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CORCON-MOD1 Preliminary Evaluation
and Application to Safety Analysis
of a Large LMFBP Plant

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SUMMARY

The CORCON-MOD1 core material-concrete interaction code, developed at the Sandia Laboratories for LWR safety analysis, was adapted for analyzing a postulated LMFBR core melt accident.

The LMFBR plant considered was a large commercial type plant of 2550 Mwt capacity. The postulated accident was assumed to be non-energetic and result in a core meltdown. Molten core debris was assumed to penetrate the reactor vessel (RV) at 1000S after neutronic shutdown. About 50 tons of core fuel, axial and inner blankets, 27 tons of steel and 10^6 kg of sodium discharged into the limestone concrete cavity following RV melt through. The molten fuel material (3100°K), molten steel (3100°K), and sodium (1160°K) were assumed to stratify after initial deposition; the heavy molten fuel formed the bottom layer followed by molten steel and sodium. Above the stratified pool a gas mixture atmosphere at an ambient temperature of 680°K was assumed.

The basic CORCON system consists of a two-dimensional axisymmetric concrete cavity with a stratified pool and a gaseous atmosphere. Each stratum (including the atmosphere) is assumed to be isothermal in bulk. The order of stratification is determined by the bulk layer densities. The CORCON model addresses the transport and conservation of energy and mass, and the chemical reactions among the core materials, concrete and the atmosphere.

CORCON-MOD1, the first version of the CORCON system and the one used in the present study, contains most of the general features of the system, but with a few significant assumptions. These include: (1) no consideration of coolant layer, (2) no interaction between the debris pool and the atmosphere, (3) sufficient gas flow through the pool to keep pool well-stirred but not to disturb the layers, (4) steady-state and locally one-dimensional concrete erosion rate. The code is thus applicable only to the analysis of an accident with the debris in a molten state which usually occurs at the early stage of the accident. Additionally, since the code is intended for the LWR safety analysis, chemical species, such as Na and PuO_2 , typical of the LMFBR, are not included.

The CORCON analysis of the LMFBR postulated meltdown accident was primarily aimed at evaluating the capability and limitation of the code. Because of the code limitation, the results were not typical of an LMFBR plant accident and, therefore, the interpretation was essentially qualitative.

The duration of the accident analyzed was 7200S. At the end of that period, the molten debris penetration was quite small, the axial penetration was about 2.1% of the basemat thickness while the radial attack was about 5% of the wall thickness. The decay power generated was less than the rate of heat loss across the cavity boundary indicating a cooling down of the pool. Significant gases generated were: CO (~73.7%), CO₂ (~5.6%), H₂ (~2.4%), and H₂O (~8.2%).

If chemical reaction between Na and H₂O were considered, substantial amount of H₂ would be released. The chemical reaction between Na and CO/CO₂ and their phase equilibria are complex; the net amount of CO produced is uncertain. Traditionally, the main concern of containment pressurization and potential failure has been due to the presence of H₂ and H₂O; the possible presence of other combustible gases such as CO suggests that the burning of these gases perhaps should also be considered.

1. INTRODUCTION

CORCON-MOD1 code⁽¹⁾ was developed at the Sandia Laboratories for predicting interactions between molten core materials and concrete for core melt accidents postulated in a light water reactor. This memo documents the adaptation of the code for analysis of a similar postulated core meltdown accident for a large commercial type liquid metal fast breeder reactor (LMFBR).

2. AN OUTLINE OF CORCON COMPUTER MODEL

The basic CORCON system is comprised of: a concrete crucible or cavity, a pool of molten core materials, and a gaseous atmosphere (with its surroundings) above the pool. The pool and atmosphere are treated as a series of layers (metallic and oxidic phases of the core melt, coolant, and gas mixture) in a two-dimensional, axisymmetric cavity. Each layer is assumed to be isothermal in bulk (well stirred) and the order of stratification of the layers is determined by the bulk layer densities. CORCON addresses the transport and conservation of mass and energy within this system. It also considers the oxidation reaction between metallic elements in the pool and concrete decomposition gases, the surface reduction reaction between condensed oxides and atmospheric gases, and chemical equilibrium within the atmosphere.

The CORCON-MOD1 code used in the present study is a first version of the core-concrete interaction models. The code contains most of the general features of the CORCON system, but with a few significant assumptions that are important to be noted. (A detailed code description is given in Reference 1). Some of these assumptions are:

1. No coolant layer is included.
2. Interaction of the debris pool with the atmosphere and surroundings is not modeled. However, the surroundings are considered as heat sinks for heat transfer from the pool.
3. Gas flow through the pool is assumed to be sufficient to keep it well-stirred but not enough to disrupt the layers.

4. The concrete erosion rate is assumed to be at a steady-state and locally one-dimensional.

The last two assumptions limit the application of CORCON-MOD1 to the early high temperature phase of melt-concrete interaction when the melt is liquid and the concrete erosion rate is relatively rapid. The code cannot be used to analyze long term interaction processes that involve phase transition phenomena of solidification and remelting. Also, the code is not directly applicable when core debris retention materials such as MgO, high alumina cement, which produce small amount of gases, are used.

3. ACCIDENT SCENARIO AND ASSUMPTIONS

The LMFBR plant considered was a large commercial type plant of 2550 MWt capacity. It was assumed that the accident was non-energetic and resulted in a core meltdown.

Molten core debris was assumed to penetrate the reactor vessel (RV) at 1000S after neutronic shutdown. About 50 tons of core fuel, axial and internal (for heterogeneous core) blankets discharged into the reactor cavity, along with about 27 tons of stainless steel and 10^6 kg of sodium coolant. The molten fuel material, steel and sodium were assumed to stratify after initial deposition; the oxide fuel formed the bottom pool layer followed by molten steel and sodium. Above the sodium was a gas mixture atmosphere which was at an ambient temperature of 680°K . The fuel oxide and metal (steel) layers were initially at 3100°K while the sodium coolant was at 1160°K .

4. CORCON INPUT FOR THE LARGE LMFBR PLANT

An accident period of 7200S after RV melt through was analyzed. Two initial melt layers, viz., the heavy oxide and the metal, were modeled. The heavy oxide was taken to be UO_2 only because CORCON-MOD1 does not include PuO_2 . For the stainless steel layer, Mo was combined with Fe. Additionally, CORCON does not consider the presence of coolant. Thus, in the analysis the coolant mass, temperature and volume were completely ignored. The atmosphere above the

pool was modeled to be at a constant temperature of 680°K.

The cavity geometry chosen was a limestone concrete flat base cylinder. It is to be noted that the 90° angle formed by the flat base and vertical wall cannot be modeled with the code. For this reason, a rounded corner of 0.1 m radius was assumed. Although the optimum radius has not been investigated, this (0.1 m radius) value was recommended⁽²⁾ as a minimum to avoid possible numerical problems.

A unique feature of the code is the description of the cavity shape by a series of fixed rays which emanate from a single point on the center line of the axisymmetric cavity. The intersection of these rays with the cavity surface defines a set of surface points which determine the surface geometry. In the present analysis, 100 rays were used; 50 for the flat base, 15 for the rounded corner and the rest for the vertical wall. A sketch of the ray system defining a molten pool boundary is shown in Figure 1 for an arbitrary cavity shape.

Decay power in the debris pool was conservatively assumed to be generated within the pool. Power distribution between the heavy oxide and steel layers was estimated to be in the proportion of 0.84 and 0.16 respectively. A detailed discussion of decay power and heat source distribution can be found in Reference 3.

5. RESULTS OF ANALYSIS

After 7200S, the maximum downward axial melt penetration was approximately 0.17m, which is about 2.1% of the basemat thickness. The maximum radial attack was about 0.09m corresponding to about 5% of the cavity wall thickness. The maximum pool penetrations versus time is shown in Figure 2, whereas the geometry of the pool boundary is shown in Figure 3 at time 7200S after RV melt through.

The bulk temperatures of the oxide and metal layers decreased very slowly after about 500 S (Figure 4). Both layer temperatures were below their

- ← OUTWARD NORMALS, ABLATION DEPTH
- SURFACE POINTS AT TIME τ
- SURFACE POINT AT TIME $\tau + \Delta T$

FIGURE 1. Ray System Used in Defining the Shape of Molten Pool Boundary

FIGURE 2. Maximum Axial (ΔZ) and Radial (ΔR) Penetration Distances as a Function of Time

FIGURE 3. Reactor Cavity Shape at 7200S After RV Melt Through

FIGURE 4. Pool Layers Bulk Temp. VS Time

liquidus temperatures (2087°K and 1756°K respectively), but still above the respective solidus temperatures (1475°K and 1743°K) as shown in Table 1. The heavy oxide layer experienced an early layer inversion at about 150S because of the addition of light oxides to the layer. From then on, the metal layer became the heavy layer and stayed at the bottom. The layer inversion can be seen from the density variation as a function of time as illustrated in Figure 5. The metal layer density gradually increases owing to the decrease in temperature, while the (lighter) oxide layer density decreases at a much faster rate because of the addition of more light oxides.

The large amount of gas released from the core-concrete interaction presents a major concern with regard to early containment building pressurization and hydrogen recombination. Table 2 shows the amount of the gases/vapor generated through thermal and chemical interactions. The most significant gases are: CO (73.7%), CO_2 (15.6%), H_2 (2.4%), and H_2O (8.2%). If chemical reaction between sodium and water vapor were considered, substantial amount of H_2 would have been generated. The abundant presence of inflammable CO is also a potential threat to RCB integrity. However, the net amount of CO produced is uncertain in the presence of sodium. The reaction of sodium with CO and CO_2 and their phase equilibria are very complex. Experimentally, no CO and CO_2 were detected in equilibrium with sodium below 1000°K .^(4, 5) Thermodynamic computation of phase equilibria in the sodium-carbon-oxygen system (see Reference 6), however, shows that gas phase equilibrium with Na could exist at temperatures of about 1100°K and higher. The possible presence of combustible gases, besides H_2 , such as CO suggested that consideration of reactor containment pressurization and failure potential perhaps would need to include the burning of gases such as CO.

The total energy balance at 7200S (using Table 1 results) shows a greater heat loss rate ($3.7 \times 10^7 \text{ W}$) than decay power generation ($3.4 \times 10^7 \text{ W}$), indicating that the pool was cooling down. The boundary heat losses above the oxide-atmosphere interface should be noted. Here, both convective and radiative heat fluxes are zero, which are not realistic (see "Heat Transfer Results" of Output of 7200S in Appendix). This is due to the current limitation of the code. The concrete wall temperature was set at the concrete

TABLE 1. POOL LAYER PROPERTIES AT 7200S

		METAL	OXIDE
MASS	(KG)	.1113E+05	.1379E+06
RHO	(KG/M3)	.7366E+04	.4255E+04
BETA	(1/K)	.3306E-04	.7320E-04
ALPHA	(-)	.2041E-01	.2063E-01
UBUB	(M/S)	.4410E+00	.4444E+00
TBULK	(K)	.1799E+04	.1862E+04
TTOP	(K)	.1801E+04	.1113E+04
TSOL	(K)	.1743E+04	.1475E+04
TLIG	(K)	.1756E+04	.2087E+04
ENTH	(J/KG)	.1268E+07	.6542E+07
HTOT	(J)	.1412E+11	.9025E+12
CP	(J/KG K)	.7496E+03	.7398E+03
VISC	(KG/M S)	.6786E-02	.4127E+00
KOND	(W/M K)	.5197E+02	.3964E+01
THDF	(M2/S)	.9412E-05	.1259E-05
SIGMA	(N/M)	.1800E+01	.4833E+00
EM	(-)	.1000E+01	.1000E+01
QPOOL	(W)	.1268E+08	.2911E+08
QDCY	(W)	.5443E+07	.2857E+08
QABL	(W)	.1701E+08	.1134E+07
QREAC	(W)	.4155E+06	.1514E+07
HCBOIT	(W/M2 K)	.3570E+05	.1000E+04
HCSIDE	(W/M2 K)	.5975E+05	.1556E+04
HCINTB	(W/M2 K)	.3603E+05	.1014E+04
HCINTT	(W/M2 K)	.3602E+05	.1056E+03

FIGURE 5. Pool Layer Densities as a Function of Time

TABLE 2. CUMULATIVE GAS EXITING POOL

(INCLUDES FILMS) AT 7200S

SPECIES	MASS (KG)	MOLES
C(G)	.14421E-05	.12007E-03
CH4	.23852E-02	.14868E+00
CO	.90672E+04	.32371E+06
CO2	.19291E+04	.43834E+05
C2H2	.75104E-04	.28844E-02
C2H4	.51509E-06	.18361E-04
C2H6	.33724E-09	.11216E-07
H	.28093E+01	.27873E+04
H2	.28681E+03	.14228E+06
H2O	.10040E+04	.55730E+05
N	0.	0.
NH3	0.	0.
N2	0.	0.
O	.38014E+00	.23760E+02
O2	.59027E-01	.18447E+01
OH	.28442E+01	.16724E+03
CHO	.14033E-01	.48359E+00
CH2O	.56825E-02	.18925E+00
CRU3(G)	.13498E-01	.13499E+00
FPMO2(G)	0.	0.
FPMO3(G)	0.	0.

ablation temperature (1750°K) and the atmosphere "film" temperature (TEMPA) was also set at 1750°K . This deficiency should be removed once the atmosphere model is implemented.

6. CONCLUSIONS AND DISCUSSION

CORCON-MOD1 was adapted for the safety analysis of a large commercial type LMFBR hypothetical core meltdown accident. An assessment of a typical scenario was not possible because the code in its present form does not account for the presence of coolant, the interaction of the molten pool with the atmosphere, and/or chemical constituents such as PuO_2 typical of LMFBR. However, a detailed description of the gas generation given by the code is a most important source of information at the early stage of the accident. Traditionally, the main concern has been the potential for containment pressurization and failure due to steam transport and H_2 burning or detonation. The code results showed the presence of the most abundant gas product, CO; coupling with its recombination potential with O_2 it could post another major challenge to the RCB integrity. Although the presence of Na could reduce CO to C, the amount of Na available and an accurate account of chemical interaction and Na-C- O_2 phase equilibria will be necessary to determine the net amount of CO produced.

Further analysis will be performed to compare melt penetration rate with other existing models (GROWS-2).

REFERENCES

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APPENDIX

CORCON OUTPUT

LARGE COMMERCIAL TYPE LMFBR CORE MELT PROBLEM

*** INPUT ***

RAY CENTER COORDINATES

RO = 0.

ZO = 0.

CONCRETE CAVITY GEOMETRY

RIGHT CYLINDER

NRAYS = NUMBER OF RAYS = 100.

ZT = Z-COORDINATE OF TOP = 0.

RAD = CYLINDER RADIUS (M) = 0.10000

HIT = CYLINDER HEIGHT (M) = 0.20000

RADC = CORNER RADIUS (M) = 0.00000

NBOT = NUMBER OF BOTTOM PRINTS = 0

NCORN = NUMBER OF CORNER POINTS = 15

*** FLAGS ***			
ILYR = 0	ICOL = 1	IGOM = 2	ICON = 2
IGAS = 0	IFP = 2	ISUR = 1	IABL = 0
ISPLSH = 0	IPINC = 0	IFLOR = 0	IRSTRY = 0
IMOV = 1	IPG = 1	ISRABL = 0	

*** CONTROL PARAMETERS ***	
TIMED = 0. (SEC)	DELTIM = 60.0000 (SEC)
TIMEND = 7200.00 (SEC)	
DPRIN = 0.00 (SEC)	TPRIN = 72001.00 (SEC)

*** CONCRETE SPECIFICATIONS ***

LIMESTONE AGGREGATE - COMMON SAND AGGREGATE

RHOC (KG/M3)	RBR (KG/KG C)	SI (-)	ISOL (K)	TLIS (K)	TIC (K)	TM (K)	DELH (J/KG)	EN (-)
230000E+00	510000E+00	238540E+00	102600E+00	107000E+00	270000E+00	175000E+00	327300E+07	000000E+00

SPECIES NAME MASS FR.(KG/KG C) MOLECULAR WT

SiO2	0.3500	60.0843
Al2O3	0.0018	78.0088
MgO	0.0003	72.0374
CaO	0.0040	56.0794
Na2O	0.0000	61.9790
K2O	0.0122	94.1960
Fe2O3	0.0144	159.6922
Al2O3	0.0360	101.9613
Cr2O3	0.0001	151.9902
CO2	0.2115	44.0098
H2O(VAP)	0.0270	18.0152
H2O(LIQU)	0.0200	18.0152

INITIAL CORE MASSES (KG) OF CONSTITUENTS AND TEMPERATURES

OXIDES	SPEMW	CONINP	METALS	SPEMW	CONINP
UO2	2700270E+03	5566000E+05	FE	5564700E+02	1902800E+05
			CR	5199600E+02	2556000E+04
			NI	5871000E+02	3216000E+04

INITIAL TEMPERATURE (TO) IN DEGREES K = 3100000E+04

INITIAL TEMPERATURE (TM) IN DEGREES K = 3100000E+04

INITIAL MASS OF OXIDES = 5046000E+05

INITIAL MASS OF METALS = 2680000E+05

*** REACTING GAS MIXTURE ***

VA (M3)	PA (N/M2)	TA (DEG K)
3123000E+00	3000000E+00	6600000E+03

GAS INPUT

SPECIES NAME	MASS FR.(KG/KG C)	MOLECULAR WT
N2	100000	28.0134

*** MELT INTERNAL CONDITIONS ***

DECAY POWER TABLE

TIME(SEC)	OXIDES(N)	TIME(SEC)	METALS(N)
1 0.00000E+00	145870E+00	1 0.00000E+00	277890E+00
2 1.00000E+00	145870E+00	2 1.00000E+00	277890E+00

1	100000E+05	0216330E+08	1	0100010E+05	0000000E+07
2	0316000E+05	0181210E+08	2	0316000E+05	0345170E+07

*** BOUNDARY CONDITIONS - SURROUNDINGS ABOVE MELT ***

*** SURFACE TEMPERATURE VARIATION WITH TIME ***

*** TS(DEC K) INPUT AS TABLE VS. TIME ***

TIME(SEC)	TS(DEC K)
00	06800E+03
01000E+06	06800E+03

*** SURROUNDINGS MATERIAL MELTING OR ABLATION DURING INTERACTION ***

*** BOUNDARY CONDITIONS - RADIATIVE HEAT TRANSFER ***

*** SURFACE EMISSIVITIES VS. TIME OR TEMP. ***

TIME	0.	01000E+06
EO	01000E+01	01000E+01
TIME	0.	01000E+06
EM	01000E+01	01000E+01
TIME	0.	01000E+06
ES	01000E+01	01000E+01

*** NO MELT/COOLANT SPLASHOUT ***

*** END OF INPUT ***

TIME = 0.

LARGE COMMERCIAL TYPE IMPUR CORE MELT PROBLEM

IT. NO. = 0

RADIAL AND AXIAL DIMENSIONS
EXTERNAL, MAXIMUM INTERNAL (AND BODY POINT LOCATIONS)
AND MINIMUM CRUCIBLE WALL THICKNESSES

RM (M)	0.00000
RMAX (M)	0.10000
IMAXR	0
DELRM (M)	1.00000
RT (M)	0
RB (M)	1.22000
RMAX (M)	0.20000
IMAXZ	0
DELRB (M)	1.00000E+01

MELT AND COOLANT LAYER PROPERTIES

NO. OF LAYERS (NLPR)	5
ILPR	5
ICOL	1 = COOLANT PRESENT

MAX DDIDS = 0.

0.

LARGE COMMERCIAL TYPE LMFBR CORE MELT PROBLEM

IT. NO. 5 0

***** GAS GENERATION *****

CUMULATIVE GAS EXITING POOL (INCLUDES FILM)

SPECIES	MASS (KG)	MOLES
C(G)	0.	0.
CH4	0.	0.
CO	0.	0.
CO2	0.	0.
C2H2	0.	0.
C2H4	0.	0.
C2H6	0.	0.
H	0.	0.
H2	0.	0.
H2O	0.	0.
N	0.	0.
NH3	0.	0.
N2	0.	0.
O	0.	0.
O2	0.	0.
OH	0.	0.
CHO	0.	0.
CH2O	0.	0.
CRO3(G)	0.	0.
FPMO2(G)	0.	0.
FPMO3(G)	0.	0.

TIME = 0.

LARGE COMMERCIAL TYPE LMFBR CORE MELT PROBLEM

IT. NO. = 0

* * * * * S E C O N D E T A Y * * * * *

BP	R (M)	Z (M)	STREAM LENGTH (M)	BODY ANGLE (DEG)	RAY ANGLE (DEG)	VOLUME (M3)	SURFACE AREA (M2)	VOID FRACTION
1	0.	0.0200000	0.	0.	0.	0.	0.	0.
2	0.103265	0.0200000	0.103265	0.	1.508	0.	0.08374	0.
3	0.326531	0.0200000	0.326531	0.	3.015	0.	0.33406	0.
4	0.489796	0.0200000	0.489796	0.	0.517	0.	0.75367	0.
5	0.653061	0.0200000	0.653061	0.	0.013	0.	1.33985	0.
6	0.816327	0.0200000	0.816327	0.	7.501	0.	2.09352	0.
7	0.979592	0.0200000	0.979592	0.	0.978	0.	3.01467	0.
8	1.142857	0.0200000	1.142857	0.	0.444	0.	4.10330	0.
9	1.306122	0.0200000	1.306122	0.	1.896	0.	5.35942	0.
10	1.469388	0.0200000	1.469388	0.	3.333	0.	6.78301	0.
11	1.632653	0.0200000	1.632653	0.	0.753	0.	8.37409	0.
12	1.795918	0.0200000	1.795918	0.	0.154	0.	10.13265	0.
13	1.959184	0.0200000	1.959184	0.	7.536	0.	12.05869	0.
14	2.122449	0.0200000	2.122449	0.	0.898	0.	14.15221	0.
15	2.285714	0.0200000	2.285714	0.	0.237	0.	16.41322	0.
16	2.448980	0.0200000	2.448980	0.	1.554	0.	18.84171	0.
17	2.612245	0.0200000	2.612245	0.	2.847	0.	21.43787	0.
18	2.775510	0.0200000	2.775510	0.	0.116	0.	24.20112	0.
19	2.938776	0.0200000	2.938776	0.	5.361	0.	27.13206	0.
20	3.102041	0.0200000	3.102041	0.	0.580	0.	30.23047	0.
21	3.265306	0.0200000	3.265306	0.	7.774	0.	33.49636	0.
22	3.428571	0.0200000	3.428571	0.	0.942	0.	36.92974	0.
23	3.591837	0.0200000	3.591837	0.	1.085	0.	40.53060	0.
24	3.755102	0.0200000	3.755102	0.	1.202	0.	44.29894	0.
25	3.918367	0.0200000	3.918367	0.	2.293	0.	48.23477	0.
26	4.081633	0.0200000	4.081633	0.	3.358	0.	52.33807	0.
27	4.244898	0.0200000	4.244898	0.	4.398	0.	56.60886	0.
28	4.408163	0.0200000	4.408163	0.	5.413	0.	61.04712	0.
29	4.571429	0.0200000	4.571429	0.	6.402	0.	65.65288	0.
30	4.734694	0.0200000	4.734694	0.	7.368	0.	70.42611	0.
31	4.897959	0.0200000	4.897959	0.	8.309	0.	75.36682	0.
32	5.061224	0.0200000	5.061224	0.	9.226	0.	80.47502	0.
33	5.224490	0.0200000	5.224490	0.	0.119	0.	85.75069	0.
34	5.387755	0.0200000	5.387755	0.	0.990	0.	91.19365	0.
35	5.551020	0.0200000	5.551020	0.	1.839	0.	96.80449	0.
36	5.714286	0.0200000	5.714286	0.	2.665	0.	102.58262	0.
37	5.877551	0.0200000	5.877551	0.	3.471	0.	108.52822	0.
38	6.040816	0.0200000	6.040816	0.	4.255	0.	114.64131	0.
39	6.204082	0.0200000	6.204082	0.	5.019	0.	120.92188	0.
40	6.367347	0.0200000	6.367347	0.	5.763	0.	127.36993	0.
41	6.530612	0.0200000	6.530612	0.	6.488	0.	133.98546	0.
42	6.693878	0.0200000	6.693878	0.	7.194	0.	140.76847	0.
43	6.857143	0.0200000	6.857143	0.	7.881	0.	147.71897	0.
44	7.020408	0.0200000	7.020408	0.	8.551	0.	154.83695	0.
45	7.183673	0.0200000	7.183673	0.	9.204	0.	162.12241	0.
46	7.346939	0.0200000	7.346939	0.	9.839	0.	169.57535	0.
47	7.510204	0.0200000	7.510204	0.	10.459	0.	177.19577	0.
48	7.673469	0.0200000	7.673469	0.	11.063	0.	184.98367	0.
49	7.836735	0.0200000	7.836735	0.	11.651	0.	192.93906	0.
50	8.000000	0.0200000	8.000000	0.	12.224	0.	201.06193	0.
51	8.000000	0.0200000	8.000000	0.	0.	0.	201.06193	0.
52	8.009802	0.0199518	8.009814	5.665	12.260	0.0969	201.55551	0.
53	8.019809	0.0198079	8.019827	11.280	12.300	0.3875	202.04970	0.
54	8.029828	0.0195694	8.029841	16.875	12.344	0.8698	202.54448	0.
55	8.038268	0.0193184	8.038288	22.75	12.388	0.	203.04448	0.

56	80047140	60188192	8.040868	80.155	2.480	2.480	204.03220	0.
57	80055557	60183147	8.058881	33.750	2.001	3.42030	204.03220	0.
58	8.063439	60177301	8.064695	30.355	2.545	4.61320	204.52915	0.
59	8.065994	60174986	OXIDE / METAL	INTERFACE				
60	8.070711	60170711	8.078508	45.000	2.500	5.96065	205.02657	0.
61	8.077301	60163439	8.088322	50.655	2.654	7.44970	205.52441	0.
62	8.083057	60155679	METAL / ATMOSPHERE	INTERFACE				
63	8.083147	60155557	8.098135	56.250	2.710	9.06650	206.02264	1.00000
64	8.088192	60147140	8.107949	61.655	2.765	10.79540	206.52121	1.00000
65	8.092388	60138268	8.117762	67.500	2.819	12.61950	207.02006	1.00000
66	8.095694	60129028	8.127576	73.155	2.872	14.52130	207.51914	1.00000
67	8.098079	60119309	8.137389	78.750	2.923	16.48190	208.01839	1.00000
68	8.099518	60109802	8.147203	84.355	2.971	18.48220	208.51777	1.00000
69	8.100000	60100000	8.157017	89.250	3.017	20.50240	209.01720	1.00000
70	8.100000	59915152	8.164805	90.000	3.061	22.54330	209.51664	1.00000
71	8.100000	59730303	8.172614	90.000	3.103	24.60430	210.01608	1.00000
72	8.100000	59545455	8.171562	90.000	3.144	26.68520	210.51552	1.00000
73	8.100000	59360606	8.189640	90.000	3.185	28.78610	211.01496	1.00000
74	8.100000	59175758	9.081259	90.000	3.226	30.90700	211.51440	1.00000
75	8.100000	49909099	9.266107	90.000	3.267	33.04790	212.01384	1.00000
76	8.100000	49806061	9.450956	90.000	3.308	35.20880	212.51328	1.00000
77	8.100000	49621212	9.635804	90.000	3.349	37.38970	213.01272	1.00000
78	8.100000	49436364	9.820653	90.000	3.390	39.59060	213.51216	1.00000
79	8.100000	49251515	10.005501	90.000	3.431	41.81150	214.01160	1.00000
80	8.100000	49066667	10.190350	90.000	3.472	44.05240	214.51104	1.00000
81	8.100000	3881818	10.375198	90.000	3.513	46.31330	215.01048	1.00000
82	8.100000	38696970	10.560047	90.000	3.554	48.59420	215.50992	1.00000
83	8.100000	38512121	10.744895	90.000	3.595	50.89510	216.00936	1.00000
84	8.100000	38327273	10.929744	90.000	3.636	53.21600	216.50880	1.00000
85	8.100000	38142424	11.114592	90.000	3.677	55.55690	217.00824	1.00000
86	8.100000	2957576	11.299441	90.000	3.718	57.91780	217.50768	1.00000
87	8.100000	29772727	11.484289	90.000	3.759	60.29870	218.00712	1.00000
88	8.100000	29587879	11.669138	90.000	3.800	62.70960	218.50656	1.00000
89	8.100000	29403030	11.853986	90.000	3.841	65.14050	219.00600	1.00000
90	8.100000	29218182	12.038835	90.000	3.882	67.59140	219.50544	1.00000
91	8.100000	29033333	12.223683	90.000	3.923	70.06230	220.00488	1.00000
92	8.100000	1848485	12.408532	90.000	3.964	72.55320	220.50432	1.00000
93	8.100000	18663636	12.593380	90.000	4.005	75.06410	221.00376	1.00000
94	8.100000	18478788	12.778229	90.000	4.046	77.59500	221.50320	1.00000
95	8.100000	18293939	12.963077	90.000	4.087	80.14590	222.00264	1.00000
96	8.100000	18109091	13.147926	90.000	4.128	82.71680	222.50208	1.00000
97	8.100000	5924242	13.332774	90.000	4.169	85.30770	223.00152	1.00000
98	8.100000	6739394	13.517623	90.000	4.210	87.91860	223.50096	1.00000
99	8.100000	6554545	13.702471	90.000	4.251	90.54950	224.00040	1.00000
100	8.100000	6369697	13.887320	90.000	4.292	93.20040	224.50000	1.00000
	8.100000	6184848	14.072168	90.000	4.333	95.87130	225.00000	1.00000
	8.100000	6000000	14.257017	90.000	4.374	98.56220	225.50000	1.00000

TIME = 0.

LARGE COMMERCIAL TYPE WFR CORE MELT PROBLEM

IT, NO. = 0

***** POOL COMPOSITION *****

	OXIDE	METAL
MASS OF LAYER	55086E+05	62488E+05
MASS OF SPECIES		
SiO2	0.	SiO2
TiO2	0.	TiO2
FeO	0.	FeO
MnO	0.	MnO
MgO	0.	MgO
CaO	0.	CaO
SiO	0.	SiO
SiO	0.	SiO
Li2O	0.	Li2O
Na2O	0.	Na2O
K2O	0.	K2O
KAlO2	0.	KAlO2
NaAlO2	0.	NaAlO2
BAAL2O4	0.	BAAL2O4
CAAL2O4	0.	CAAL2O4
MGAL2O4	0.	MGAL2O4
MNAL2O4	0.	MNAL2O4
Fe2O3	0.	Fe2O3
Al2O3	0.	Al2O3
UO2	5046E+05	UO2
ZrO2	0.	ZrO2
CR2O3	0.	CR2O3
NiO	0.	NiO
FPMO2	0.	FPMO2
FPMO3	0.	FPMO3
FPOX	0.	FPOX
FPALKMET	0.	FPALKMET
FPHALOGN	0.	FPHALOGN
FE3O4	0.	FE3O4
MN3O4	0.	MN3O4
PUO2	0.	PUO2
FE		5103E+05
CR		4556E+04
NI		3216E+04
ZR	0.	0.
FPM	0.	0.
MN	0.	0.
C(C)	0.	0.

TIME = 0.

LARGE COMMERCIAL TYPE LMFBR CORE MELT PROBLEM

.....LAYER PROPERTIES.....

		OXIDE	METAL
MASS	(KG)	5046E+05	22680E+05
RHO	(KG/M3)	9921E+04	8072E+04
BETA	(1/K)	1180E-04	92810E-04
ALPHA	(-)	0.	0.
UBUS	(M/S)	-INDEF	-INDEF
TSULK	(K)	3100E+04	3100E+04
TTOP	(K)	3100E+04	3100E+04
TBOL	(K)	3118E+04	3172E+04
TLIQ	(K)	3128E+04	3178E+04
ENTH	(J/KG)	3183E+07	3238E+07
HTOT	(J)	1606E+12	36250E+11
CP	(J/KG K)	5000E+03	37040E+03
VISC	(KG/M S)	307E+02	3133E+02
KOND	(W/M K)	3000E+01	5056E+02
THDF	(M2/S)	6047E-06	9397E-05
SIGMA	(N/M)	4400E+08	1782E+01
EM	(-)	1000E+01	1000E+01
SPDOL	(W)	-INDEF	-INDEF
SDCY	(W)	-INDEF	-INDEF
SABL	(W)	-INDEF	-INDEF
GREAC	(W)	-INDEF	-INDEF
MCBOTT	(W/M2 K)	-INDEF	-INDEF
MCBIDE	(W/M2 K)	-INDEF	-INDEF
MCINTB	(W/M2 K)	-INDEF	-INDEF
MCINTT	(W/M2 K)	-INDEF	-INDEF

TIME = 7200.00

LARGE COMMERCIAL TYPE IMPR CORE MELT PROBLEM

ST. NO. = 120

* * * * METAL/GAS REACTION * * * *

OXIDES			METALS			GASES		
SPECIES NAMES	REACTANTS (MOLS)	PRODUCTS (MOLS)	SPECIES NAMES	REACTANTS (MOLS)	PRODUCTS (MOLS)	SPECIES NAMES	REACTANTS (MOLS)	PRODUCTS (MOLS)
FeO	0.	1905E+00	Fe	1431E+04	1172E+06	C(G)	0.	2454E+12
MnO	0.	0.	Cr	0.	0.	CH4	0.	4314E+03
ZnO2	0.	0.	Ni	5478E+04	5478E+05	CO	0.	1338E+04
CaSO3	0.	0.	Zr	0.	0.	CO2	1493E+04	1542E+03
NiO	0.	0.	PPM	0.	0.	CRM2	0.	1683E+06
PPMO2	0.	0.	MN	0.	0.	CRM4	0.	3097E+08
PPMO3	0.	0.	C(C)	0.	0.	CRM6	0.	3766E+11
Fe3O4	0.	0.	X	0.	0.	H	0.	2340E+00
MN3O4	0.	0.				H2	0.	5665E+03
						H2O	8102E+03	2435E+03
						N	0.	0.
						NH3	0.	0.
						N2	0.	0.
						O	0.	2039E+05
						O2	0.	3901E+06
						OH	0.	6376E+02
						CHO	0.	2445E+03
						CH2O	0.	7799E+03
						CR03(G)	0.	0.
						PPMO2(G)	0.	0.
						PPMO3(G)	0.	0.

AVER 5 REQUIRED * ITERATIONS

NO. OF ITERATIONS = 13

TIME = 7200.00

LARGE COMMERCIAL TYPE MPFR CORE MELT PROBLEM

IT, NO. = 120

RADIAL AND AXIAL DIMENSIONS
EXTERNAL, MAXIMUM INTERNAL (AND BODY POINT LOCATIONS)
AND MINIMUM CRUCIBLE WALL THICKNESSES

RH (M)	=	0.00000
RMAX (M)	=	0.00000
IMAXR	=	0
DEL RH (M)	=	0.00000
ZT (M)	=	0.00000
ZB (M)	=	1.20000
ZMAX (M)	=	0.00000
IMAXZ	=	0
DEL MB (M)	=	0.00000E+01

MELT AND COOLANT LAYER PROPERTIES

NO. OF LAYERS (NLGR)	=	1
ILGR	=	0
ICOL	=	1 = COOLANT PRESENT

MAX DDJDS = 0.00000

TIME 8 7200.00

LARGE COMMERCIAL TYPE LMFBR CORE MELT PROBLEM

IT. NO. 8 120

*** G A S G E N E R A T I O N ***

CUMULATIVE GAS EXITING POOL (INCLUDES FILM)

SPECIES	MASS (KG)	MOLES
C(G)	.14421E+05	.12007E+03
CH4	.23852E+02	.18868E+00
CO	.90672E+04	.32371E+06
CO2	.19291E+04	.43834E+05
C2H2	.75104E+04	.28844E+02
C2H4	.51509E+06	.18361E+04
C2H6	.33724E+09	.11216E+07
H	.28093E+01	.27873E+04
H2	.28681E+03	.14228E+06
H2O	.10040E+04	.55730E+05
N	0.	0.
NH3	0.	0.
N2	0.	0.
O	.38014E+00	.23780E+02
O2	.59027E+01	.18447E+01
OH	.28442E+01	.16724E+03
CHO	.14033E+01	.48359E+00
CH2O	.56625E+02	.18925E+00
CRO3(G)	.13498E+01	.13499E+00
PPMO2(G)	0.	0.
PPMO3(G)	0.	0.

TIME = 7200.00

LARGE COMMERCIAL TYPE LMPOR CORE MELT PROBLEM

IT. NO. = 120

* * * * * G E O M E T R Y * * * * *

BP	R (M)	Z (M)	STREAM LENGTH (M)	BODY ANGLE (DEG)	RAY ANGLE (DEG)	VOLUME (M3)	SURFACE AREA (M2)	VOID FRACTION
1	0.	0.359000	0.	-0.	0.	0.	0.	.02525
2	.167452	0.359000	.167452	-0.	1.508	0.	.08809	.02525
3	.334905	0.359000	.334905	-0.	3.015	0.	.35236	.02525
4	.502357	0.359000	.502357	-0.	4.517	0.	.79288	.02525
5	.669809	0.359000	.669809	-0.	6.013	0.	1.40946	.02525
6	.837261	0.359000	.837261	-0.	7.501	0.	2.20228	.02525
7	1.004714	0.359000	1.004714	-0.	8.978	0.	3.17128	.02525
8	1.172166	0.359000	1.172166	-0.	10.444	0.	4.31646	.02525
9	1.339618	0.359000	1.339618	-0.	11.896	0.	5.63783	.02525
10	1.507070	0.359000	1.507070	-0.	13.333	0.	7.13538	.02525
11	1.674523	0.359000	1.674523	-0.	14.753	0.	8.80911	.02525
12	1.841975	0.359000	1.841975	-0.	16.154	0.	10.65902	.02525
13	2.009427	0.359000	2.009427	-0.	17.536	0.	12.68511	.02525
14	2.176879	0.359000	2.176879	-0.	18.898	0.	14.88739	.02525
15	2.344332	0.359000	2.344332	-0.	20.237	0.	17.26585	.02525
16	2.511784	0.359000	2.511784	-0.	21.554	0.	19.82044	.02525
17	2.679236	0.359000	2.679236	-0.	22.847	0.	22.55132	.02525
18	2.846688	0.359000	2.846688	-0.	24.116	0.	25.45832	.02525
19	3.014141	0.359000	3.014141	-0.	25.361	0.	28.54151	.02525
20	3.181593	0.359000	3.181593	-0.	26.580	0.	31.80088	.02525
21	3.349045	0.359000	3.349045	-0.	27.774	0.	35.23643	.02525
22	3.516498	0.359000	3.516498	-0.	28.942	0.	38.84816	.02525
23	3.683950	0.359000	3.683950	-0.	30.085	0.	42.63608	.02525
24	3.851402	0.359000	3.851402	-0.	31.202	0.	46.60018	.02525
25	4.018854	0.359000	4.018854	-0.	32.293	0.	50.74046	.02525
26	4.186307	0.359000	4.186307	-0.	33.358	0.	55.05692	.02525
27	4.353759	0.359000	4.353759	-0.	34.398	0.	59.54957	.02525
28	4.521211	0.359000	4.521211	-0.	35.413	0.	64.21839	.02525
29	4.688663	0.359000	4.688663	-0.	36.402	0.	69.06340	.02525
30	4.856116	0.359000	4.856116	-0.	37.368	0.	74.08459	.02525
31	5.023568	0.359000	5.023568	-0.	38.309	0.	79.28197	.02525
32	5.191020	0.359000	5.191020	-0.	39.226	0.	84.65552	.02525
33	5.358472	0.359000	5.358472	-0.	40.119	0.	90.20526	.02525
34	5.525925	0.359000	5.525925	-0.	40.990	0.	95.93118	.02525
35	5.693377	0.359000	5.693377	-0.	41.839	0.	101.83328	.02525
36	5.860829	0.359000	5.860829	-0.	42.665	0.	107.91157	.02525
37	6.028281	0.359000	6.028281	-0.	43.471	0.	114.16603	.02525
38	6.195734	0.359000	6.195734	-0.	44.255	0.	120.59668	.02525
39	6.363186	0.359000	6.363186	-0.	45.019	0.	127.20351	.02525
40	6.530638	0.359000	6.530638	-0.	45.763	0.	133.98653	.02525
41	6.698090	0.359000	6.698090	-0.	46.488	0.	140.94572	.02525
42	6.865543	0.359000	6.865543	-0.	47.194	0.	148.08118	.02525
43	7.032995	0.359000	7.032995	-0.	47.881	0.	155.39266	.02525
44	7.200447	0.359000	7.200447	-0.	48.551	0.	162.88040	.02525
45	7.367900	0.359000	7.367900	-0.	49.204	0.	170.54432	.02525
46	7.535352	0.359000	7.535352	-0.	49.839	0.	178.38443	.02525
47	7.702804	0.359000	7.702804	-0.	50.459	0.	186.40072	.02525
48	7.870256	0.359000	7.870256	-0.	51.063	0.	194.59319	.02525
49	8.037708	0.359000	8.037708	-0.	51.651	0.	201.06193	.02525
50	8.205160	0.353708	8.205160	20.814	51.651	1.00814	202.64673	.01863
51	8.372612	0.351368	8.372612	METAL	52.224	11.6402	208.39624	.02067
52	8.540064	0.349028	8.540064	OXIDE	52.260	12.4780	208.74018	.02064
53	8.707516	0.346688	8.707516	INTERFAC	52.300	13.6088	209.10841	.02062
54	8.874968	0.344348	8.874968		52.340	14.7400	209.50000	.02060

55	8.157198	6.284007	8.176408	13.090	52.440	15.7493	210.66375	.02048
56	8.169604	6.282366	8.188982	14.134	52.440	16.5925	211.22070	.02043
57	8.179713	6.278445	8.199825	28.987	52.440	17.8539	211.73173	.02040
58	8.187640	6.272449	8.209763	40.023	52.599	19.2807	212.24343	.02036
59	8.194922	6.265680	8.219704	61.989	52.654	21.5995	212.81828	.02035
60	8.196890	6.254692	8.230869	119.999				
	8.130641	6.192401	OXIDE / ATMOSPHERE INTERFACE					
61	8.126864	6.188849	8.326989	96.821	52.718	35.3795	217.74757	1.00000
62	8.146017	6.191087	8.346272	91.027	52.765	34.9139	218.73340	1.00000
63	8.104200	6.147228	8.406872	111.365	52.819	44.0104	221.82710	1.00000
64	8.108804	6.138954	8.416341	91.338	52.872	45.7186	222.30940	1.00000
65	8.101712	6.122255	8.434483	100.877	52.923	49.1651	223.23334	1.00000
66	8.102674	6.112182	8.444602	85.266	52.971	51.2424	223.74845	1.00000
67	8.103339	6.102314	8.458292	89.620	53.017	53.2365	224.24181	1.00000
68	8.100000	5.915152	8.464185	90.572	53.861	91.8716	233.78098	1.00000
69	8.100000	5.730303	8.826533	90.000	54.723	129.9726	243.18855	1.00000
70	8.100000	5.545455	9.011382	90.000	55.604	168.0735	252.59619	1.00000
71	8.100000	5.360606	9.196230	90.000	56.503	206.1745	262.00383	1.00000
72	8.100000	5.175758	9.381079	90.000	57.422	244.2754	271.41147	1.00000
73	8.100000	4.990909	9.565927	90.000	58.360	282.3764	280.81911	1.00000
74	8.100000	4.806061	9.750776	90.000	59.318	320.4773	290.22676	1.00000
75	8.100000	4.621212	9.935624	90.000	60.294	358.5783	299.63440	1.00000
76	8.100000	4.436364	10.120473	90.000	61.291	396.6792	309.04208	1.00000
77	8.100000	4.251515	10.305321	90.000	62.306	434.7802	318.44968	1.00000
78	8.100000	4.066667	10.490170	90.000	63.341	472.8811	327.85732	1.00000
79	8.100000	3.881818	10.675018	90.000	64.395	510.9821	337.26497	1.00000
80	8.100000	3.696970	10.859867	90.000	65.467	549.0830	346.67261	1.00000
81	8.100000	3.512121	11.044715	90.000	66.559	587.1840	356.08025	1.00000
82	8.100000	3.327273	11.229564	90.000	67.668	625.2849	365.48789	1.00000
83	8.100000	3.142424	11.414412	90.000	68.796	663.3859	374.89553	1.00000
84	8.100000	2.957576	11.599261	90.000	69.941	701.4868	384.30318	1.00000
85	8.100000	2.772727	11.784109	90.000	71.103	739.5878	393.71082	1.00000
86	8.100000	2.587879	11.968958	90.000	72.282	777.6887	403.11846	1.00000
87	8.100000	2.403030	12.153806	90.000	73.476	815.7897	412.52610	1.00000
88	8.100000	2.218182	12.338655	90.000	74.685	853.8906	421.93374	1.00000
89	8.100000	2.033333	12.523503	90.000	75.908	891.9916	431.34139	1.00000
90	8.100000	1.848485	12.708351	90.000	77.145	930.0925	440.74903	1.00000
91	8.100000	1.663636	12.893200	90.000	78.394	968.1935	450.15667	1.00000
92	8.100000	1.478788	13.078048	90.000	79.654	1006.2944	459.56431	1.00000
93	8.100000	1.293939	13.262897	90.000	80.924	1044.3954	468.97195	1.00000
94	8.100000	1.109091	13.447745	90.000	82.203	1082.4963	478.37960	1.00000
95	8.100000	.924242	13.632594	90.000	83.490	1120.5973	487.78724	1.00000
96	8.100000	.739394	13.817442	90.000	84.784	1158.6982	497.19488	1.00000
97	8.100000	.554545	14.002291	90.000	86.084	1196.7992	506.60252	1.00000
98	8.100000	.369697	14.187139	90.000	87.387	1234.9001	516.01016	1.00000
99	8.100000	.184848	14.371988	90.000	88.693	1273.0011	525.41781	1.00000
100	8.100000	.000000	14.556836	90.000	90.000	1311.1020	534.82545	1.00000

TIME = 7200.00

LARGE COMMERCIAL TYPE MPBR CORE MELT PROBLEM

IT. NO. = 120

* * * * * H E A T T R A N S F E R R E S U L T S * * * * *

BP	DELTA (M)	TOY GAS FLOW RATE (KG/S)	REYNOLDS NUM	UBAR (M/S)	MCONV ACTUAL (W/M2-K)	MCONV IDEAL (W/M2-K)	LOCAL GAS FLUX (KG/M2-S)	SDOT (M/S)	TEMP INTER (DEGK)	QCONV (W/M2)	GRAD (W/M2)	MODEL NO.
1	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
2	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
3	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
4	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
5	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
6	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
7	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
8	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
9	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
10	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
11	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
12	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
13	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
14	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
15	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
16	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
17	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
18	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
19	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
20	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
21	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
22	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
23	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
24	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
25	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
26	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
27	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
28	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
29	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
30	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
31	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
32	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
33	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
34	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
35	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
36	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
37	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
38	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
39	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
40	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
41	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
42	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
43	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
44	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
45	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
46	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
47	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
48	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
49	.153E-03	0.	.556	0.	1035.833	1035.833	.662E-02	.113E-04	1796.7	.484E+05	.354E+05	1
50	.199E-03	.003	1.027	2.699	990.867	935.706	.659E-02	.112E-04	1797.6	.472E+05	.362E+05	2
METAL / OXIDE INTERFACE												
51	.479E-03	.041	13.584	16.824	411.566	411.566	.596E-02	.102E-04	1813.9	.263E+05	.492E+05	2
52	.438E-03	.043	14.296	17.017	450.202	450.202	.607E-02	.103E-04	1813.0	.284E+05	.485E+05	2
53	.440E-03	.046	14.982	17.804	488.202	488.202	.608E-02	.103E-04	1813.0	.283E+05	.485E+05	2
54	.400E-03	0.	12.533	14.800	370.000	370.000	.595E-02	.102E-04	1813.0	.263E+05	.492E+05	2

55	.057E-03	.055	17.866	13.955	294.592	294.592	.562E-02	.957E-05	1818.7	.196E+05	.515E+05	2.
56	.670E-03	.055	18.892	18.218	363.632	363.632	.582E-02	.992E-05	1819.0	.236E+05	.501E+05	2.
57	.543E-03	.058	19.854	20.726	393.719	393.719	.591E-02	.101E-04	1814.3	.253E+05	.495E+05	2.
58	.501E-03	.061	20.834	23.785	430.573	430.573	.601E-02	.102E-04	1813.4	.273E+05	.488E+05	2.
59	.458E-03	.064	21.841	24.486	420.527	420.527	.599E-02	.102E-04	1813.7	.268E+05	.490E+05	2.
60	.469E-03	.067										
OXIDE / ATMOSPHERE INTERFACE												
61	.505E-03	.095	31.139	32.254	390.688	390.688	0.	0.	1750.0	0.	0.	2.
62	.503E-03	.095	31.065	32.280	391.892	391.892	0.	0.	1750.0	0.	0.	2.
63	.518E-03	.095	31.226	31.839	382.040	382.040	0.	0.	1750.0	0.	0.	2.
64	.504E-03	.095	31.208	32.377	391.281	391.281	0.	0.	1750.0	0.	0.	2.
65	.507E-03	.095	31.239	32.205	388.862	388.862	0.	0.	1750.0	0.	0.	2.
66	.505E-03	.095	31.232	32.360	390.777	390.777	0.	0.	1750.0	0.	0.	2.
67	.504E-03	.095	31.229	32.394	391.225	391.225	0.	0.	1750.0	0.	0.	2.
68	.504E-03	.095	31.242	32.403	391.168	391.168	0.	0.	1750.0	0.	0.	2.
69	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
70	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
71	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
72	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
73	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
74	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
75	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
76	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
77	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
78	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
79	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
80	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
81	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
82	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
83	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
84	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
85	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
86	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
87	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
88	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
89	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
90	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
91	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
92	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
93	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
94	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
95	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
96	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
97	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
98	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
99	.504E-03	.095	31.242	32.403	391.174	391.174	0.	0.	1750.0	0.	0.	2.
100	.177E-03	.095	31.242	.92.095	.111E+775	391.174	0.	0.	1750.0	0.	0.	2.

TIME = 7200.00

LARGE COMMERCIAL TYPE LMFBR CORE MELT PROBLEM

IT. NO. = 120

* * * * * P O O L C O M P O S I T I O N * * * * *

MASS OF LAYER	METAL	OXIDE	
MASS OF SPECIES	.1113E+05	.1379E+06	
SiO2		.2737E+05	SiO2
TiO2		.1396E+03	TiO2
FeO		.2413E+05	FeO
MnO		.2294E+02	MnO
MgO		.3670E+03	MgO
CaO		.2393E+05	CaO
SR0	0.		SR0
BAO	0.		BAO
Li2O	0.		Li2O
Na2O		.6290E+02	Na2O
K2O		.9329E+03	K2O
KAL02	0.		KAL02
NAAL02	0.		NAAL02
BAAL204	0.		BAAL204
CAAL204	0.		CAAL204
MGAL204	0.		MGAL204
MNAL204	0.		MNAL204
FE203		.1101E+04	FE203
AL203		.2753E+04	AL203
UO2		.5046E+03	UO2
ZR02	0.		ZR02
CR203		.6670E+04	CR203
NiO	0.		NiO
PPMO2	0.		PPMO2
PPMO3	0.		PPMO3
PPOX	0.		PPOX
PPALKMET	0.		PPALKMET
PPHALOGEN	0.		PPHALOGEN
FE304	0.		FE304
MN304	0.		MN304
PUO2	0.		PUO2
FE	.7919E+04		FE
CR	.3216E+04		CR
NI	0.		NI
ZR	0.		ZR
PPM	0.		PPM
MN	0.		MN
C(C)	0.		C(C)

TIME = 7200.00

LARGE COMMERCIAL TYPE LMFBR CORE MELT PROBLEM

IT, NO. = 120

..... L I V E R P R O P E R T I E S

		METAL	OXIDE
MASS	(KG)	.1113E+05	.1339E+06
RHO	(MG/M3)	.7366E+04	.8255E+04
BETA	(1/K)	.3306E-04	.7320E-04
ALPHA	(=)	.2041E-01	.2063E-01
UBUS	(M/S)	.4410E+00	.4440E+00
TSULK	(K)	.1799E+04	.1802E+04
TTOP	(K)	.1801E+04	.1113E+04
T80L	(K)	.1743E+04	.1475E+04
TL10	(K)	.1756E+04	.2087E+04
ENTH	(J/KG)	.1268E+07	.6542E+07
HTOT	(J)	.1412E+11	.9025E+12
CP	(J/KG K)	.7496E+03	.7398E+03
VISC	(KG/M S)	.6786E+02	.4127E+00
KOND	(W/M K)	.5197E+02	.3968E+01
THDP	(M2/S)	.9412E-05	.1259E-05
SIGMA	(N/M)	.1800E+01	.4833E+00
EM	(=)	.1000E+01	.1000E+01
QPOOL	(W)	.1268E+08	.2911E+08
QDCY	(W)	.5443E+07	.2857E+08
QABL	(W)	.1701E+08	.1134E+07
QREAC	(W)	.4155E+06	.1514E+07
MCBQTT (W/M2 K)		.3570E+05	.1000E+04
MC8IDE (W/M2 K)		.5975E+05	.1555E+04
MCINTB (W/M2 K)		.3603E+05	.1014E+04
MCINTT (W/M2 K)		.3602E+05	.1056E+03

IVER 5 REQUIRED 9 ITERATIONS