER GENERATION BY OXIDATION
* THIS ENTRY INCLUDES ENERGY GENERATED BY THE BUNDLE
* AND THE SHROUD AS THE CORE PACKAGE PRESENTLY DOES

```

* NOT SEPARATE THE TWO

* CF609

.

.....

*CF60900 'OXID ENERGY' EQUALS 1 0.001 0.0

*CF60910 1.0 1.0 COR-EMWR-RAT

.....

.

.....

* TABLE 2 ENTRY 76-135 UO2 DISSOLVED

* CF610 - CF669

.....

.

* FIRST RING, LEVELS 3 TO 17 -200MM TO 1300MM

.

CF61000 'DISOLV FU 103' EQUALS 1 1397.7666 0.0

CF61010 1.0 0.0 COR-MUO2-DB 103

CF61100 'DISOLV FU 104' EQUALS 1 1397.7666 0.0

CF61110 1.0 0.0 COR-MUO2-DB 104

CF61200 'DISOLV FU 105' EQUALS 1 1397.7666 0.0

CF61210 1.0 0.0 COR-MUO2-DB 105

CF61300 'DISOLV FU 106' EQUALS 1 1397.7666 0.0

CF61310 1.0 0.0 COR-MUO2-DB 106

CF61400 'DISOLV FU 107' EQUALS 1 1397.7666 0.0

CF61410 1.0 0.0 COR-MUO2-DB 107

CF61500 'DISOLV FU 108' EQUALS 1 1397.7666 0.0

CF61510 1.0 0.0 COR-MUO2-DB 108

CF61600 'DISOLV FU 109' EQUALS 1 1397.7666 0.0

CF61610 1.0 0.0 COR-MUO2-DB 109

CF61700 'DISOLV FU 110' EQUALS 1 1397.7666 0.0

CF61710 1.0 0.0 COR-MUO2-DB 110

CF61800 'DISOLV FU 111' EQUALS 1 1397.7666 0.0

CF61810 1.0 0.0 COR-MUO2-DB 111

CF61900 'DISOLV FU 112' EQUALS 1 1397.7666 0.0

CF61910 1.0 0.0 COR-MUO2-DB 112

CF62000 'DISOLV FU 113' EQUALS 1 1397.7666 0.0

CF62010 1.0 0.0 COR-MUO2-DB 113

CF62100 'DISOLV FU 114' EQUALS 1 1397.7666 0.0

CF62110 1.0 0.0 COR-MUO2-DB 114

CF62200 'DISOLV FU 115' EQUALS 1 1397.7666 0.0

CF62210 1.0 0.0 COR-MUO2-DB 115

CF62300 'DISOLV FU 116' EQUALS 1 1397.7666 0.0

CF62310 1.0 0.0 COR-MUO2-DB 116

CF62400 'DISOLV FU 117' EQUALS 1 1397.7666 0.0

CF62410 1.0 0.0 COR-MUO2-DB 117

.

* SECOND RING, LEVELS 3 TO 17 -200MM TO 1300MM

.

CF62500 'DISOLV FU 203' EQUALS 1 0.0 0.0

CF62510 1.0 0.0 COR-MUO2-DB 203

CF62600 'DISOLV FU 204' EQUALS 1 0.0 0.0

CF62610 1.0 0.0 COR-MUO2-DB 204

CF62700 'DISOLV FU 205' EQUALS 1 618.186 0.0

CF62710 1.0 0.0 COR-MUO2-DB 205

CF62800 'DISOLV FU 206' EQUALS 1 618.186 0.0

CF62810 1.0 0.0 COR-MUO2-DB 206

CF62900 'DISOLV FU 207' EQUALS 1 618.186 0.0

CF62910 1.0 0.0 COR-MUO2-DB 207

CF63000 'DISOLV FU 208' EQUALS 1 618.186 0.0

CF63010 1.0 0.0 COR-MUO2-DB 208

CF63100 'DISOLV FU 209' EQUALS 1 618.186 0.0

CF63110 1.0 0.0 COR-MUO2-DB 209

CF63200 'DISOLV FU 210' EQUALS 1 618.186 0.0

CF63210 1.0 0.0 COR-MUO2-DB 210

CF63300 'DISOLV FU 211' EQUALS 1 618.186 0.0

CF63310 1.0 0.0 COR-MUO2-DB 211

CF63400 'DISOLV FU 212' EQUALS 1 618 186 0.0
 CF63410 1.0 0.0 COR-MUO2-DB.212
 CF63500 'DISOLV FU 213' EQUALS 1 618 186 0.0
 CF63510 1.0 0.0 COR-MUO2-DB.213
 CF63600 'DISOLV FU 214' EQUALS 1 618 186 0.0
 CF63610 1.0 0.0 COR-MUO2-DB.214
 CF63700 'DISOLV FU 215' EQUALS 1 0.0 0.0
 CF63710 1.0 0.0 COR-MUO2-DB.215
 CF63800 'DISOLV FU 216' EQUALS 1 0.0 0.0
 CF63810 1.0 0.0 COR-MUO2-DB.216
 CF63900 'DISOLV FU 217' EQUALS 1 0.0 0.0
 CF63910 1.0 0.0 COR-MUO2-DB.217

* THIRD RING, LEVELS 3 TO 17 -200MM TO 1300MM

CF64000 'DISOLV FU 303' EQUALS 1 232 9699 0.0
 CF64010 1.0 0.0 COR-MUO2-DB.303
 CF64100 'DISOLV FU 304' EQUALS 1 232 9699 0.0
 CF64110 1.0 0.0 COR-MUO2-DB.304
 CF64200 'DISOLV FU 305' EQUALS 1 232 9699 0.0
 CF64210 1.0 0.0 COR-MUO2-DB.305
 CF64300 'DISOLV FU 306' EQUALS 1 232 9699 0.0
 CF64310 1.0 0.0 COR-MUO2-DB.306
 CF64400 'DISOLV FU 307' EQUALS 1 232 9699 0.0
 CF64410 1.0 0.0 COR-MUO2-DB.307
 CF64500 'DISOLV FU 308' EQUALS 1 232 9699 0.0
 CF64510 1.0 0.0 COR-MUO2-DB.308
 CF64600 'DISOLV FU 309' EQUALS 1 232 9699 0.0
 CF64610 1.0 0.0 COR-MUO2-DB.309
 CF64700 'DISOLV FU 310' EQUALS 1 232 9699 0.0
 CF64710 1.0 0.0 COR-MUO2-DB.310
 CF64800 'DISOLV FU 311' EQUALS 1 232 9699 0.0
 CF64810 1.0 0.0 COR-MUO2-DB.311
 CF64900 'DISOLV FU 312' EQUALS 1 232 9699 0.0
 CF64910 1.0 0.0 COR-MUO2-DB.312
 CF65000 'DISOLV FU 313' EQUALS 1 232 9699 0.0
 CF65010 1.0 0.0 COR-MUO2-DB.313
 CF65100 'DISOLV FU 314' EQUALS 1 232 9699 0.0
 CF65110 1.0 0.0 COR-MUO2-DB.314
 CF65200 'DISOLV FU 315' EQUALS 1 232 9699 0.0
 CF65210 1.0 0.0 COR-MUO2-DB.315
 CF65300 'DISOLV FU 316' EQUALS 1 232 9699 0.0
 CF65310 1.0 0.0 COR-MUO2-DB.316
 CF65400 'DISOLV FU 317' EQUALS 1 232 9699 0.0
 CF65410 1.0 0.0 COR-MUO2-DB.317

* FOURTH RING, LEVELS 3 TO 17 -200MM TO 1300MM

CF65500 'DISOLV FU 403' EQUALS 1 0.0 0.0
 CF65510 1.0 0.0 COR-MUO2-DB.403
 CF65600 'DISOLV FU 404' EQUALS 1 0.0 0.0
 CF65610 1.0 0.0 COR-MUO2-DB.404
 CF65700 'DISOLV FU 405' EQUALS 1 206 062 0.0
 CF65710 1.0 0.0 COR-MUO2-DB.405
 CF65800 'DISOLV FU 406' EQUALS 1 206 062 0.0
 CF65810 1.0 0.0 COR-MUO2-DB.406
 CF65900 'DISOLV FU 407' EQUALS 1 206 062 0.0
 CF65910 1.0 0.0 COR-MUO2-DB.407
 CF66000 'DISOLV FU 408' EQUALS 1 206 062 0.0
 CF66010 1.0 0.0 COR-MUO2-DB.408
 CF66100 'DISOLV FU 409' EQUALS 1 206 062 0.0
 CF66110 1.0 0.0 COR-MUO2-DB.409
 CF66200 'DISOLV FU 410' EQUALS 1 206 062 0.0
 CF66210 1.0 0.0 COR-MUO2-DB.410
 CF66300 'DISOLV FU 411' EQUALS 1 206 062 0.0
 CF66310 1.0 0.0 COR-MUO2-DB.411

```

CF66400 'DISOLV FU 412' EQUALS 1 206.062 0.0
CF66410 1.0 0.0 COR-MUO2-DB.412
CF66500 'DISOLV FU 413' EQUALS 1 206.062 0.0
CF66510 1.0 0.0 COR-MUO2-DB.413
CF66600 'DISOLV FU 414' EQUALS 1 206.062 0.0
CF66610 1.0 0.0 COR-MUO2-DB.414
CF66700 'DISOLV FU 415' EQUALS 1 0.0 0.0
CF66710 1.0 0.0 COR-MUO2-DB.415
CF66800 'DISOLV FU 416' EQUALS 1 0.0 0.0
CF66810 1.0 0.0 COR-MUO2-DB.416
CF66900 'DISOLV FU 417' EQUALS 1 0.0 0.0
CF66910 1.0 0.0 COR-MUO2-DB.417
.
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.
.....
* TABLE 2 ENTRY 271-286 MOLTEN ZIRCALOY
* CF670 - CF???
.....
.
* FIRST RING, LEVELS 3 TO 17 -200MM TO 1300MM
.
CF67000 'ZR MOLTEN 103' EQUALS 1 6635.7000 0.0
CF67010 1.0 0.0 COR-MZR-DB.103
CF67100 'ZR MOLTEN 104' EQUALS 1 6635.7000 0.0
CF67110 1.0 0.0 COR-MZR-DB.104
CF67200 'ZR MOLTEN 105' EQUALS 1 6635.7000 0.0
CF67210 1.0 0.0 COR-MZR-DB.105
CF67300 'ZR MOLTEN 106' EQUALS 1 6635.7000 0.0
CF67310 1.0 0.0 COR-MZR-DB.106
CF67400 'ZR MOLTEN 107' EQUALS 1 6635.7000 0.0
CF67410 1.0 0.0 COR-MZR-DB.107
CF67500 'ZR MOLTEN 108' EQUALS 1 6635.7000 0.0
CF67510 1.0 0.0 COR-MZR-DB.108
CF67600 'ZR MOLTEN 109' EQUALS 1 6635.7000 0.0
CF67610 1.0 0.0 COR-MZR-DB.109
CF67700 'ZR MOLTEN 110' EQUALS 1 6635.7000 0.0
CF67710 1.0 0.0 COR-MZR-DB.110
CF67800 'ZR MOLTEN 111' EQUALS 1 6635.7000 0.0
CF67810 1.0 0.0 COR-MZR-DB.111
CF67900 'ZR MOLTEN 112' EQUALS 1 6635.7000 0.0
CF67910 1.0 0.0 COR-MZR-DB.112
CF68000 'ZR MOLTEN 113' EQUALS 1 5497.4959 0.0
CF68010 1.0 0.0 COR-MZR-DB.113
CF68100 'ZR MOLTEN 114' EQUALS 1 6635.7000 0.0
CF68110 1.0 0.0 COR-MZR-DB.114
CF68200 'ZR MOLTEN 115' EQUALS 1 6635.7000 0.0
CF68210 1.0 0.0 COR-MZR-DB.115
CF68300 'ZR MOLTEN 116' EQUALS 1 6635.7000 0.0
CF68310 1.0 0.0 COR-MZR-DB.116
CF68400 'ZR MOLTEN 117' EQUALS 1 6635.7000 0.0
CF68410 1.0 0.0 COR-MZR-DB.117
.
* SECOND RING, LEVELS 3 TO 17 -200MM TO 1300MM
.
CF68500 'ZR MOLTEN 203' EQUALS 1 1658.925 0.0
CF68510 1.0 0.0 COR-MZR-DB.203
CF68600 'ZR MOLTEN 204' EQUALS 1 1658.925 0.0
CF68610 1.0 0.0 COR-MZR-DB.204
CF68700 'ZR MOLTEN 205' EQUALS 1 1658.925 0.0
CF68710 1.0 0.0 COR-MZR-DB.205
CF68800 'ZR MOLTEN 206' EQUALS 1 1658.925 0.0
CF68810 1.0 0.0 COR-MZR-DB.206
CF68900 'ZR MOLTEN 207' EQUALS 1 1658.925 0.0
CF68910 1.0 0.0 COR-MZR-DB.207
CF69000 'ZR MOLTEN 208' EQUALS 1 1658.925 0.0

```

CF69010 1.0 0.0 COR-MZR-DB.208
 CF69100 'ZR MOLTEN 209' EQUALS 1 1658.925 0.0
 CF69110 1.0 0.0 COR-MZR-DB.209
 CF69200 'ZR MOLTEN 210' EQUALS 1 1658.925 0.0
 CF69210 1.0 0.0 COR-MZR-DB.210
 CF69300 'ZR MOLTEN 211' EQUALS 1 1658.925 0.0
 CF69310 1.0 0.0 COR-MZR-DB.211
 CF69400 'ZR MOLTEN 212' EQUALS 1 1658.925 0.0
 CF69410 1.0 0.0 COR-MZR-DB.212
 CF69500 'ZR MOLTEN 213' EQUALS 1 1332.260 0.0
 CF69510 1.0 0.0 COR-MZR-DB.213
 CF69600 'ZR MOLTEN 214' EQUALS 1 1658.925 0.0
 CF69610 1.0 0.0 COR-MZR-DB.214
 CF69700 'ZR MOLTEN 215' EQUALS 1 1658.925 0.0
 CF69710 1.0 0.0 COR-MZR-DB.215
 CF69800 'ZR MOLTEN 216' EQUALS 1 1658.925 0.0
 CF69810 1.0 0.0 COR-MZR-DB.216
 CF69900 'ZR MOLTEN 217' EQUALS 1 1658.925 0.0
 CF69910 1.0 0.0 COR-MZR-DB.217
 .

* THIRD RING, LEVELS 3 TO 17 -200MM TO 1300MM

.

CF70000 'ZR MOLTEN 303' EQUALS 1 748.783 0.0
 CF70010 1.0 0.0 COR-MZR-DB.303
 CF70100 'ZR MOLTEN 304' EQUALS 1 748.783 0.0
 CF70110 1.0 0.0 COR-MZR-DB.304
 CF70200 'ZR MOLTEN 305' EQUALS 1 748.783 0.0
 CF70210 1.0 0.0 COR-MZR-DB.305
 CF70300 'ZR MOLTEN 306' EQUALS 1 748.783 0.0
 CF70310 1.0 0.0 COR-MZR-DB.306
 CF70400 'ZR MOLTEN 307' EQUALS 1 748.783 0.0
 CF70410 1.0 0.0 COR-MZR-DB.307
 CF70500 'ZR MOLTEN 308' EQUALS 1 748.783 0.0
 CF70510 1.0 0.0 COR-MZR-DB.308
 CF70600 'ZR MOLTEN 309' EQUALS 1 748.783 0.0
 CF70610 1.0 0.0 COR-MZR-DB.309
 CF70700 'ZR MOLTEN 310' EQUALS 1 748.783 0.0
 CF70710 1.0 0.0 COR-MZR-DB.310
 CF70800 'ZR MOLTEN 311' EQUALS 1 748.783 0.0
 CF70810 1.0 0.0 COR-MZR-DB.311
 CF70900 'ZR MOLTEN 312' EQUALS 1 748.783 0.0
 CF70910 1.0 0.0 COR-MZR-DB.312
 CF71000 'ZR MOLTEN 313' EQUALS 1 604.631 0.0
 CF71010 1.0 0.0 COR-MZR-DB.313
 CF71100 'ZR MOLTEN 314' EQUALS 1 748.783 0.0
 CF71110 1.0 0.0 COR-MZR-DB.314
 CF71200 'ZR MOLTEN 315' EQUALS 1 748.783 0.0
 CF71210 1.0 0.0 COR-MZR-DB.315
 CF71300 'ZR MOLTEN 316' EQUALS 1 748.783 0.0
 CF71310 1.0 0.0 COR-MZR-DB.316
 CF71400 'ZR MOLTEN 317' EQUALS 1 748.783 0.0
 CF71410 1.0 0.0 COR-MZR-DB.317
 .

* FOURTH RING, LEVELS 3 TO 17 -200MM TO 1300MM

.

CF71500 'ZR MOLTEN 403' EQUALS 1 552.975 0.0
 CF71510 1.0 0.0 COR-MZR-DB.403
 CF71600 'ZR MOLTEN 404' EQUALS 1 552.975 0.0
 CF71610 1.0 0.0 COR-MZR-DB.404
 CF71700 'ZR MOLTEN 405' EQUALS 1 230.8722 0.0
 CF71710 1.0 0.0 COR-MZR-DB.405
 CF71800 'ZR MOLTEN 406' EQUALS 1 230.8722 0.0
 CF71810 1.0 0.0 COR-MZR-DB.406
 CF71900 'ZR MOLTEN 407' EQUALS 1 230.8722 0.0
 CF71910 1.0 0.0 COR-MZR-DB.407
 CF72000 'ZR MOLTEN 408' EQUALS 1 230.8722 0.0

```

CF72010 1.0 0.0 COR-MZR-DB 408
CF72100 'ZR MOLTEN 409' EQUALS 1 230.8722 0.0
CF72110 1.0 0.0 COR-MZR-DB.409
CF72200 'ZR MOLTEN 410' EQUALS 1 230.8722 0.0
CF72210 1.0 0.0 COR-MZR-DB.410
CF72300 'ZR MOLTEN 411' EQUALS 1 230.8722 0.0
CF72310 1.0 0.0 COR-MZR-DB.411
CF72400 'ZR MOLTEN 412' EQUALS 1 230.8722 0.0
CF72410 1.0 0.0 COR-MZR-DB.412
CF72500 'ZR MOLTEN 413' EQUALS 1 189.6094 0.0
CF72510 1.0 0.0 COR-MZR-DB.413
CF72600 'ZR MOLTEN 414' EQUALS 1 230.8722 0.0
CF72610 1.0 0.0 COR-MZR-DB.414
CF72700 'ZR MOLTEN 415' EQUALS 1 230.8722 0.0
CF72710 1.0 0.0 COR-MZR-DB.415
CF72800 'ZR MOLTEN 416' EQUALS 1 230.8722 0.0
CF72810 1.0 0.0 COR-MZR-DB.416
CF72900 'ZR MOLTEN 417' EQUALS 1 552.975 0.0
CF72910 1.0 0.0 COR-MZR-DB.417

```

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* isp31, cora13: MELCOR model of cora13 experiment

.

* Robert J. Gross and Gale M. Martinez

.

* 11/91 - Generated first input deck

.

.....

.....

TITLE 'CORA 13 - MODEL #1'

JOBID 'CORA 13 - MODEL #1'

.....

RESTARTF 'cora13.rst'

*****RESTART 4359 * -1 * RESTART FILE CYCLE NUMBER

RESTART -1 * RESTART FILE CYCLE NUMBER

OUTPUTF 'cora13.out'

MESSAGEF 'cora13.mes'

DIAGF 'cora13.dia'

PLOTF 'cora13.plt'

.

* ITEMp IMASS IVOL IASUR IP2D IPOW

COREDVC1 1 1 0 0 0 1

* IRAD ICND ICNV IOXD IDRP ITDZ IB4C IRDS IDEJ

*CORTST01 0 0 0 0 0 0 0 0 0 0

.....

* MELCOR CORA13 INPUT

.

DTIME 0.2

CPULEFT 40

CPULIM 70000

***** CVHTRACE

TIME DTMAX DTMIN DTEDIT DTPLOT DTRST DCREST

TIME1 0 1.0 0.001 100. 10.0 99999 1200

TIME2 3000. 1.0 0.001 100. 10.0 99999 1200.

TIME3 3100. 1.0 0.0001 100. 10.0 99999 1200.

TIME4 4000 1.0 0.0001 100. 2.5 99999 1200

TIME5 4800. 0.10 0.0001 100. 2.5 99999 1200

TIME6 4850 0.10 0.0001 100. 2.5 99999 1200

TEND 5051.

*TEND 4850

.....

Appendix B: Electrical Heater Subroutines

MELCOR does not have an internal model for electrical heater rods and the associated electrical circuits. MELCOR 1.8.2 does have a standard interface which will allow the user to supply FORTRAN routines to model the specific electrical features of a test facility and return the power generated when supplied with the time and temperature distribution. This FORTRAN code can be loaded with MELCOR using the MELCOR link utility "MULINKMEL" and will replace dummy routines in the default MELCOR source code library.

The code used for the CORA 13 experiment is shown below. There are five subroutines.

1. ELHEAT - This is the only routine called from MELCOR. Given the time and current temperature distribution in the COR materials, it must return the current power distribution. The specific nodalization used in the MELCOR model (19 axial levels and 4 radial rings) is assumed in the code. Additional details are contained in the comments in the code.
2. ELVOLT - This routine returns the electrical voltage, current, and power from the defined boundary conditions for this experiment, given the time and ring number.
3. ELREST - This routine defines the electrical resistance, given the material and the temperature for a rod section.
4. ELCONS - This routine contains the geometrical information concerning the electrical rod configuration.
5. ELOUTF - This routine controls the separate output file generated by these routines. If a calculation is being restarted, the file is positioned to the correct point for extension. The output file can be listed or read by another code to generate plotted information.

```

*DECK ELHEAT
SUBROUTINE ELHEAT (NCOMP,NLEVEL,NRING,TEMP,POWER)
C
C*****
C          ***** CORA 13 - ISP 31 *****
C
C      This is a special routine for MELCOR to treat electrical heater
C      rods for CORA 13 test (ISP 31). Specific COR zoning is assumed.
C      The COR model has 19 levels and 4 rings. Rings 2 and 4 have
C      electrical rods.
C
C      For input time and temperature, return power in each rod section.
C
C      Inputs:
C
C      NCOMP = number of components - this calculation only uses one of
C              values, KCOMP, to insert power. NCOMP is for dimensions
C              of arrays.
C
C      NLEVEL = number of MELCOR levels in COR - NOTE: The EL package
C              for CORA will have one more level than COR package for
C              CU section of rods which are not in the MELCOR COR
C              nodalization. Extra level is at top.
C
C      NRING = number of MELCOR rings (must be 4 for this package)
C
C      TEMP = array of temperatures - dimension (NCOMP,NLEVEL,NRING)
C
C      Outputs:
C
C      POWER = array of powers - dimension (NLEVEL,NRING)
C              (rings 1 & 3 will always be zero)
C
C      Inputs from common block
C
C      TIME = time (s)
C
C      DT = time step
C
C      NCYCLE = cycle number
C
C      Reference - CORA 13 Specification Report
C*****
C      This routine replaces a dummy routine in standard MELCOR package.
C      Routine is replaced at link time with normal melcor maintenance
C      utility mulinkmel. This is the only entry into EL package.
C
C      This package generates its own output file "corael.out" separate
C      from normal melcor output. The file serves for both printed and
C      graphics output. The file is automatically extended during a
C      restart.
C
C      The call to this package is activated by setting the third
C      parameter on COR input record COR00002.
C
C      Data for specific CORA test is hard coded in following routines.
C
C      written by      S. L. Thompson & R. J. Gross
C                      Thermal/Hydraulic Analysis Department, 6418
C                      Sandia National Laboratory
C                      Albuquerque, New Mexico USA 87185-5800
C*****
C                      SLT 11/6/91 *****
C
C      SAVE
C      DIMENSION TEMP(NCOMP,NLEVEL,NRING),POWER(NLEVEL,NRING)
C
C      component number for electrical part of rod

```

PARAMETER (KCOMP=1)	ELHEAT.72
C	ELHEAT.73
C cor model must have 19 levels	ELHEAT.74
C	ELHEAT.75
PARAMETER (KLEVEL=20)	ELHEAT.76
DIMENSION TK(2,KLEVEL),POW(2,KLEVEL)	ELHEAT.77
DIMENSION TVOLTS(2),CURR(2),TRESIS(2),TCON(3)	ELHEAT.78
DIMENSION CRESIS(2,KLEVEL)	ELHEAT.79
DIMENSION CRECOR(2,KLEVEL)	ELHEAT.80
DIMENSION RINGR(2),RINGP(2),RSCALE(2),RINGRC(2)	ELHEAT.81
C	ELHEAT.82
C following are melcor common blocks (system independent)	ELHEAT.83
C	ELHEAT.84
*- INCLUDE MXXTIM	ELHEAT.85
C TIME COMMON BLOCK	ELHEAT.86
C TIME = PROBLEM TIME	ELHEAT.87
C DT = TIMESTEP	ELHEAT.88
C CPU = CPU TIME	ELHEAT.89
C NCYCLE = CYCLE NUMBER	ELHEAT.90
C NDTPAK = PACKAGE CONTROLLING TIMESTEP	ELHEAT.91
COMMON /MXXTIM/ TIME, DT, CPU, NCYCLE	ELHEAT.92
COMMON /MXXTPK/ NDTPAK	ELHEAT.93
CHARACTER*3 NDTPAK	ELHEAT.94
C	ELHEAT.95
*-	ELHEAT.96
*- INCLUDE MXXEI7	ELHEAT.97
COMMON /MXXEI7/ JTITLE	ELHEAT.98
CHARACTER*110 JTITLE	ELHEAT.99
*-	ELHEAT.100
C print unit number	ELHEAT.101
COMMON /ELPUNT/ IPU	ELHEAT.102
C	ELHEAT.103
C rod materials & geometry for each ring and level	ELHEAT.104
C length in M area in mm2 material number	ELHEAT.105
COMMON /HRODAT/ FLENG(KLEVEL),AREA(KLEVEL),IMAT(KLEVEL)	ELHEAT.106
C	ELHEAT.107
DATA IONCE /0/	ELHEAT.108
DATA LONCE /0/	ELHEAT.109
C	ELHEAT.110
IF (IONCE.EQ.0) THEN	ELHEAT.111
C	ELHEAT.112
C check for good dimensions	ELHEAT.113
IF((KLEVEL.NE.NLEVEL+1).OR.(NRING.NE.4)) GO TO 800	ELHEAT.114
C set model constants	ELHEAT.115
CALL ELCONS (KLEVEL,FLENG,AREA,IMAT,TIMPNT,PRNTDT,TCON)	ELHEAT.116
C	ELHEAT.117
END IF	ELHEAT.118
C	ELHEAT.119
C load arrays, set constant values and given boundary conditions	ELHEAT.120
C	ELHEAT.121
IR=2	ELHEAT.122
DO 10 I=1,2	ELHEAT.123
DO 20 J=3,KLEVEL-1	ELHEAT.124
20 TK(I,J)=TEMP(KCOMP,J-1,IR)	ELHEAT.125
TK(I,1)=TCON(1)	ELHEAT.126
TK(I,2)=TCON(2)	ELHEAT.127
TK(I,KLEVEL)=TCON(3)	ELHEAT.128
CALL ELVOLT(TIME,I,TVOLTS(I),CURR(I),TRESIS(I))	ELHEAT.129
10 IR=4	ELHEAT.130
C	ELHEAT.131
C Now determine resistances from temperatures.	ELHEAT.132
C These will not, in general, give the same total rod resistance	ELHEAT.133
C and power as defined in the given data. Will renormalize.	ELHEAT.134
C Above current for ring is assumed correct. We could also use	ELHEAT.135
C resistance and rescale current for same result.	ELHEAT.136
C	ELHEAT.137
C In addition each rod has a cable at each end with 0.25 milliohm	ELHEAT.138
C resistance (cora test report).	ELHEAT.139
C	ELHEAT.140
DO 30 I=1,2	ELHEAT.141
RINGR(I)=0.	ELHEAT.142
RINGP(I)=0.	ELHEAT.143
DO 40 J=1,KLEVEL	ELHEAT.144

	CALL ELREST (IMAT(J),TK(I,J),CRESIS(I,J))	ELHEAT.145
	CRESIS(I,J)=CRESIS(I,J)*FLENG(J)/AREA(J)	ELHEAT.146
C		ELHEAT.147
C	add 0.25 milliohms to top and bottom element	ELHEAT.148
C		ELHEAT.149
	IF((J.EQ.1).OR.(J.EQ.KLEVEL)) THEN	ELHEAT.150
	CRESIS(I,J)=CRESIS(I,J)+0.00025	ELHEAT.151
	END IF	ELHEAT.152
C		ELHEAT.153
	RINGR(I)=RINGR(I) + CRESIS(I,J)	ELHEAT.154
	RINGP(I)=RINGP(I) + CRESIS(I,J)*CURR(I)**2	ELHEAT.155
40	CONTINUE	ELHEAT.156
30	CONTINUE	ELHEAT.157
	IF(IONCE.EQ.0) THEN	ELHEAT.158
	RCONS = CRESIS(1,1) + CRESIS(1,2) + CRESIS(1,KLEVEL)	ELHEAT.159
	IONCE = 1	ELHEAT.160
	END IF	ELHEAT.161
C		ELHEAT.162
C	determine rescale numbers	ELHEAT.163
C	now normalize on resistance instead of power	ELHEAT.164
C	(both use experimental voltage and current)	ELHEAT.165
C	exclude resistance from elements 1,2 and 20 because the	ELHEAT.166
C	calculation should agree very well with experiment	ELHEAT.167
C		ELHEAT.168
	DO 50 I=1,2	ELHEAT.169
	IF(RINGP(I).LE.RCONS) THEN	ELHEAT.170
	RSCALE(I)=1.	ELHEAT.171
	ELSE	ELHEAT.172
	RSCALE(I)=((TVOLTS(I)/CURR(I)) - RCONS) / (RINGR(I)-RCONS)	ELHEAT.173
	END IF	ELHEAT.174
C		ELHEAT.175
C	rescale resistance and set power	ELHEAT.176
C		ELHEAT.177
	CRECOR(I,1) = CRESIS(I,1)	ELHEAT.178
	CRECOR(I,2) = CRESIS(I,2)	ELHEAT.179
	CRECOR(I,KLEVEL) = CRESIS(I,KLEVEL)	ELHEAT.180
	DO 55 J=3,KLEVEL-1	ELHEAT.181
55	CRECOR(I,J) = RSCALE(I)*CRESIS(I,J)	ELHEAT.182
	DO 60 J=1,KLEVEL	ELHEAT.183
60	POW(I,J) = CRECOR(I,J)*CURR(I)**2	ELHEAT.184
50	CONTINUE	ELHEAT.185
C		ELHEAT.186
C	load cumulative power from each cell into the COR POWER array	ELHEAT.187
C	don't forget to multiply ring 2 by 4 and ring 4 by 12 to	ELHEAT.188
C	account for the number of rods in each ring	ELHEAT.189
C		ELHEAT.190
	DO 70 J=1,NLEVEL	ELHEAT.191
	POWER(J,2) = POW(1,J)*4.0	ELHEAT.192
70	POWER(J,4) = POW(2,J)*12.0	ELHEAT.193
C		ELHEAT.194
C	always return zero power in rings 1 and 3	ELHEAT.195
C		ELHEAT.196
	DO 71 J=1,3,2	ELHEAT.197
	DO 71 I=1,NLEVEL	ELHEAT.198
71	POWER(I,J) = 0.0	ELHEAT.199
C		ELHEAT.200
C	list stuff to log file if time is right	ELHEAT.201
C		ELHEAT.202
	IF (TIME+0.5*DT .GT. TIMPNT) THEN	ELHEAT.203
	TIMPNT = TIMPNT + PRNTDT	ELHEAT.204
	IF (LONCE.EQ.0) THEN	ELHEAT.205
C	for restart	ELHEAT.206
	LONCE=1	ELHEAT.207
69	CONTINUE	ELHEAT.208
	IF (TIME+0.5*DT .GT. TIMPNT) THEN	ELHEAT.209
	TIMPNT = TIMPNT + PRNTDT	ELHEAT.210
	GO TO 69	ELHEAT.211
	END IF	ELHEAT.212
	END IF	ELHEAT.213
C		ELHEAT.214
C	sum resistance and power for print	ELHEAT.215
C		ELHEAT.216
	DO 82 I=1,2	ELHEAT.217

	RINGRC(I)=0.	ELHEAT.218
	RINGP(I)=0.	ELHEAT.219
	DO 81 J=1,KLEVEL	ELHEAT.220
	RINGRC(I) = RINGRC(I)+CRECOR(I,J)	ELHEAT.221
81	RINGP(I) = RINGP(I)+POW(I,J)	ELHEAT.222
82	CONTINUE	ELHEAT.223
C		ELHEAT.224
	WRITE(IPU,79) TIME,(I,TVOLTS(I),CURR(I),TRESIS(I),	ELHEAT.225
&	RINGR(I),RINGRC(I),RSCALE(I),I=1,2)	ELHEAT.226
79	FORMAT(' %%%',/, ' TIME=',1PE13.5,/,	ELHEAT.227
&	' ring voltage current resist_data resist_cal re',	ELHEAT.228
&	' sist_corr rescale (rod)'	ELHEAT.229
&	,/, 1X,11,6E12.4,/,	ELHEAT.230
&	1X,11,6E12.4)	ELHEAT.231
C		ELHEAT.232
	WRITE(IPU,78) 1,RINGP(1),4.*RINGP(1),	ELHEAT.233
&	2,RINGP(2),12.*RINGP(2),4.*RINGP(1)+12.*RINGP(2)	ELHEAT.234
78	FORMAT(' ring power/rod power/ring total_power'	ELHEAT.235
&	,/,1X,11,1P,2E12.4,/,1X,11,3E12.4)	ELHEAT.236
C		ELHEAT.237
	WRITE(IPU,86)	ELHEAT.238
86	FORMAT(' level mat temp, resist, power',14x,	ELHEAT.239
&	' temp, resist, power',/,	ELHEAT.240
&	18X,' ring 1',27X,' ring 2 (per rod)'	ELHEAT.241
	DO 88 J=KLEVEL,1,-1	ELHEAT.242
	WRITE(IPU,84) J,IMAT(J),(TK(I,J),CRECOR(I,J),POW(I,J),I=1,2)	ELHEAT.243
88	CONTINUE	ELHEAT.244
84	FORMAT(1X,2I2,1P,6E12.4)	ELHEAT.245
C		ELHEAT.246
	END IF	ELHEAT.247
C		ELHEAT.248
	RETURN	ELHEAT.249
C		ELHEAT.250
C	error	ELHEAT.251
C		ELHEAT.252
800	STOP '800ELHEAT'	ELHEAT.253
	END	ELHEAT.254

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*DECK ELVOLT
SUBROUTINE ELVOLT (TIME,IRING,VOLTS,CURR,TRESIS)
C
C***** CORA 13 - ISP 31 *****
C   For given time and MELCOR ring, determine voltage, current and
C   total resistance per rod from specification report data.
C
C   Inputs:
C   TIME = CORA test time
C   IRING = MELCOR ring (1 or 2)
C
C   Outputs:
C   VOLTS = voltage drop across entire rod
C   CURR  = single rod current (4 rods in inner ring - 12 in outer)
C   TRESIS = total single rod resistance in ohm
C
C   Reference - CORA 13 Specification Report
C***** SLT 11/6/91 *****
C
SAVE IONCE, TP, P, TV, V, IPP, IPV
DIMENSION TP(8),P(8)
DIMENSION TV(10),V(2,10)
DATA IONCE /0/
DATA IPP /1/
DATA IPV /1/
C
IF(IONCE.EQ.0) THEN
C
C   power table
C
C       time(s)      power (w)
C   TP(1)= -1000.
C   P(1) =          650.
C   TP(2)=  3000.
C   P(2) =          650.
C   TP(3)=  3015.
C   P(3) =         6000.
C   TP(4)=  4735.
C   P(4) =        26500.
C   TP(5)=  4800.
C   P(5) =        27000.
C   TP(6)=  4905.
C   P(6) =        27000.
C   TP(7)=  4910.
C   P(7) =           0.
C   TP(8)= 100000.
C   P(8) =           0.
C
C   ring voltage
C
C       time(s)      ring 1      ring 2
C                   voltage (v)  voltage (v)
C   TV(1)= -1000.
C   V(1,1) =          .58
C   V(2,1) =          .58
C   TV(2)=  3000.
C   V(1,2) =          .58
C   V(2,2) =          .58
C   TV(3)=  3015.
C   V(1,3) =          1.9
C   V(2,3) =          1.9
C   TV(4)=  4100.
C   V(1,4) =          4.8
C   V(2,4) =          4.6

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TV(5)=	4300.			ELVOLT.73
V(1,5) =		5.7		ELVOLT.74
V(2,5) =			5.5	ELVOLT.75
TV(6)=	4400.			ELVOLT.76
V(1,6) =		5.9		ELVOLT.77
V(2,6) =			5.8	ELVOLT.78
TV(7)=	4735.			ELVOLT.79
V(1,7) =		6.8		ELVOLT.80
V(2,7) =			6.8	ELVOLT.81
TV(8)=	4905.			ELVOLT.82
V(1,8) =		6.8		ELVOLT.83
V(2,8) =			6.8	ELVOLT.84
TV(9)=	4910.			ELVOLT.85
V(1,9) =		0.2		ELVOLT.86
V(2,9) =			0.2	ELVOLT.87
TV(10)=	10000.			ELVOLT.88
V(1,10) =		0.2		ELVOLT.89
V(2,10) =			0.2	ELVOLT.90
IONCE=1				ELVOLT.91
C	END IF			ELVOLT.92
C	determine position in tables			ELVOLT.93
C	determine power in each rod			ELVOLT.94
C	power in each rod is the same			ELVOLT.95
C				ELVOLT.96
10	CONTINUE			ELVOLT.97
	IF (TIME.GT.TP (IPP+1)) THEN			ELVOLT.98
	IPP=IPP+1			ELVOLT.99
	GO TO 10			ELVOLT.100
	END IF			ELVOLT.101
11	CONTINUE			ELVOLT.102
	IF (TIME.LT.TP (IPP)) THEN			ELVOLT.103
	IPP=IPP-1			ELVOLT.104
	GO TO 11			ELVOLT.105
	END IF			ELVOLT.106
20	CONTINUE			ELVOLT.107
	IF (TIME.GT.TV (IPV+1)) THEN			ELVOLT.108
	IPV=IPV+1			ELVOLT.109
	GO TO 20			ELVOLT.110
	END IF			ELVOLT.111
21	CONTINUE			ELVOLT.112
	IF (TIME.LT.TV (IPV)) THEN			ELVOLT.113
	IPV=IPV-1			ELVOLT.114
	GO TO 21			ELVOLT.115
	END IF			ELVOLT.116
C				ELVOLT.117
C	determine power in each rod			ELVOLT.118
C	power in each rod is the same			ELVOLT.119
C				ELVOLT.120
	RODP= (P (IPP+1) * (TIME-TP (IPP)) + P (IPP) * (TP (IPP+1) - TIME)) /			ELVOLT.121
	& (16. * (TP (IPP+1) - TP (IPP)))			ELVOLT.122
	IR=MAX (1, MIN (2, IRING))			ELVOLT.123
	VOLTS= (V (IR, IPV+1) * (TIME-TV (IPV)) + V (IR, IPV) * (TV (IPV+1) - TIME)) /			ELVOLT.124
	& (TV (IPV+1) - TV (IPV))			ELVOLT.125
	CURR=RODP/VOLTS			ELVOLT.126
	TRESIS=RODP/MAX (1.E-20, CURR**2)			ELVOLT.127
	RETURN			ELVOLT.128
	END			ELVOLT.129
				ELVOLT.130
				ELVOLT.131

*DECK ELREST	ELREST.1
SUBROUTINE ELREST (IMAT,TEMP,RESIST)	ELREST.2
C	ELREST.3
C*****	ELREST.4
C ***** CORA 13 - ISP 31 *****	ELREST.5
C Determine electrical resistance for materials in heater rods	ELREST.6
C and electrodes.	ELREST.7
C	ELREST.8
C Inputs:	ELREST.9
C	ELREST.10
C IMAT = material number	ELREST.11
C = 1, CU	ELREST.12
C = 2, MO	ELREST.13
C = 3, W	ELREST.14
C	ELREST.15
C TEMP = temperature (K)	ELREST.16
C	ELREST.17
C Outputs:	ELREST.18
C	ELREST.19
C RESIST = resistance in ohm*mm**2/m	ELREST.20
C	ELREST.21
C Reference - CORA 13 Specification Report	ELREST.22
C	ELREST.23
C***** SLT 11/6/91 *****	ELREST.24
C	ELREST.25
C print unit number	ELREST.26
C COMMON /ELPUNT/ IPU	ELREST.27
C	ELREST.28
C T=MAX(300.,TEMP)	ELREST.29
C	ELREST.30
C IF(IMAT.EQ.3) THEN	ELREST.31
C w	ELREST.32
C RESIST=-0.0261 + T * (0.263E-3 + 0.220E-7 * T)	ELREST.33
C	ELREST.34
C ELSEIF(IMAT.EQ.2) THEN	ELREST.35
C mo	ELREST.36
C RESIST= 2.249E-2 + T * (5.36E-5 + T * (1.38E-7 - T * 2.22E-11))	ELREST.37
C	ELREST.38
C ELSEIF(IMAT.EQ.1) THEN	ELREST.39
C cu	ELREST.40
C RESIST=-7.89E-3 + T * (9.90E-5 - T * (5.49E-8 - T * 3.16E-11))	ELREST.41
C	ELREST.42
C ELSE	ELREST.43
C WRITE(IPU,10) IMAT,TEMP	ELREST.44
C WRITE(6,10) IMAT,TEMP	ELREST.45
10 FORMAT(' BAD INPUT TO ELREST imat,temp',I5,1PE14.7)	ELREST.46
STOP 'ELREST'	ELREST.47
END IF	ELREST.48
RETURN	ELREST.49
END	ELREST.50


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*DECK ELCONS                                ELCONS.1
      SUBROUTINE ELCONS (KLEVEL, FLENG, AREA, IMAT, TIMPNT, PRNTDT, TCON) ELCONS.2
C                                           ELCONS.3
C***** ELCONS.4
C          ***** CORA 13 - ISP 31 ***** ELCONS.5
C      Set rod materials & geometry for each ring and level. Data must ELCONS.6
C      agree with MELCOR COR input. ELCONS.7
C                                           ELCONS.8
C      Reference - CORA 13 Specification Report ELCONS.9
C                                           ELCONS.10
C      Inputs: ELCONS.11
C                                           ELCONS.12
C      KLEVEL = number of axial levels ELCONS.13
C                                           ELCONS.14
C      Outputs: ELCONS.15
C                                           ELCONS.16
C      FLENG = array of axial segments lengths in meters ELCONS.17
C                                           ELCONS.18
C      AREA = array of cross-sectional areas in mm2 ELCONS.19
C                                           ELCONS.20
C      IMAT = array of material numbers for each section ELCONS.21
C              copper is 1 ELCONS.22
C              molybdenum is 2 ELCONS.23
C              tungsten is 3 ELCONS.24
C                                           ELCONS.25
C      TIMPNT = print frequency for this package ELCONS.26
C                                           ELCONS.27
C      TCON = three element temperature array for ELCONS.28
C              bottom two nodes (in quench bucket) and ELCONS.29
C              top node (top shroud - element 3). These are ELCONS.30
C              used to determine resistance and are assumed ELCONS.31
C              constant during the calculation. ELCONS.32
C                                           ELCONS.33
C***** SLT 11/6/91 ***** ELCONS.34
C                                           ELCONS.35
C      SAVE ELCONS.36
C      PARAMETER (PIE=3.1415926) ELCONS.37
C      PARAMETER (LLEVEL=20) ELCONS.38
C                                           ELCONS.39
C      following are melcor common blocks (system independent) ELCONS.40
C                                           ELCONS.41
C      *- INCLUDE MXXTIM ELCONS.42
C      TIME COMMON BLOCK ELCONS.43
C      TIME = PROBLEM TIME ELCONS.44
C      DT = TIMESTEP ELCONS.45
C      CPU = CPU TIME ELCONS.46
C      NCYCLE = CYCLE NUMBER ELCONS.47
C      NDTPAK = PACKAGE CONTROLLING TIMESTEP ELCONS.48
C      COMMON /MXXTIM/ TIME, DT, CPU, NCYCLE ELCONS.49
C      COMMON /MXXTPK/ NDTPAK ELCONS.50
C      CHARACTER*3 NDTPAK ELCONS.51
C                                           ELCONS.52
C      *- ELCONS.53
C      rod materials & geometry for each ring and level ELCONS.54
C              length in M area in mm2 material number ELCONS.55
C      DIMENSION FLENG(KLEVEL), AREA(KLEVEL), IMAT(KLEVEL), TCON(3) ELCONS.56
C                                           ELCONS.57
C      print unit number ELCONS.58
C                                           ELCONS.59
C      COMMON /ELPUNT/ IPU ELCONS.60
C      DATA IONCE /0/ ELCONS.61
C                                           ELCONS.62
C      set print frequency for output (in seconds) ELCONS.63
C                                           ELCONS.64
C      PRNTDT = 2.5 ELCONS.65
C      TIMPNT = PRNTDT ELCONS.66
C                                           ELCONS.67
C      temperatures for bottom (2) levels and top level ELCONS.68
C                                           ELCONS.69
C      TCON(1)=313. ELCONS.70
C      TCON(2)=313. ELCONS.71
C      TCON(3)=393. ELCONS.72

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C		ELCONS.73
C	check dimensions	ELCONS.74
C		ELCONS.75
C	IF(LLEVEL.NE.KLEVEL) STOP 'ELCONS ERROR'	ELCONS.76
C		ELCONS.77
C	load some defaults	ELCONS.78
C		ELCONS.79
	DO 10 J=1,KLEVEL	ELCONS.80
	FLENG(J)=0.1000	ELCONS.81
	IMAT(J)=3	ELCONS.82
10	AREA(J)=6.	ELCONS.83
C		ELCONS.84
C	material indicators	ELCONS.85
C		ELCONS.86
C	level 1 is copper (1)	ELCONS.87
C	levels 2-4 are molybdenum (2)	ELCONS.88
C	levels 5-14 are tungsten (3)	ELCONS.89
C	levels 15-17 are molybdenum	ELCONS.90
C	levels 18-19 are copper below the flange	ELCONS.91
C	level 20 is copper above the flange	ELCONS.92
C		ELCONS.93
	IMAT(1)=1	ELCONS.94
	IMAT(2)=2	ELCONS.95
	IMAT(3)=2	ELCONS.96
	IMAT(4)=2	ELCONS.97
	IMAT(KLEVEL-5)=2	ELCONS.98
	IMAT(KLEVEL-4)=2	ELCONS.99
	IMAT(KLEVEL-3)=2	ELCONS.100
	IMAT(KLEVEL-2)=1	ELCONS.101
	IMAT(KLEVEL-1)=1	ELCONS.102
	IMAT(KLEVEL)=1	ELCONS.103
C		ELCONS.104
C	set diameters in area array	ELCONS.105
C		ELCONS.106
	AREA(1)=8.6	ELCONS.107
	AREA(2)=8.6	ELCONS.108
	AREA(3)=8.6	ELCONS.109
	AREA(4)=8.6	ELCONS.110
	AREA(KLEVEL-5)=8.6	ELCONS.111
	AREA(KLEVEL-4)=8.6	ELCONS.112
	AREA(KLEVEL-3)=8.6	ELCONS.113
	AREA(KLEVEL-2)=8.6	ELCONS.114
	AREA(KLEVEL-1)=8.6	ELCONS.115
	AREA(KLEVEL)=8.6	ELCONS.116
C		ELCONS.117
C	set areas	ELCONS.118
C		ELCONS.119
	DO 50 J=1,KLEVEL	ELCONS.120
50	AREA(J)=PIF*(AREA(J)**2)/4.	ELCONS.121
C		ELCONS.122
C	set lengths of rod sections	ELCONS.123
C		ELCONS.124
	FLENG(1)=0.189	ELCONS.125
	FLENG(2)=0.100	ELCONS.126
	FLENG(3)=0.100	ELCONS.127
	FLENG(4)=0.100	ELCONS.128
	FLENG(5)=0.1024	ELCONS.129
	FLENG(6)=0.1024	ELCONS.130
	FLENG(7)=0.1024	ELCONS.131
	FLENG(8)=0.1024	ELCONS.132
	FLENG(9)=0.1024	ELCONS.133
	FLENG(10)=0.1024	ELCONS.134
	FLENG(11)=0.1024	ELCONS.135
	FLENG(12)=0.1024	ELCONS.136
	FLENG(13)=0.1024	ELCONS.137
	FLENG(14)=0.1024	ELCONS.138
	FLENG(15)=0.100	ELCONS.139
	FLENG(16)=0.100	ELCONS.140
	FLENG(17)=0.100	ELCONS.141
	FLENG(18)=0.100	ELCONS.142
	FLENG(19)=0.047	ELCONS.143
C	next length is 661 mm - 147 mm	ELCONS.144
	FLENG(20)=0.514	ELCONS.145

C		ELCONS.146
C	print results once	ELCONS.147
C		ELCONS.148
	IF (IONCE.EQ.0) THEN	ELCONS.149
	IONCE=1	ELCONS.150
C		ELCONS.151
	CALL ELOUTF	ELCONS.152
C		ELCONS.153
	TOP=-(0.25+0.239)	ELCONS.154
	DO 60 J=1,KLEVEL	ELCONS.155
60	TOP=TOP+FLENG(J)	ELCONS.156
	WRITE(IPU,70) TOP	ELCONS.157
70	FORMAT(//,' electric rod geometry and material data',//,2X,	ELCONS.158
&	'elevation (m)',5X,'length (m)',5X,'area (mm2)',5X,'material'	ELCONS.159
&	,//,3X,1PE12.5)	ELCONS.160
80	FORMAT(3X,1PE12.5,2E15.5,I10,I5)	ELCONS.161
	DO 90 J=KLEVEL,1,-1	ELCONS.162
	TOP=TOP-FLENG(J)	ELCONS.163
90	WRITE(IPU,80) TOP,FLENG(J),AREA(J),IMAT(J),J	ELCONS.164
	END IF	ELCONS.165
C		ELCONS.166
	RETURN	ELCONS.167
	END	ELCONS.168

*DECK ELOUTF	ELOUTF.1
SUBROUTINE ELOUTF	ELOUTF.2
C	ELOUTF.3
C*****	ELOUTF.4
C ***** CORA 13 - ISP 31 *****	ELOUTF.5
C Open EL package output file. If restart then position file.	ELOUTF.6
C Should only be called once per execution.	ELOUTF.7
C	ELOUTF.8
C If time = 0, start new file	ELOUTF.9
C > 0, try to extend file	ELOUTF.10
C	ELOUTF.11
C***** SLT 11/14/91 *****	ELOUTF.12
C	ELOUTF.13
C SAVE	ELOUTF.14
C	ELOUTF.15
C following are melcor common blocks (system independent)	ELOUTF.16
C	ELOUTF.17
C *- INCLUDE MXXTIM	ELOUTF.18
C TIME COMMON BLOCK	ELOUTF.19
C TIME = PROBLEM TIME	ELOUTF.20
C DT = TIMESTEP	ELOUTF.21
C CPU = CPU TIME	ELOUTF.22
C NCYCLE = CYCLE NUMBER	ELOUTF.23
C NDTPAK = PACKAGE CONTROLLING TIMESTEP	ELOUTF.24
C COMMON /MXXTIM/ TIME, DT, CPU, NCYCLE	ELOUTF.25
C COMMON /MXXTPK/ NDTPAK	ELOUTF.26
C CHARACTER*3 NDTPAK	ELOUTF.27
C	ELOUTF.28
C *-	ELOUTF.29
C *- INCLUDE MXXEI7	ELOUTF.30
C COMMON /MXXEI7/ JTITLE	ELOUTF.31
C CHARACTER*110 JTITLE	ELOUTF.32
C *-	ELOUTF.33
C CHARACTER*4 TEXT	ELOUTF.34
C print unit number	ELOUTF.35
C COMMON /ELPUNT/ IPU	ELOUTF.36
C	ELOUTF.37
C set print unit number	ELOUTF.38
C IPU=39	ELOUTF.39
C	ELOUTF.40
C IF(NCYCLE.NE.0) THEN	ELOUTF.41
C OPEN(IPU,FILE='corael.out',STATUS='OLD',ERR=100,	ELOUTF.42
C & FORM='FORMATTED')	ELOUTF.43
C ELSE	ELOUTF.44
C GO TO 110	ELOUTF.45
C END IF	ELOUTF.46
C	ELOUTF.47
C extend current file	ELOUTF.48
C	ELOUTF.49
C TLAST=0.	ELOUTF.50
C KOUNT=0	ELOUTF.51
C 10 READ(IPU,'(A)',ERR=50,END=50) TEXT	ELOUTF.52
C IF(INDEX(TEXT,'***').GT.0) THEN	ELOUTF.53
C READ(IPU,12,ERR=49,END=49) RTIME	ELOUTF.54
C 12 FORMAT(6X,E13.5)	ELOUTF.55
C IF(RTIME.GE.TIME) GO TO 49	ELOUTF.56
C TLAST=RTIME	ELOUTF.57
C END IF	ELOUTF.58
C KOUNT=KOUNT+1	ELOUTF.59
C GO TO 10	ELOUTF.60
C	ELOUTF.61
C 49 BACKSPACE IPU	ELOUTF.62
C 50 BACKSPACE IPU	ELOUTF.63
C WRITE(6,52) TLAST	ELOUTF.64
C 52 FORMAT(' Extending EL output file from time =',1PE13.5)	ELOUTF.65
C GO TO 200	ELOUTF.66
C	ELOUTF.67
C 100 CLOSE(IPU,ERR=110)	ELOUTF.68
C	ELOUTF.69
C start new file	ELOUTF.70
C	ELOUTF.71
C 110 WRITE(6,112)	ELOUTF.72

112	FORMAT(' Generating new EL output file')	ELOUTF.73
C		ELOUTF.74
	OPEN(IPU,FILE='corael.out',STATUS='UNKNOWN',ERR=900,	ELOUTF.75
	& FORM='FORMATTED')	ELOUTF.76
C		ELOUTF.77
200	WRITE(IPU,210) JTITLE(31:110),JTITLE(1:30)	ELOUTF.78
210	FORMAT(' %t',/,1X,A,/,1X,A,/)	ELOUTF.79
	RETURN	ELOUTF.80
C		ELOUTF.81
900	WRITE(6,910) IPU	ELOUTF.82
910	FORMAT(' UNABLE TO OPEN CORAEL.OUT FILE ON UNIT',I3)	ELOUTF.83
	STOP 'CORAEL'	ELOUTF.84
	END	ELOUTF.85

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