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STATUS REPORT ON THE VALIDATION OF COMMIX-1A FOR ADVANCED LIQUID METAL REACTORS WITH A DISTRIBUTED HEAT SINK USING EBR-II AS A TEST BED

by

W. A. Ragland, C. P. Tzanos, J. H. Tessier,
T. T. Anderson, and D. R. Pedersen

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ANL-SAFR--34

TI87 025841

by

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STATUS REPORT ON THE VALIDATION OF COMMIX-1A FOR ADVANCED LIQUID METAL REACTORS WITH A DISTRIBUTED HEAT SINK USING EBR-II AS A TEST BED

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ABSTRACT

The advanced reactor designs, SAFR by Rockwell International, and PRISM by General Electric, incorporate passive decay heat removal by the means of a reactor vessel auxiliary air cooling system (RVACS/PRISM; RACS/SAFR). The RVACS/RACS decay heat removal system involves direct passive decay heat removal from the guard vessel to a free convecting atmospheric air stream. The energy is transferred to the guard vessel by radiation from the reactor vessel. The reactor primary system comprises large distributed heat sinks and sources. The decay energy must be transferred by natural convection of sodium from the reactor core, a distributed heat source, to the reactor vessel surface, a distributed heat sink. It is desirable that the temperature difference between the reactor vessel and the core be at a minimum and that a minimum of stratification exist. COMMIX--a 3D thermal hydraulic code will be the primary tool for the analysis of the sodium natural convection and transport of the decay power from the reactor core to the reactor vessel. Modelling a distributed heat sink represents a substantial challenge for COMMIX. The purpose of this report is to describe the experiments used to develop a data base with a distributed sink that COMMIX can be validated against. EBR-II with substantial decay power, a large cold pool, extensive instrumentation, and a shield cooling system (distributed heat sink) represents an ideal test bed. This report represents the status as of July 1986 including the status of experiments and modelling.

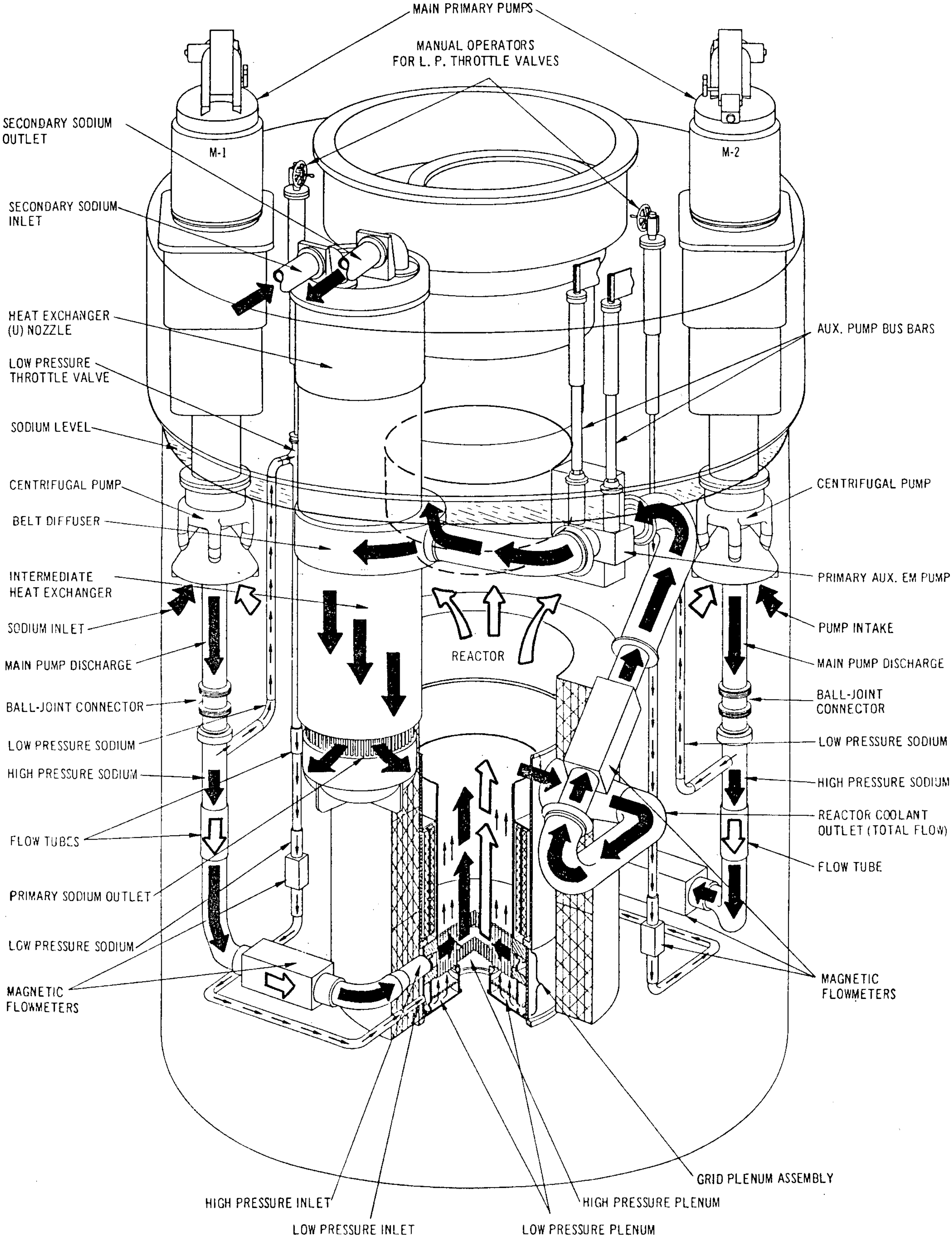
1.0 SODIUM TEST AT EBR-II

1.1 Background

The PSE-3 series of experiments are being conducted in EBR-II in support of innovative reactor designs. The nature of these tests are more along the lines of plant performance or systems tests rather than the usual fuel irradiations experiments which are routinely conducted in EBR-II, hence, the designation PSE for Plant Systems Experiment. The need for such tests comes from the innovative reactor designs such as PRISM which include the use of RVACS (Radiant Vessel Auxiliary Cooling System) as a passive decay heat removal system. The use of RVACS results in a large distributed heat sink as opposed to a concentrated heat sink, e.g. with a DRACS (Direct Reactor Auxiliary Cooling System). In order to predict the performance of such decay heat removal systems, the COMMIX code has been extended to allow calculations with RVACS type boundary conditions. The primary issue addressed by COMMIX is the assurance of adequate natural circulation of the primary sodium to transport the decay power from the core to the heat sink with a minimum temperature difference. Thus, it is necessary to provide a representative set of data against which COMMIX can be validated.

1.2 Test Description

A review of EBR-II indicates it is an appropriate test vehicle. Although EBR-II is not a true pool design but a loop inside of the pool, it is possible to simulate many aspects of a pool reactor during shutdown by using EBR-II with its reactor core top cover lifted off the top of the core allowing flow to bypass the heat exchanger (see Fig. 1). EBR-II also has a shield cooling system (see Fig. 2) which has some similarity to the RVACS except for the air flow being forced instead of circulating naturally. EBR-II is also well instrumented with thermocouples at the primary tank walls. Figures 3, 4 and 5 show the primary tank bulk sodium sensors, primary tank sensors and shield thermocouples respectively. There is also an instrumented subassembly, XX10, which can be left in the core to provide some data on subassembly flow during natural circulation.



NOTES:

BLACK ARROWS SHOW NORMAL FLOW PATHS
WHITE ARROWS SHOW REFUELING FLOW PATHS

Figure 1. Primary Cooling System

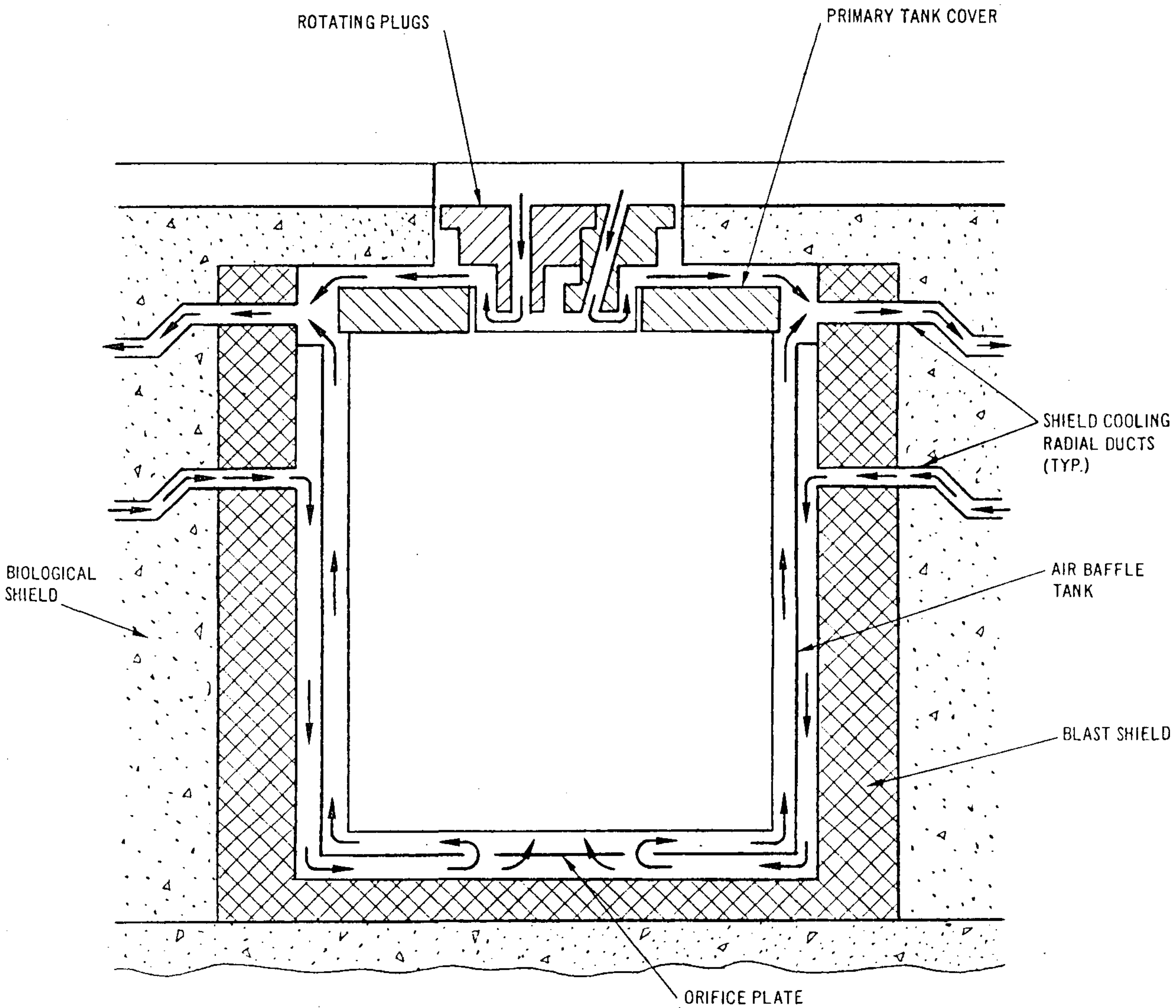


Figure 2. Air Flow Diagram

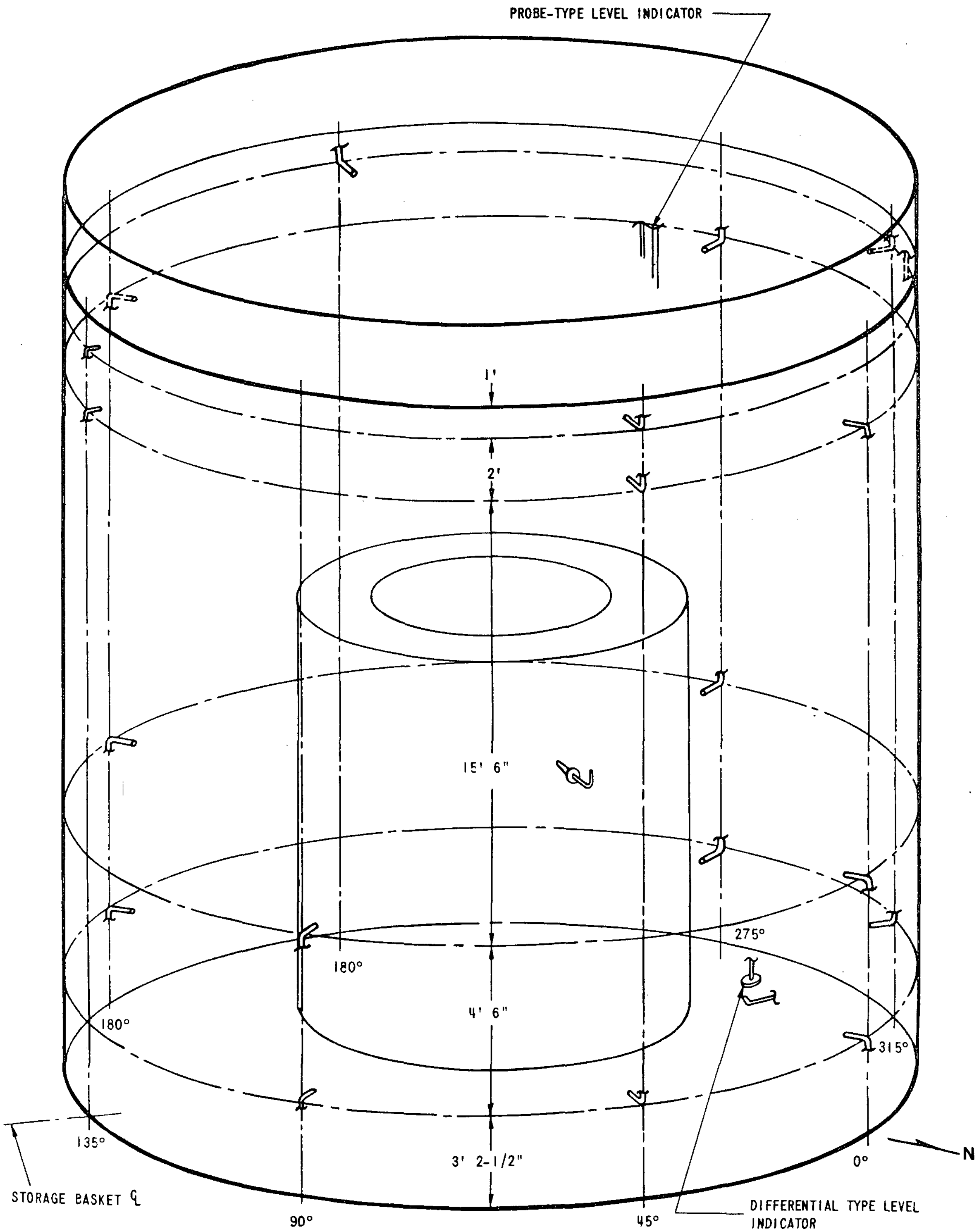
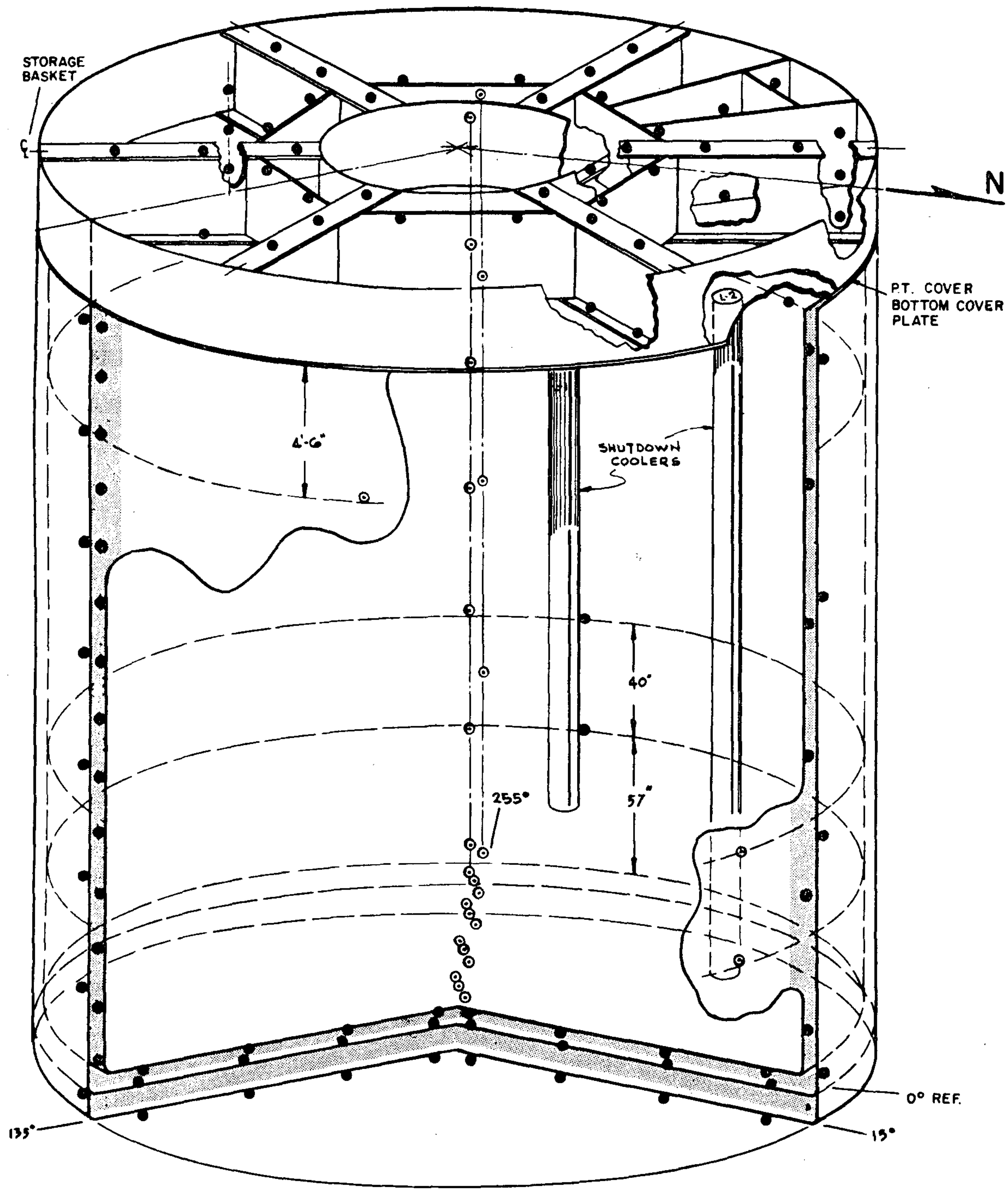


Figure 3. Primary Tank Bulk Sodium and Argon Sensors



LEGEND

● THERMOCOUPLE

⊙ THERMOCOUPLE (BEHIND OR UNDER PLATE)

Figure 4. Primary Tank Thermocouple Arrangement

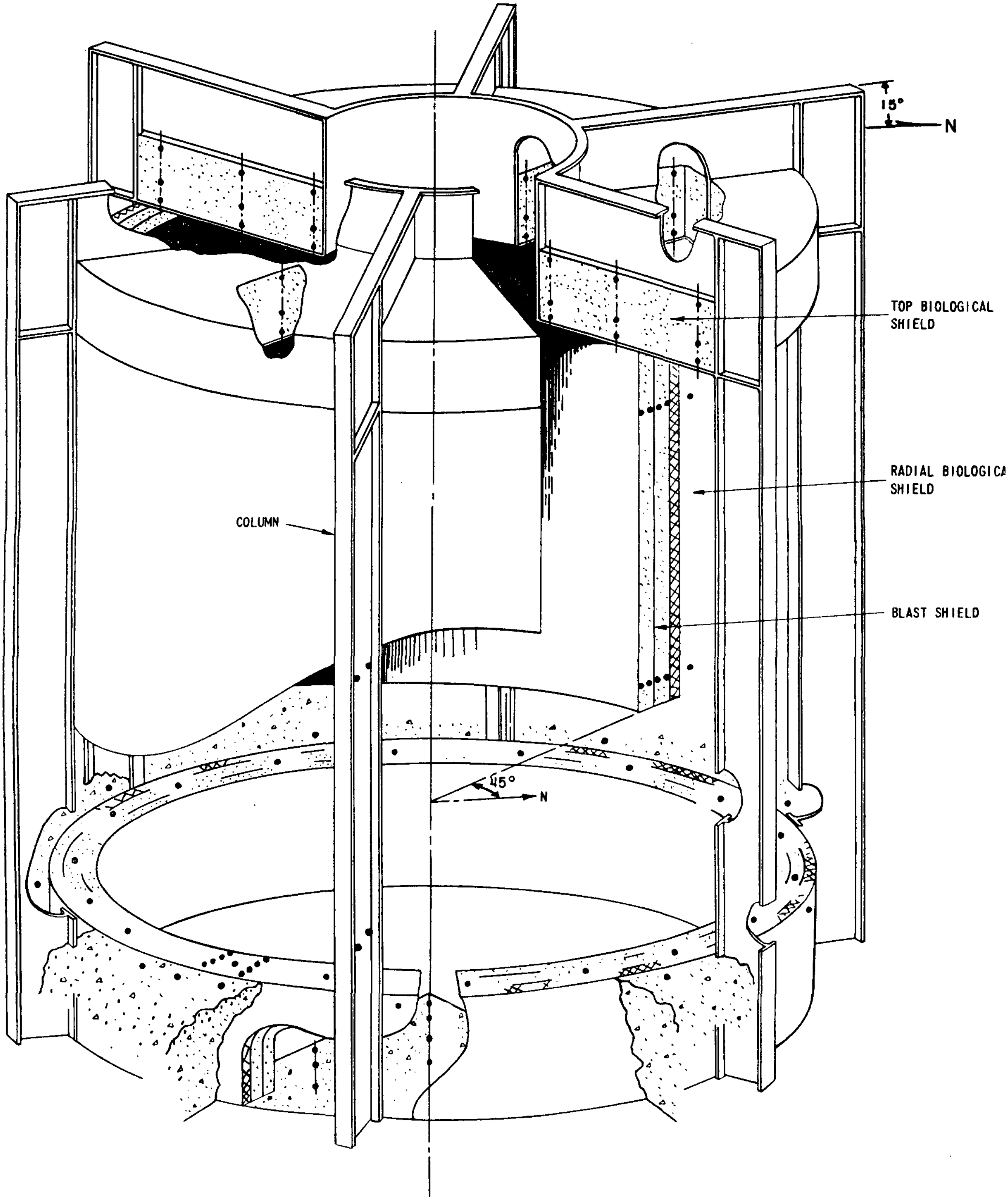


Figure 5. Blast Shield and Biological Shield Thermocouple Arrangement

Some additional instrumentation has been added in support of the PSE-3 testing. Two thermocouple probes were installed in the EBR-II primary tank to measure sodium temperatures at 32 levels at each of two radial locations. The thermocouples are supported by welded segments of 316 stainless steel pipe. The two probes are inserted in the G2 and F2 nozzles of EBR-II. Figure 6 shows a photo of the probe prior to installation in the reactor. The location of the probes in EBR-II is shown in Fig. 7. PSE-3 thermocouple probe #1 is located in the F-2 nozzle position (opposite the storage basket, 2/3 of tank radius). PSE-3 thermocouple probe #2 is located in the G-2 nozzle position (adjacent the storage basket, 1/2 of tank radius).

The formal proposal for the PSE-3 experiment in EBR-II was reviewed by the EBR-II Experiment Planning and Scheduling Committee (ESRC). The ESRC found several conflicts with existing EBR-II schedules and offered alternative solutions. The major impact on the PSE-3 experiment was due to the replacement of the EBR-II DAS during the 1986 annual shutdown. The impacts of the DAS replacement was twofold. The manpower required for preparing for DAS replacement placed limitations on the manpower available for installation of the PSE-3 thermocouple probes and connection of primary tank, shield, and shield cooling thermocouples to the PSE-3 experiment DAS.

As a result of these conflicts, several changes were made in the PSE-3 experiment schedule. The first PSE-3 experiment was limited to an abbreviated test in January 1986. For the 1986 EBR-II annual shutdown, EBR-II DAS data and thermocouple probe data was recorded only for the reactor shutdown, cooldown, and sodium dump. The third PSE-3 experiment will be conducted during the September 1986 shutdown. A fourth experiment is potentially scheduled during the 1987 EBR-II annual shutdown.

The first PSE-3 experiment was conducted on January 13, 1986. This was an abbreviated test since only one of the thermocouple probes had been installed and the tank and shield thermocouples were not connected to the experiment data system.

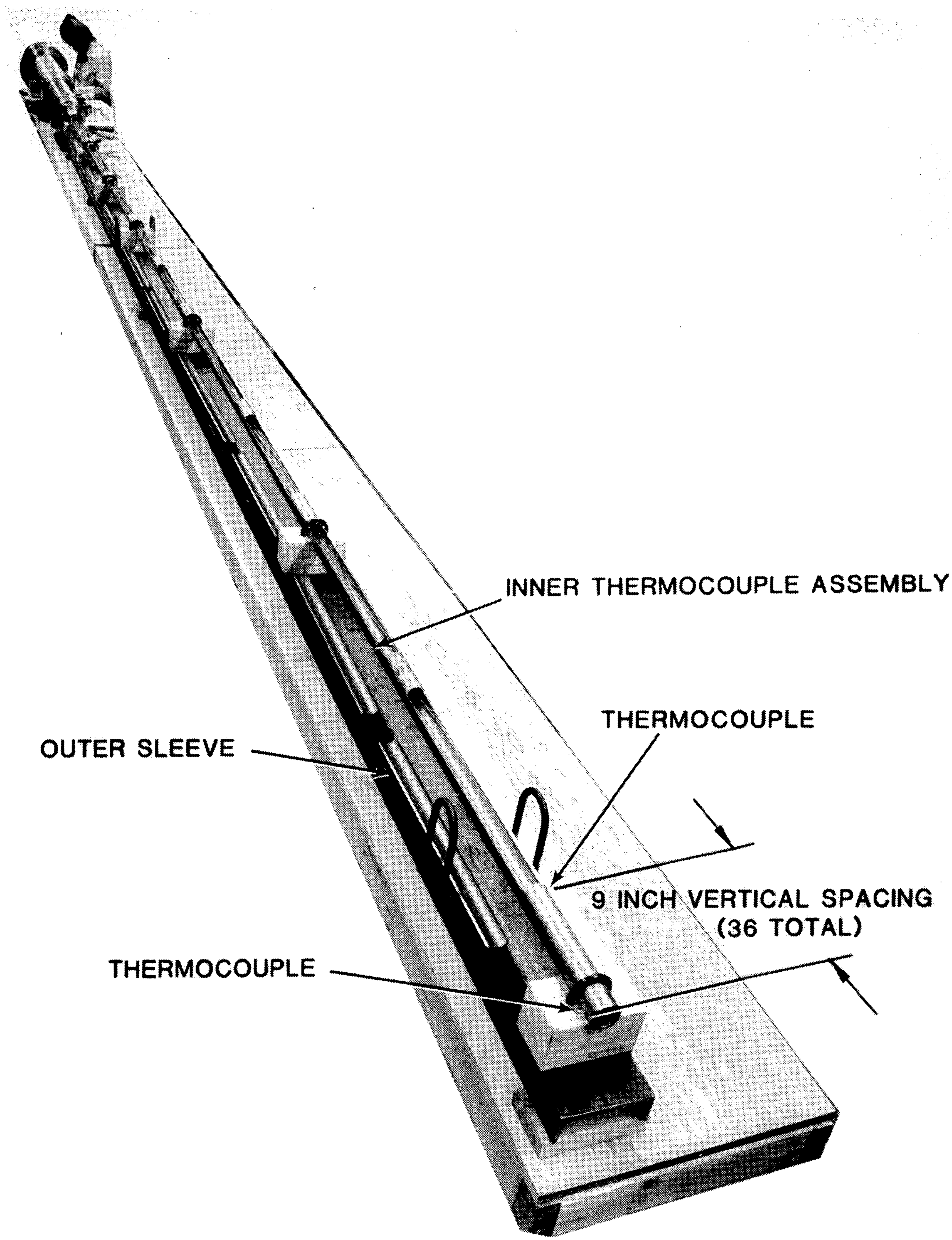


Figure 6. Temperature Probe: Thirty-two Thermocouples Each

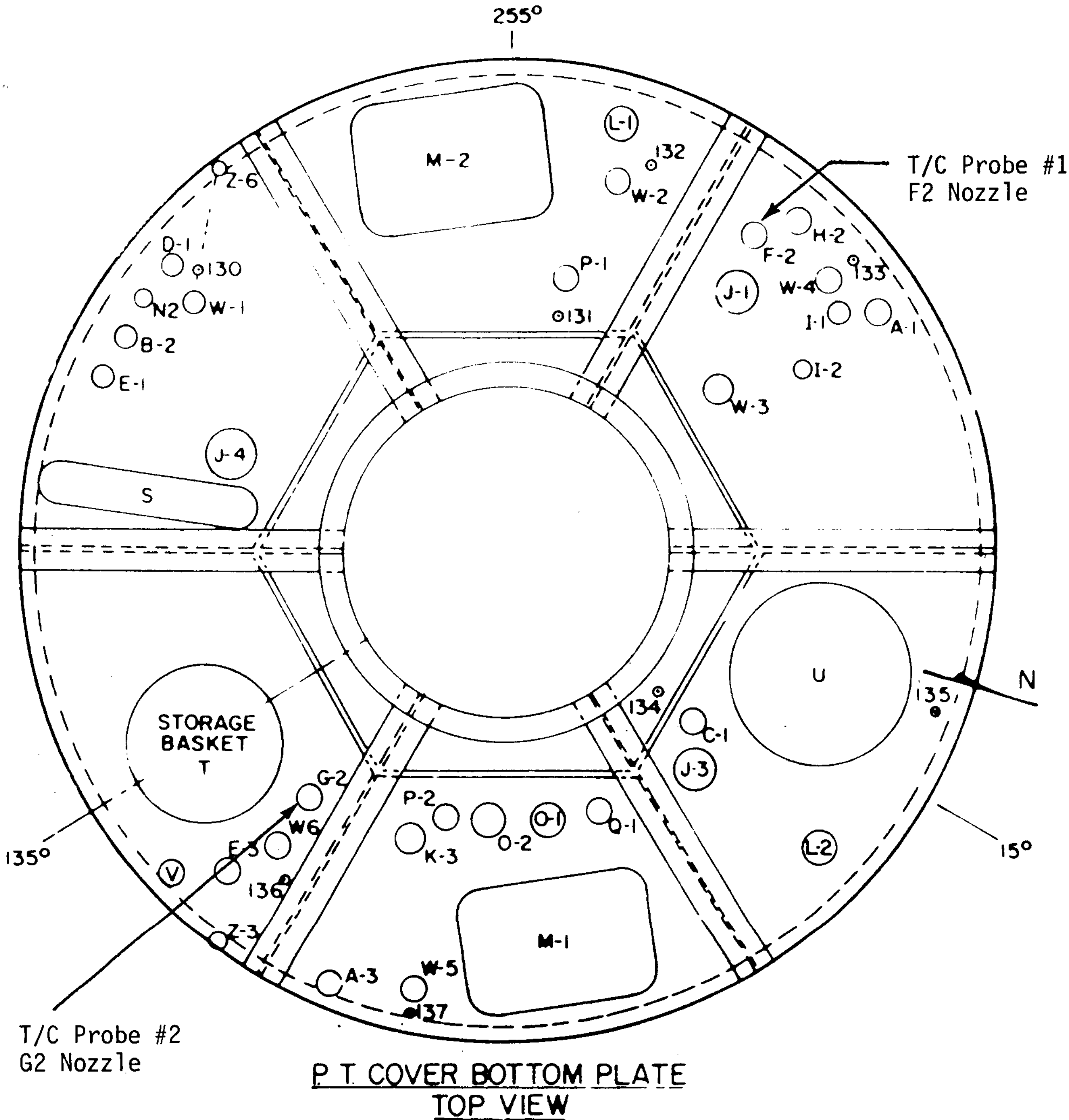


Figure 7. Primary Tank Nozzle and Plug Locations

1.3 Preliminary Experimental Results

The EBR-II was shutdown at 0200 on January 13. Data from the thermocouple probe was recorded at one minute intervals from 0131 until 1636. Manual data for a complete set of tank and shield thermocouples was recorded at 2300 on January 12, 0130, and 0430 on January 13. EBR-II DAS data was also recorded at one minute intervals for the entire period.

The reactor core cover was raised to its upper position at 1715 on January 13. This allowed natural circulation to be established in the upper portion of the sodium pool. The sodium in the lower part of the pool remained nearly stagnant. The probe thermocouple data were recorded from 1934 until after the completion of the test at 0115 on January 14. Two hours of probe data were lost on January 13 due to failure of the experiment data system to switch to a new disk. The cause of failure was identified as a software error. Corrected software and a new operating system was installed on the KAYPRO at EBR-II and tested prior to the second PSE-3 experiment. In addition a selected group of 41 thermocouples located in the tank were recorded at 30 minute intervals during the test.

Detailed data analysis has not been completed but some initial observations of the probe data show that stratification in the upper portion of the pool occurs during power operation. The combined heat loss through the shield cooling system (which simulates RVACS) and other losses through the shutdown coolers, instrument thimble cooling, and secondary system was greater than the decay heat 14 hours after shutdown as noted by a 6 K (10°F) to 9 K (15°F) decrease in pool temperature.

Software was developed to convert data from the KAYPRO to a common format with TREAT data for use on the TREAT data analysis computer. Development is still in progress to reduce both the old and new EBR-II DAS data to TREAT format. This will allow the use of existing programs for analysis and graphical display.

The attached graphs (Figs. 8 to 15) are plots of the 32 thermocouple readings from the first PSE-3 thermocouple probe for the first PSE-3

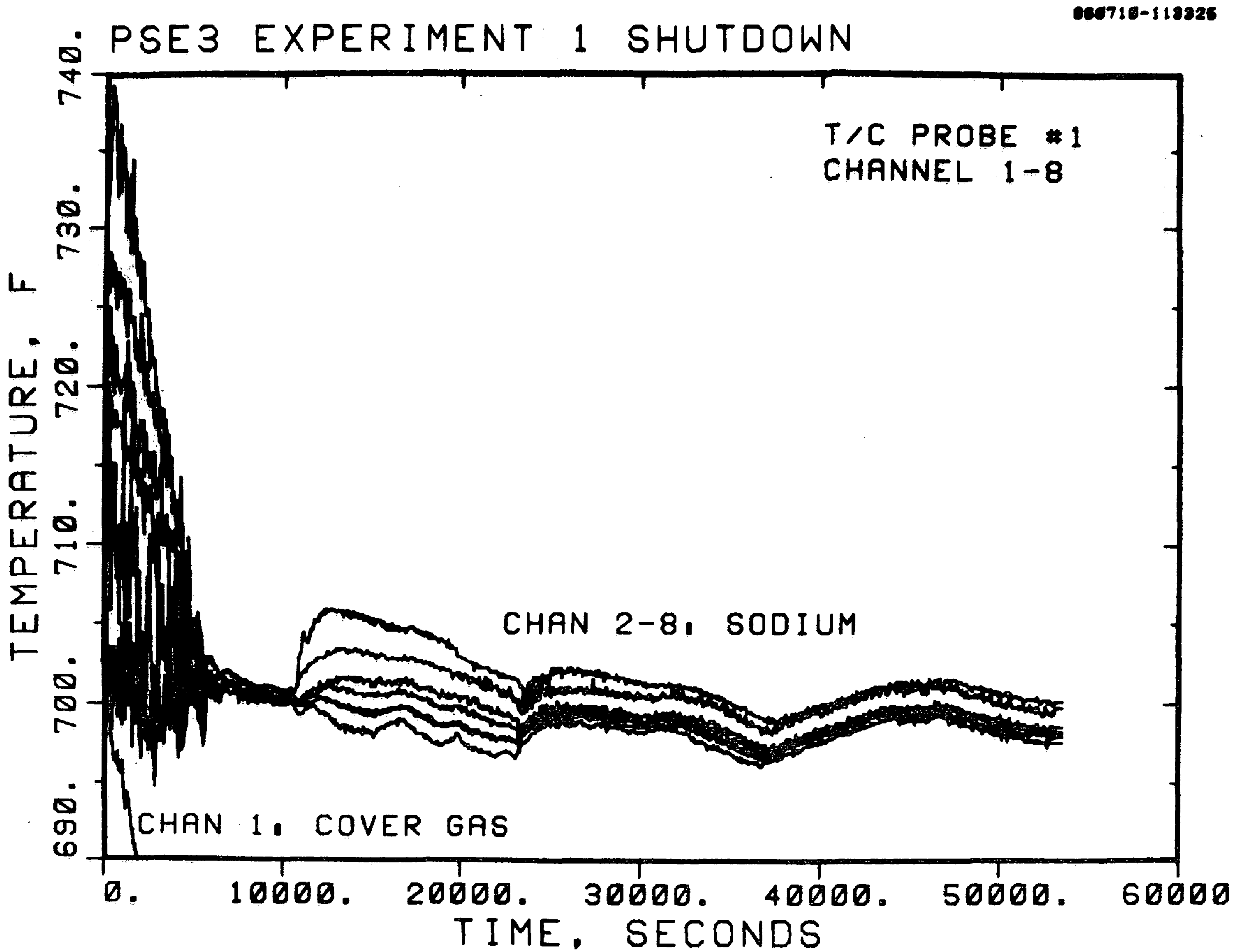


Figure 8. PSE3 Experiment 1 Shutdown (Channels 1-8)

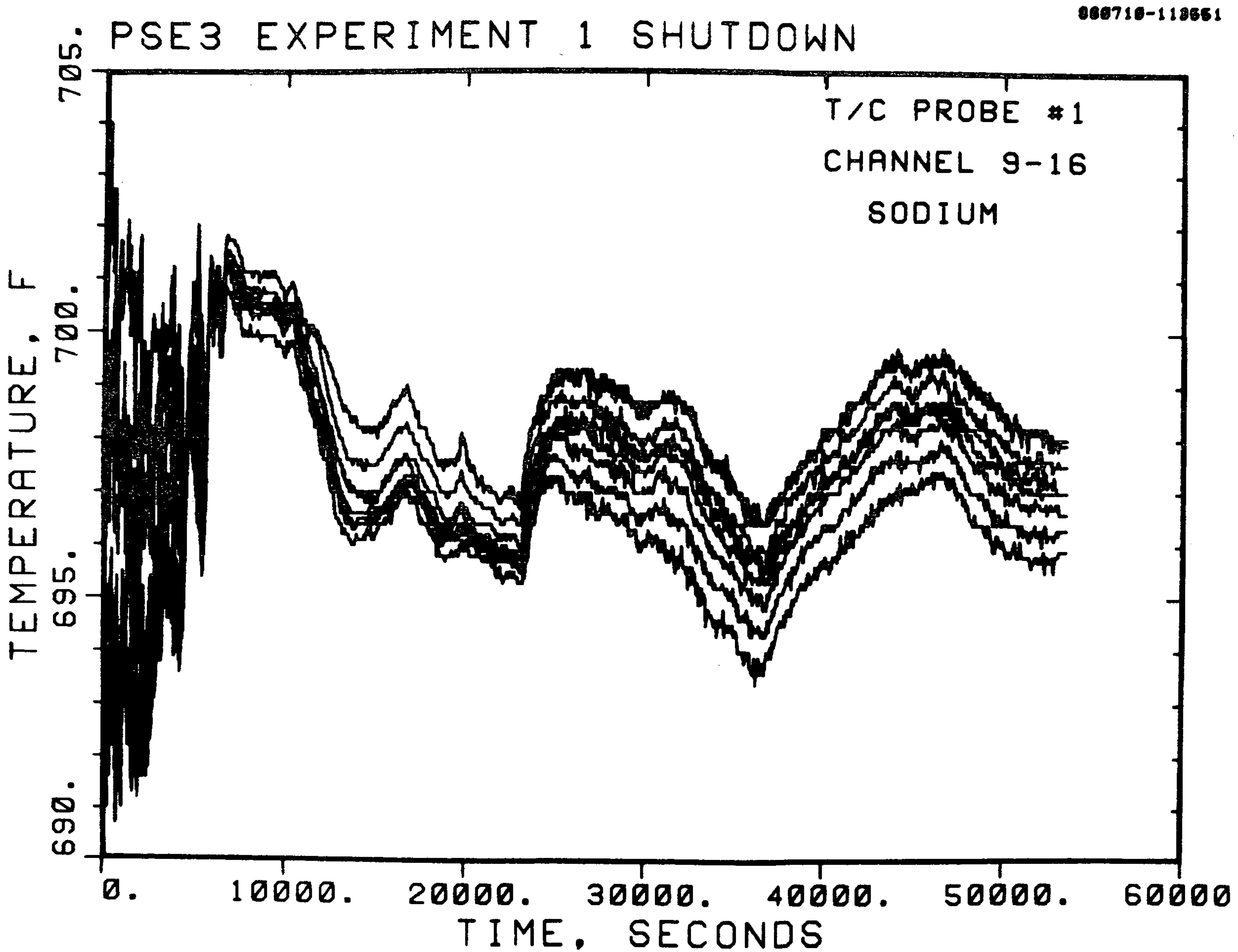


Figure 9. PSE3 Experiment 1 Shutdown (Channels 9-16)

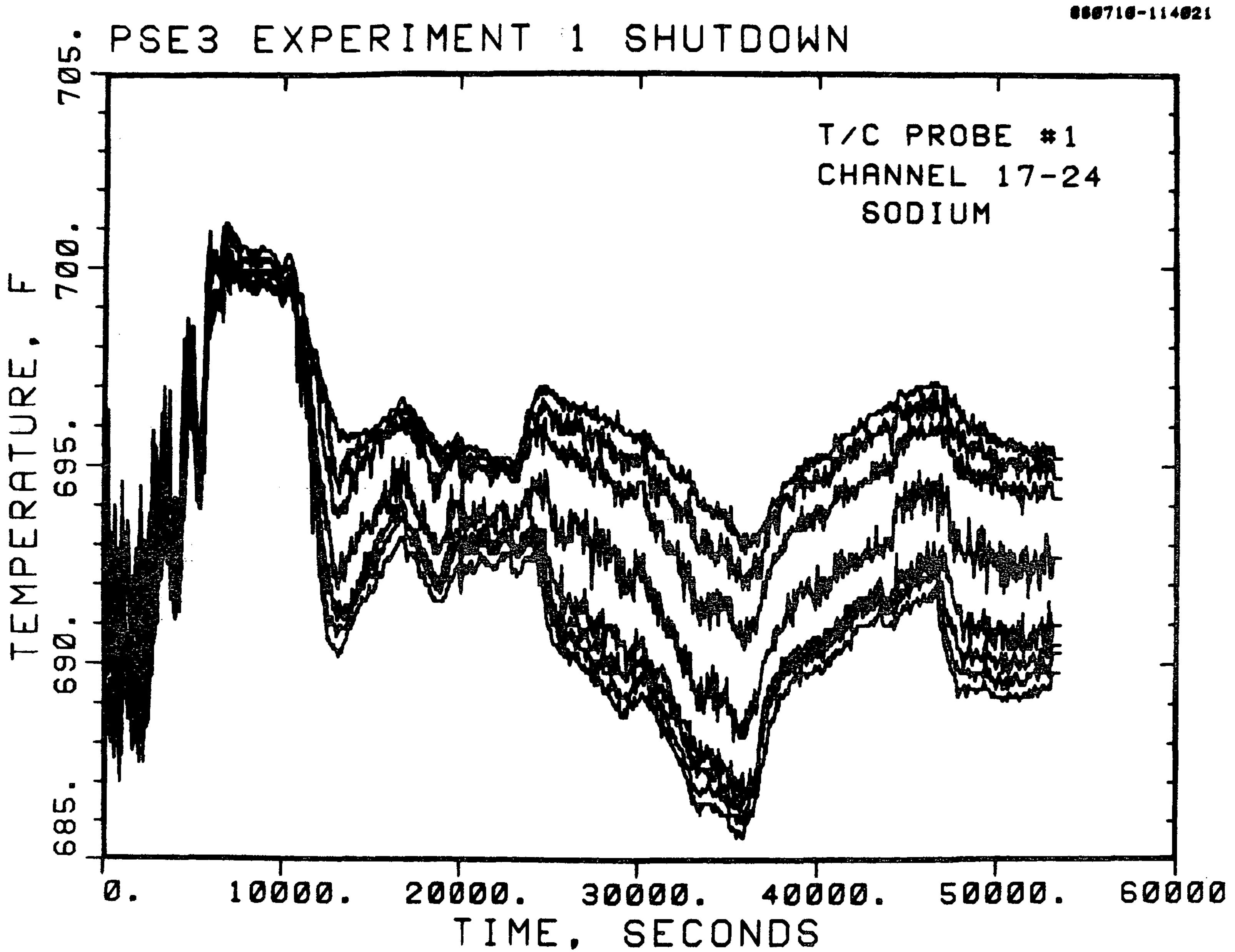


Figure 10. PSE3 Experiment 1 Shutdown (Channels 17-24)

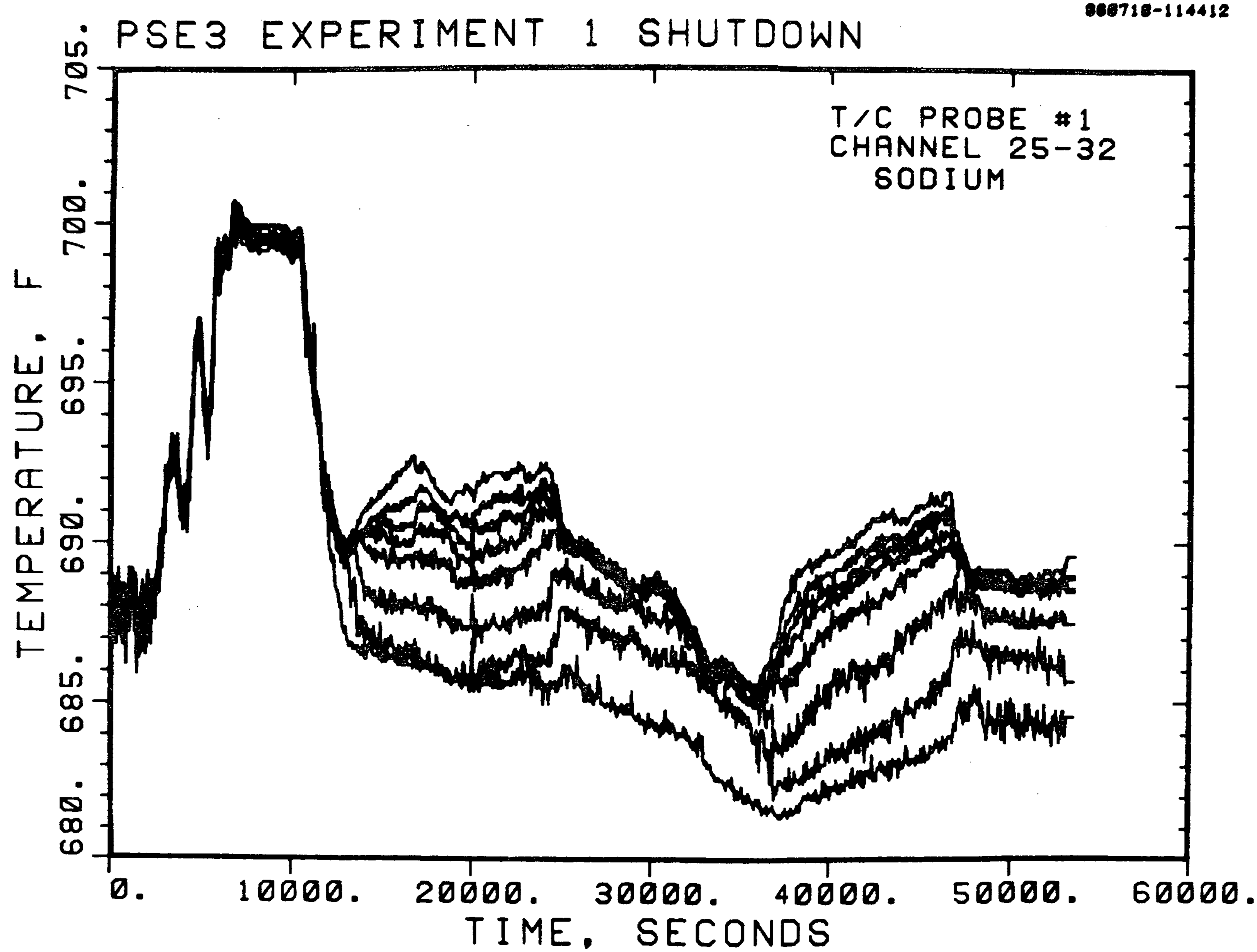


Figure 11. PSE3 Experiment 1 Shutdown (Channels 25-32)

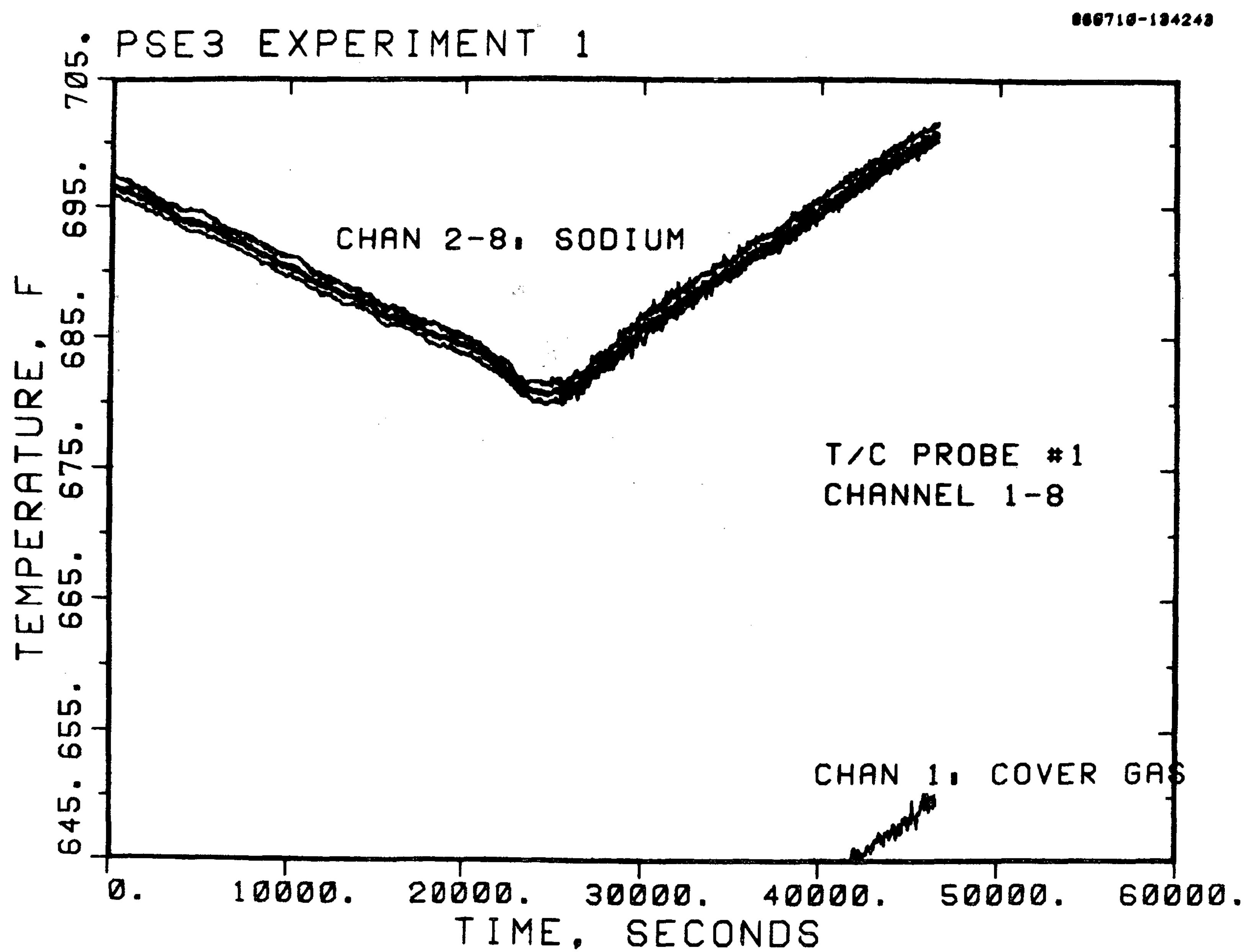


Figure 12. PSE3 Experiment 1 (Channels 1-8)

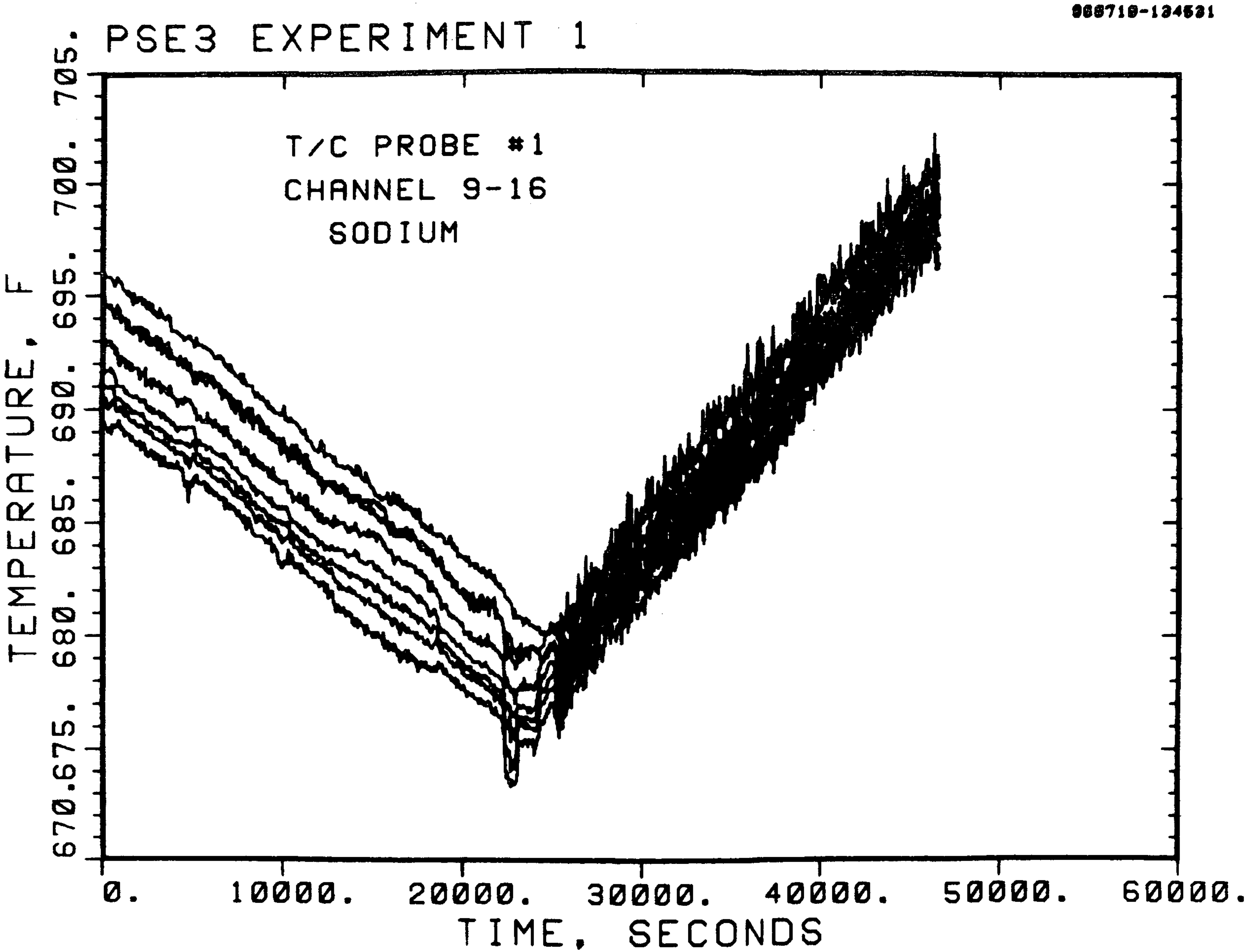


Figure 13. PSE3 Experiment 1 (Channels 9-16)

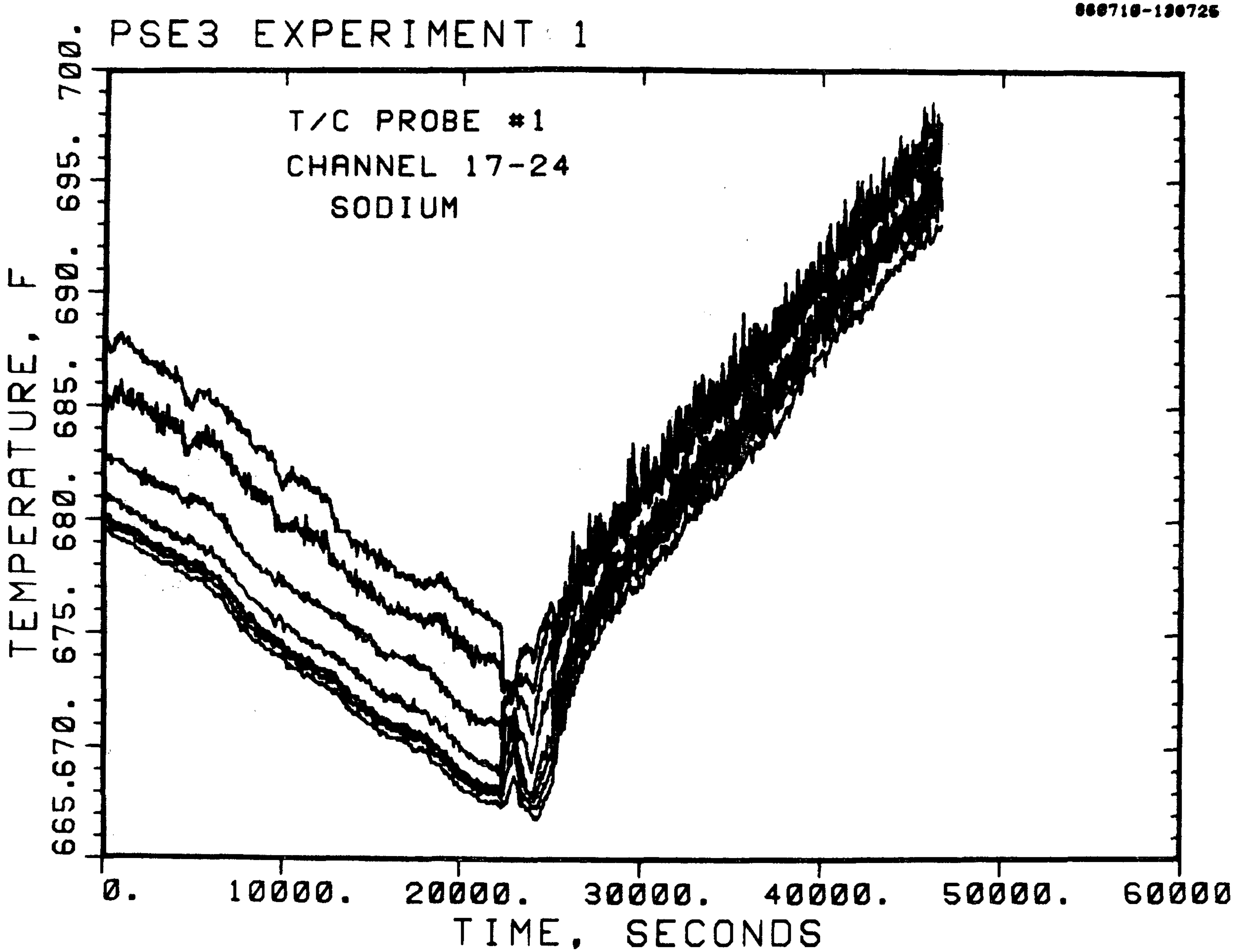


Figure 14. PSE3 Experiment 1 (Channels 17-24)

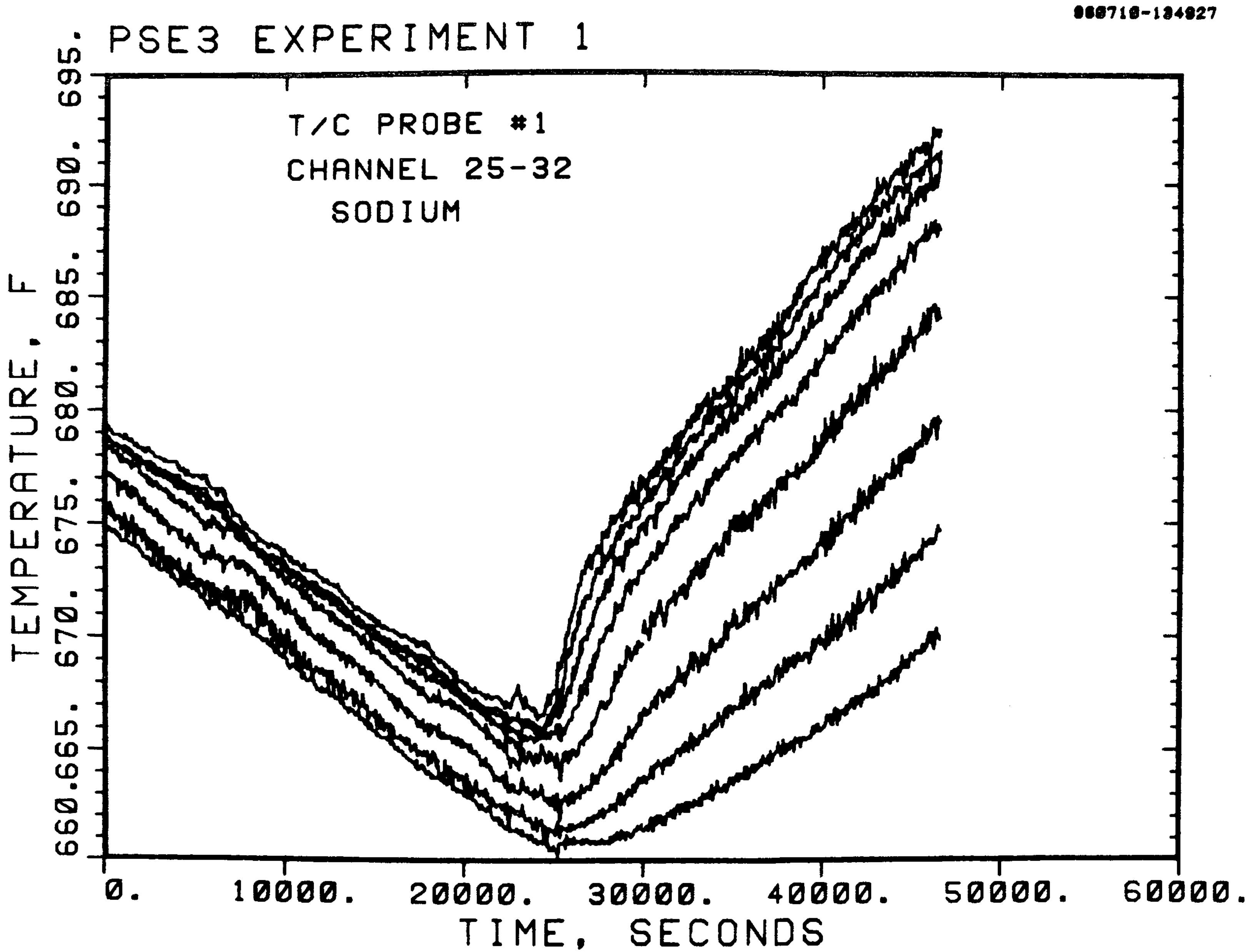


Figure 15. PSE3 Experiment 1 (Channels 25-32)

experiment. The data covers two periods, reactor shutdown and operation with the reactor head raised. PSE-3 thermocouple probe #1 is located in the F-2 nozzle position (opposite the storage basket, 2/3 of tank radius). The channel assignments are from the top of the probe with channel 1 located in the cover gas space and channels 2-32 located in the sodium at a 9 in spacing interval. In order to limit the number of graphs, eight traces are plotted on each graph. Therefore, the attached graphs are primarily presented as a means of showing possible areas for further study. Detailed plots of smaller time increments are being produced as requested for analysis purposes.

The second thermocouple probe was installed during the February 1986 shutdown and connected to the experiment data system. The remaining 134 installed thermocouples to be connected to the experiment data system and backup thermocouples have been selected and prioritized in the event that replacements are needed. This list was transmitted to EBR-II in early March. An investigation was also made of the feasibility of installing three new thermocouples in the shield cooling system in order to provide measurement of the temperature of the shield cooling flow before it mixes with that entering through the head area. After discussion with EBR-II it was determined that due to the required location within the biological shield, the cost may be excessive and that EBR-II funds are not available for this purpose.

For the second PSE-3 experiment, both thermocouple probes and associated data recording equipment was used to follow the temperature changes during the EBR-II reactor shutdown and cooldown on April 10 and 11, 1986. In addition, a limited number of manual readings were taken of all the primary tank, shield, and shield cooling system thermocouples at selected events during the cooldown.

The attached graphs (Figs. 16 to 23) are plots of the 64 thermocouple readings from the both PSE-3 thermocouple probes for the second PSE-3 experiment. The data covers the period from reactor shutdown ,through cooldown, to sodium dump. For probe #1, the channel assignments are from the top of the probe with channel 1 located in the cover gas space and channels 2-32 located in the sodium at a 9 in spacing interval. PSE-3 thermocouple

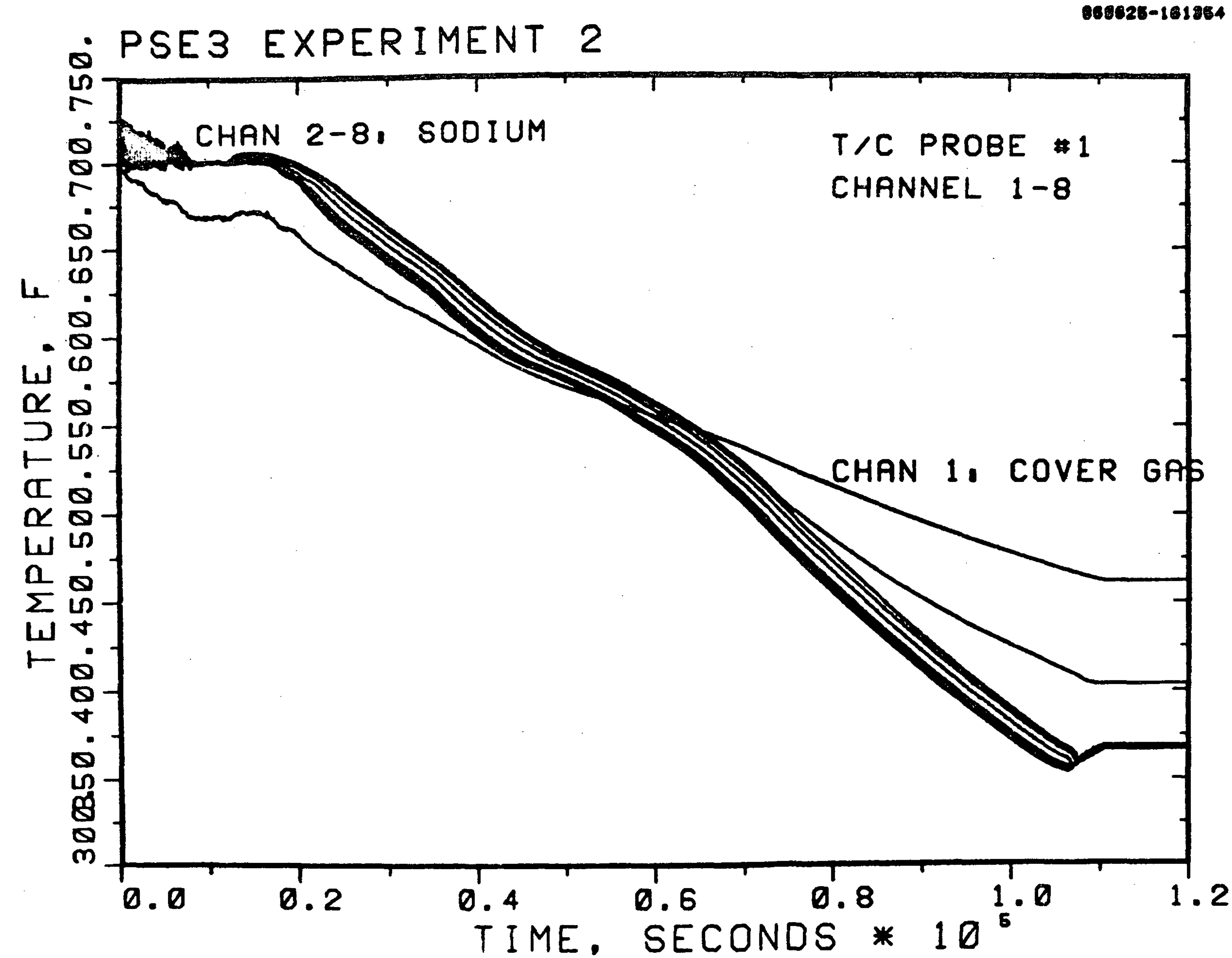


Figure 16. PSE3 Experiment 2 (Channels 1-8)

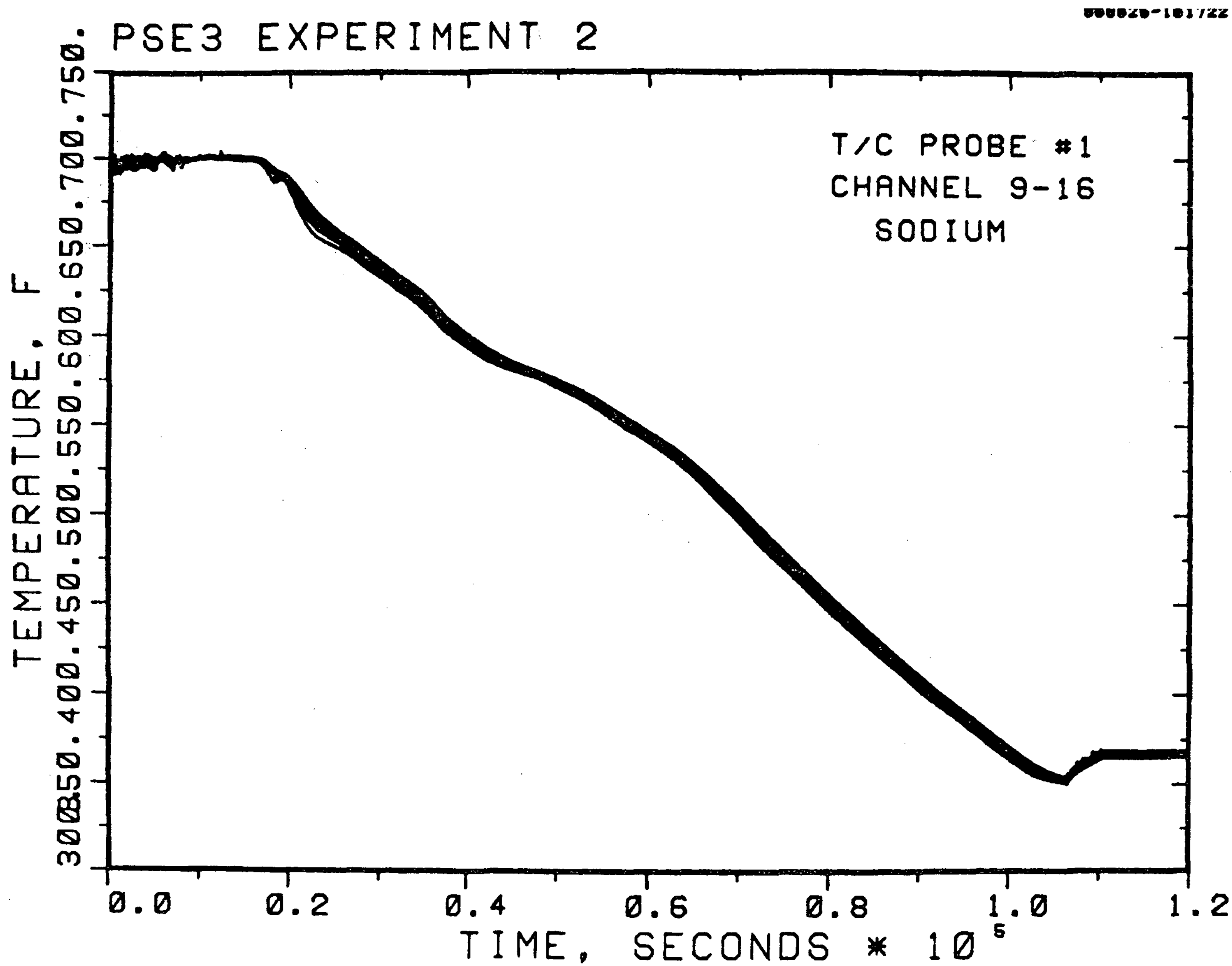


Figure 17. PSE3 Experiment 2 (Channels 9-16)

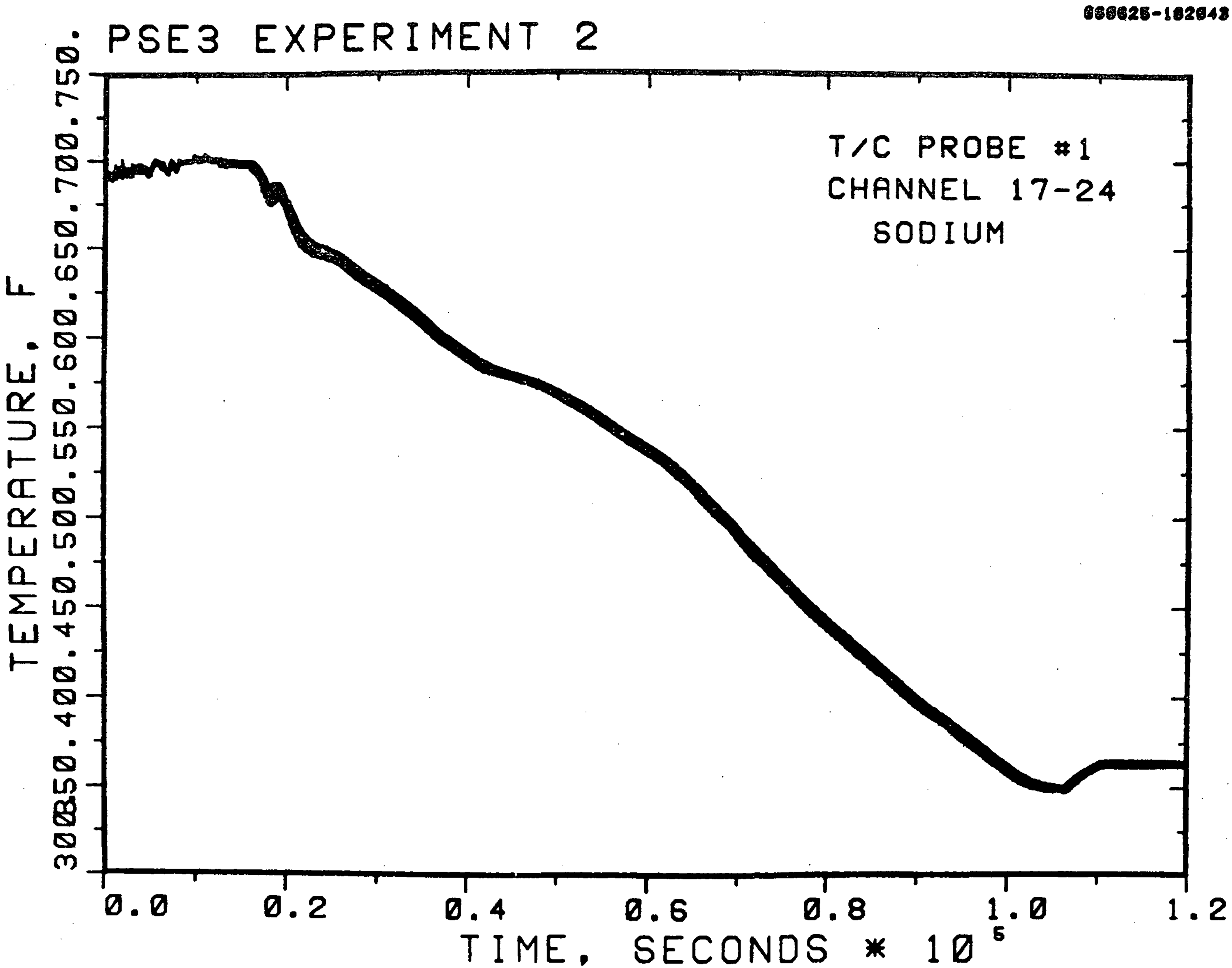


Figure 18. PSE3 Experiment 2 (Channels 17-24)

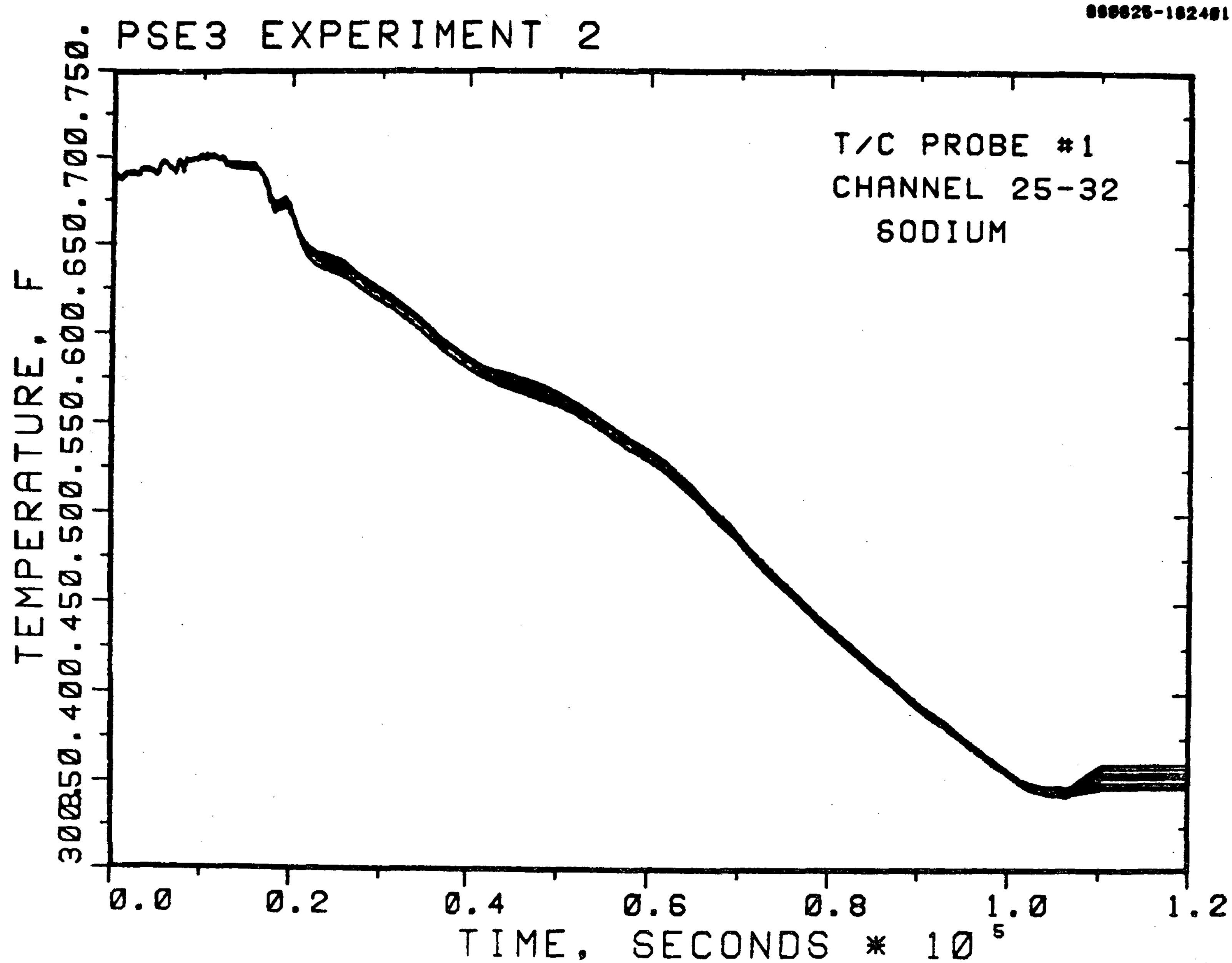


Figure 19. PSE3 Experiment 2 (Channels 25-32)

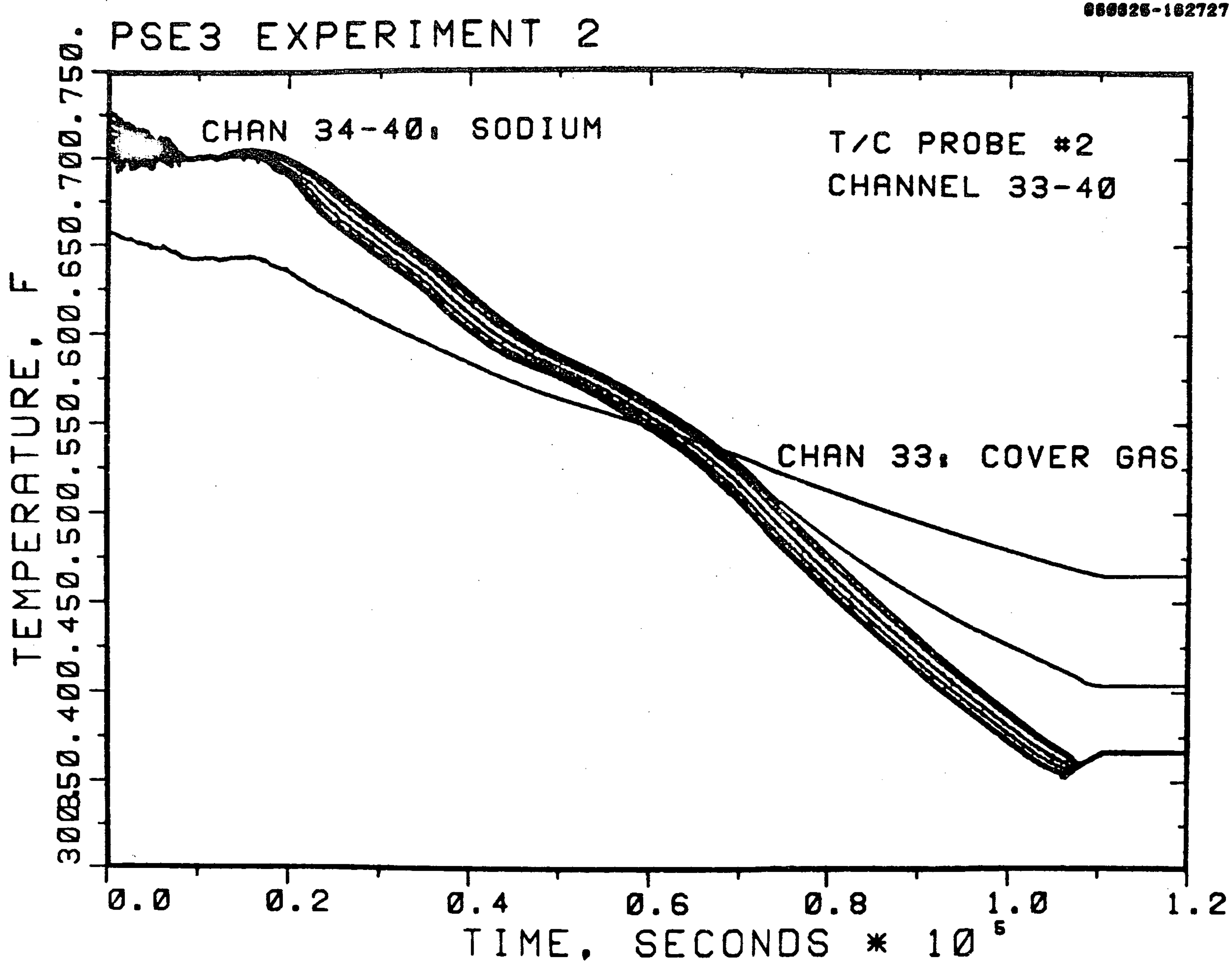


Figure 20. PSE3 Experiment 2 (Channels 33-40)

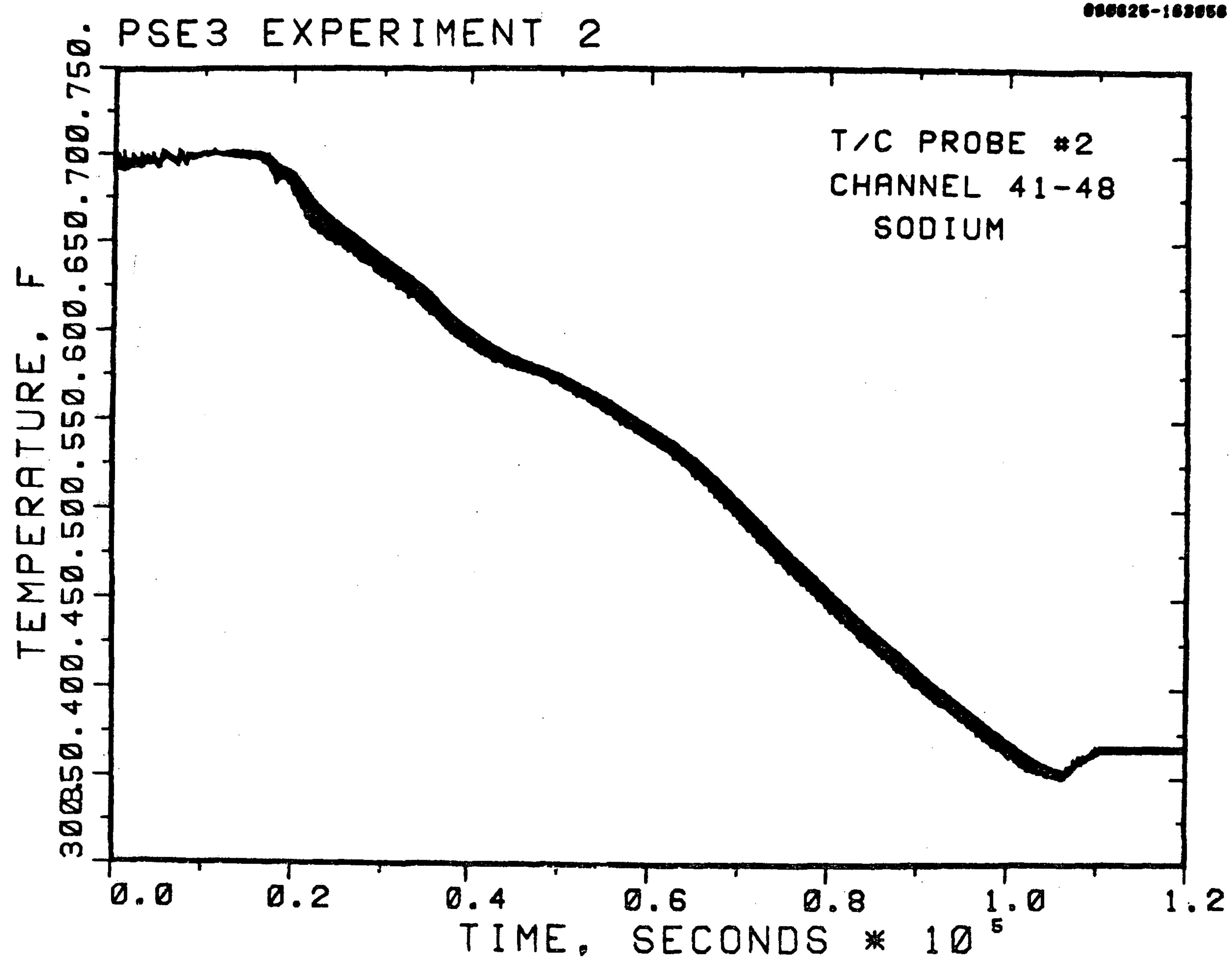


Figure 21. PSE3 Experiment 2 (Channels 41-48)

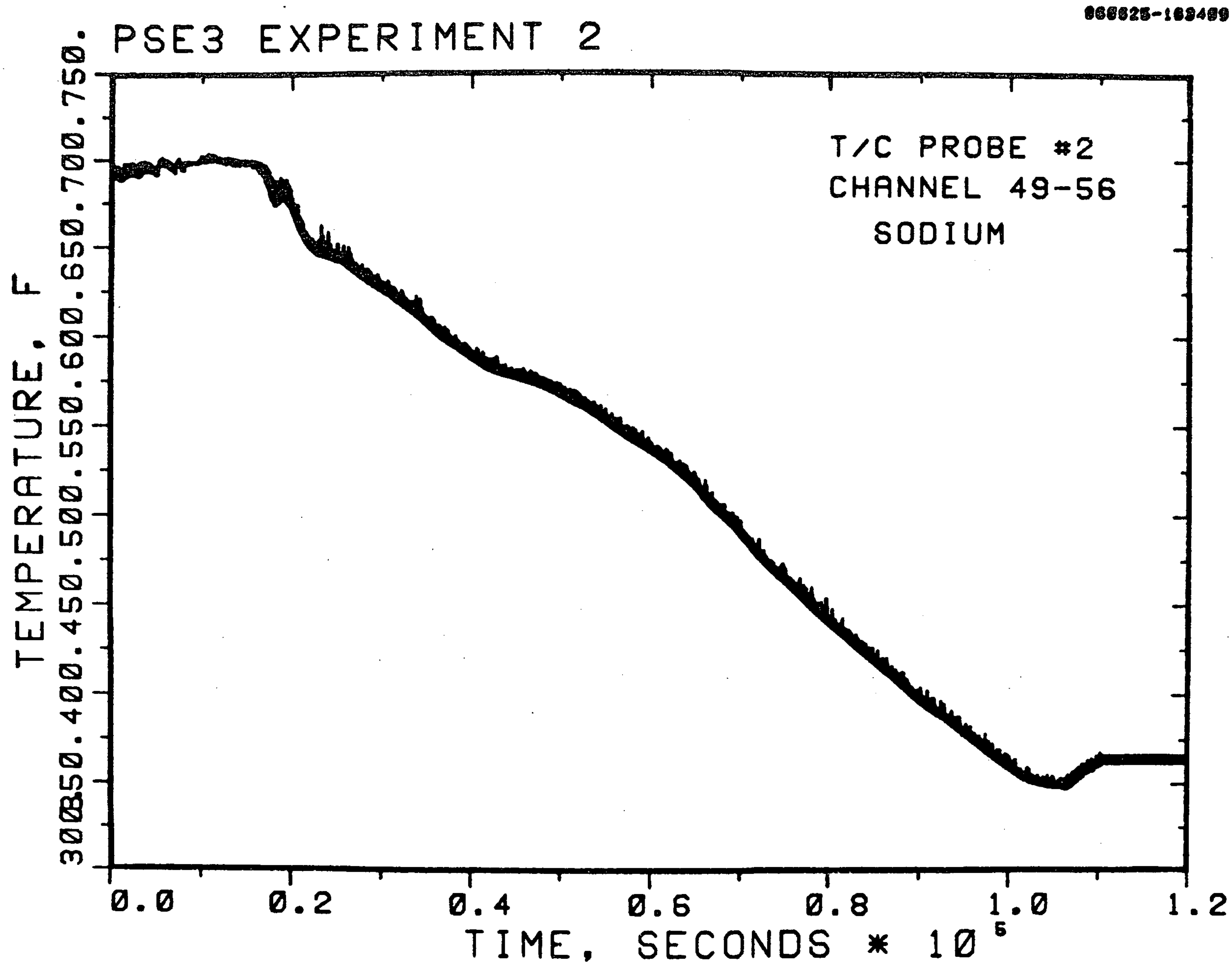


Figure 22. PSE3 Experiment 2 (Channels 49-56)

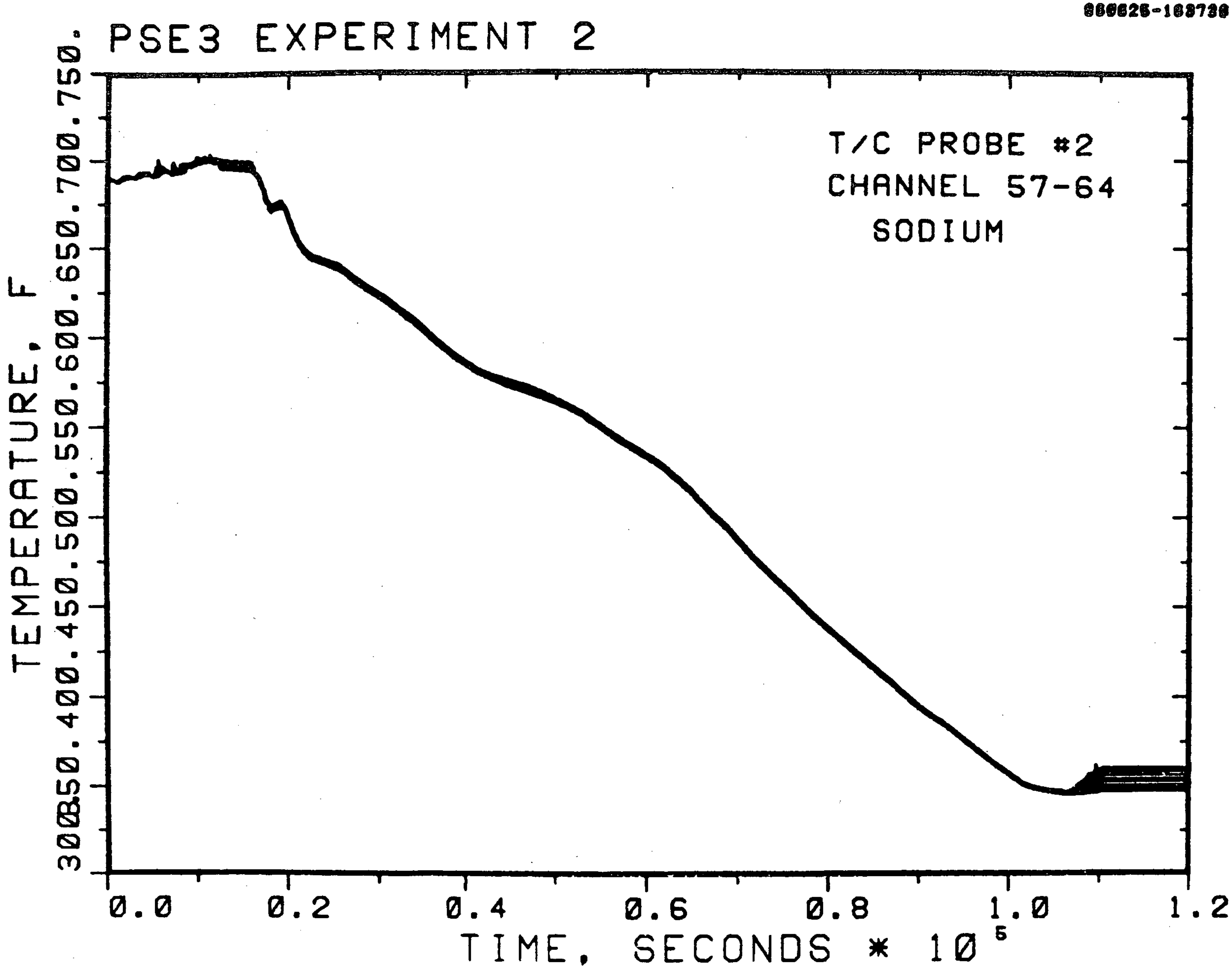


Figure 23. PSE3 Experiment 2 (Channels 57-64)

probe #2 is located in the G-2 nozzle position (adjacent the storage basket, 1/2 of tank radius). The channel assignments are from the top of probe #2 with channel 33 located in the cover gas space and channels 34-64 located in the sodium at a 9 in spacing interval. As with PSE-3 experiment 1, eight traces are plotted on each graph as a means of showing possible areas for further study. Due to spatial compression of the graphics resulting from the wide temperature range of the cooldown, the individual distinction among individual thermocouples is not as distinct as for PSE-3 experiment 1. Detailed plots are also being made of this set of graphs.

The installed thermocouple probe and associated data recording equipment used during the first PSE-3 experiment was run during the series of SHRT experiments, SHRT 33 - 45 conducted February 6 - 14. Data from both thermocouple probes was recorded during the series of SHRT demonstration experiments conducted on April 3, 1986. This data has been reduced as requested for subsequent use by the EBR-II experimenters to augment their experimental data. In addition, this data is being examined by the RAS experimenters and may be used to supplement the PSE-3 data for the validation of the COMMIX computer code.

The remaining 134 installed thermocouples will be connected to the experiment data system during the July 1986 EBR-II shutdown. One hundred of the thermocouples will be connected to a second Doric 235 and KAYPRO-1 The remaining 34 thermocouples will be connected to the first Doric 235 and KAYPRO-1 which is used for the two set of probe thermocouples. The work project and related paperwork for connecting the remaining 134 thermocouples is in progress. The second Doric 235 was shipped to the factory for trouble-shooting and recalibration. Both the second Doric 235 and second KAYPRO-1 are now at EBR-II.

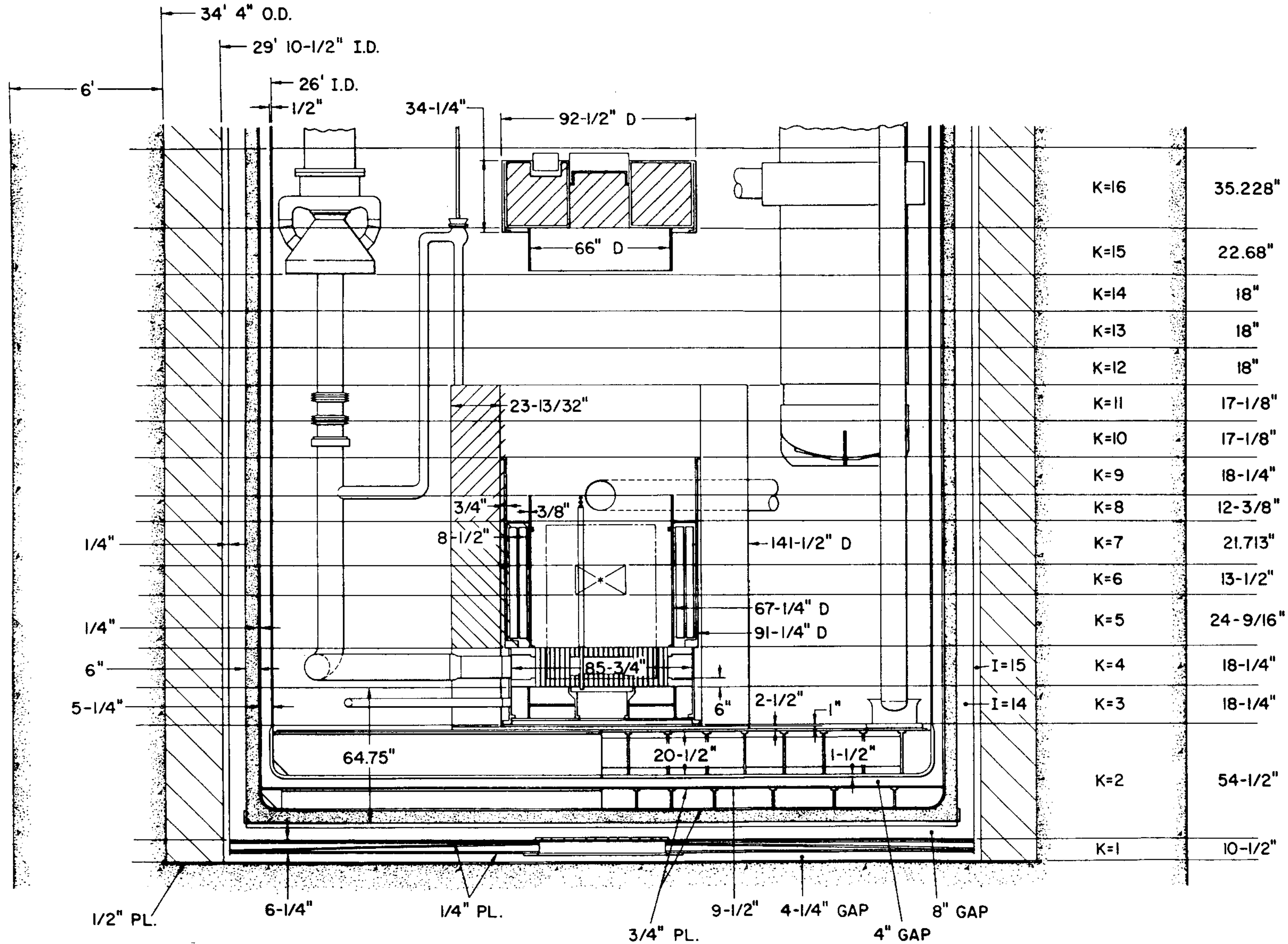
1.4 COMMIX-1A Modeling

To analyze the PSE-3 experiments with COMMIX a 3-D (R-θ-Z) model of the primary EBR-II system was developed. This model also includes the shield cooling system and the secondary side of the IHX (A detailed description of the EBR-II plant is given in Ref. 1.). Since the COMMIX computation time can be very costly, although the EBR-II primary system is not symmetric, an approximate 180° symmetric model has been developed. This model uses 13 R-nodes, 9 θ-nodes, and 16 Z-nodes. The node-structure is shown in Figs. 24 and 25. Since EBR-II has only one IHX, due to the symmetry assumption, only half of the IHX is represented in this model.

To compute pressure drops, the EBR-II primary system has been represented by 32 "force structures" [2]. Due to the coarse nodal structure, force structures of complicated geometry were significantly simplified. In EBR-II, the flow from the primary pumps is split into two streams. The high pressure stream provides coolant through a high pressure plenum to the subassemblies of active fuel (Fig. 1). The low pressure stream provides coolant through a low pressure plenum to the blanket and reflector subassemblies. Due to the coarse nodal structure, the low pressure piping is not represented explicitly. Flow is provided to the low pressure plenum from the high pressure pipe through a short pipe that branches off the high pressure pipe at the interface of the nodes: I = 5, J = 4, 5, K = 4 and I = 5, J = 4, 5, K = 3. The pressure drops in the low pressure piping and throttle valve are represented by an equivalent force structure.

For the heat transfer between solids and fluids 39 "thermal structures" [2] are used that simulate the reactor, the reactor support structures, the reactor shields, the IHX, the Z-pipe (connects the reactor upper plenum with the IHX), the fuel storage basket, the primary tank, the guard vessel, the air baffle tank of the shield cooling system, the shutdown coolers, the biological shields, and the concrete base of the reactor building. To avoid excessive computation times the shutdown coolers are modeled as thermal structures with negative heat sources. The heat loss from the Z-pipe seems to contribute significantly to the temperature difference between the top and bottom of the sodium pool. However, in a coarse nodal structure the actual Z-pipe geometry cannot be modeled. Thus, this structure has been represented by an equivalent thermal structure of slab geometry.

Since in the main series of experiments the primary pumps will not be running, they were not modeled explicitly. Thus, in steady-state computations they are represented by constant velocity boundary conditions, and in



NOTE:
SOME ASSEMBLIES ARE SHOWN OUT OF POSITION FOR CLARITY

Figure 24. Vertical Nodal Arrangement

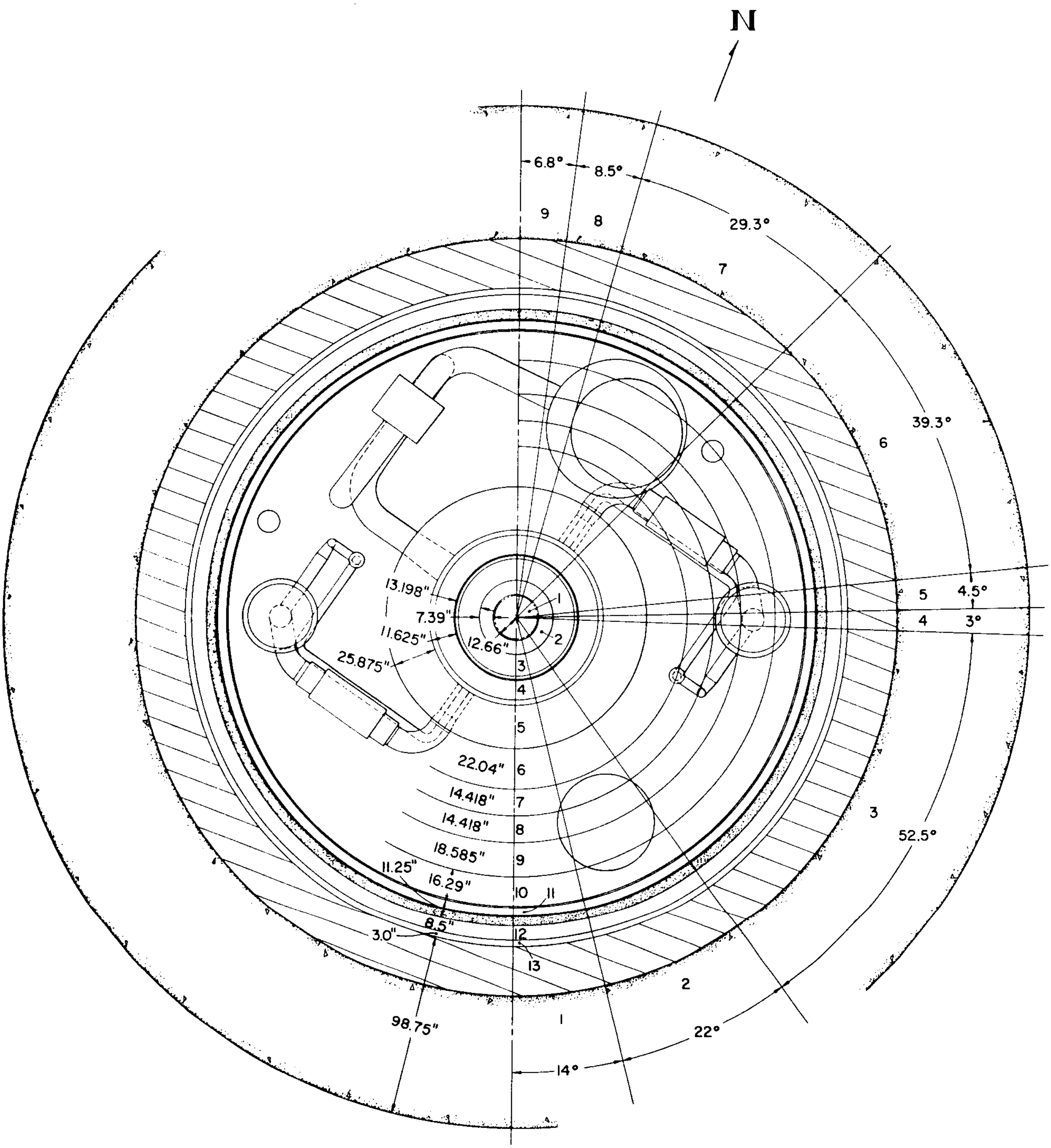


Figure 25. Azimuthal Nodal Arrangement

transient computations by an equivalent force structure that accounts for the resulting pressure drop.

To account for volume changes, due to temperature changes in the sodium pool, an artificial node (I = 2, J = 1, K = 17) was added. The secondary side of the IHX is represented by the nodes defined by: I = 14, J = 7, K = 12, 16.

Pressure Drop Correlations

To compute pressure drops the EBR-II primary system has been represented by 32 "force structures". In COMMIX, the pressure drop Δp due to friction is computed from an equation of the form

$$\Delta p = C_1 \frac{L}{D} \rho v^2 f \tag{1}$$

where

C_1 = constant
L = length
D = hydraulic diameter
ρ = density
v = velocity
f = friction factor

For the pressure drop in the reactor subassemblies the friction factor correlation [3]

$$f = K \times Re^{-m}$$

was used, where Re is the Reynolds number, and the constants K and m have the values given below.

	Laminar Flow		Turbulent Flow	
Subassembly	K	m	K	m
Driver	26.33	0.85	0.1922	0.072
Blanket	2.574	0.269	2.574	0.269
Reflector	6.48	0.03	6.48	0.03

The transition Reynolds number (from laminar to turbulent flow) is 557.5.

For the pressure drop at the inlets of the high and low pressure plena Eq. (1) is written as [3]

$$\Delta P = 0.5\ \rho v^2\ f$$

where

$$f = \frac{61.75}{Re^{0.2}}$$

for the high pressure plenum, and

$$f = 27.0$$

for the low pressure plenum.

For the flow resistance in the transverse direction caused by the lower adapter tubes in the high pressure plenum, and by the finger holders and top end fixtures in the upper plenum, the friction factor was computed from [3]

$$f = \frac{180}{Re}, \qquad Re < 202.5$$

$$f = \frac{1.92}{Re^{0.145}}, \qquad Re > 202.5$$

For the pressure drops caused by the baffles in the high and low pressure plena and the radial skirt of the reactor vessel cover the same friction factor values were used as in Ref. 3.

Large surfaces (like the primary tank walls and horizontal base, reactor shield surfaces, etc.) were simulated as flat plates with friction factors given by [4]

$$f = 1.328\ Re^{-0.5} \qquad Re < 5 \times 10^5$$

$$f = 0.0306\ Re^{-0.14286} \qquad Re > 5 \times 10^5$$

The friction factors of pipes were computed from [4]

$$f = \frac{64}{Re}, \qquad Re < 2000$$

$$f = 0.3164\ Re^{-0.25}, \qquad Re > 2000$$

The air flow of the shield cooling system was simulated as flow between infinite parallel plates and the friction factor correlations [5]

$$f = \frac{96}{Re}, \qquad Re < 3000$$

$$f = \frac{0.34}{Re}, \qquad Re > 3000$$

were used.

Based on EBR-II data [6], the following expression was derived for the friction factor of the primary side of the IHX

$$f = \frac{987 \times 10^3}{Re}, \qquad Re < 1450$$

$$f = 509.7\ Re^{-0.25}, \qquad Re > 1450$$

These expressions were used with ΔP given as

$$\Delta P = C_1\ \rho u^2\ f$$

Heat Transfer Correlations

For the heat transfer between the core subassembly elements and the sodium coolant, the heat transfer coefficient was computed from the correlation [3]

$$Nu = 4.5 + 0.0052 \times Re^{0.3}$$

where Nu is the Nusselt number. For the gap between the fuel and the cladding a gap conductance value of 10,000 W/m^2K was used [3].

In the shield cooling system, the heat transfer coefficient of air was computed from [5]

$$Nu = 0.023\ Re^{0.8}\ Pr^{0.4}$$

where Pr is the Prandtl number. For air Pr $\approx$ 0.7 and this expression becomes

$$Nu = 0.019942\ Re^{0.8}$$

Since the cylindrical vertical surfaces of interest (tank walls, reactor shields) have a large diameter, for the computation of the heat transfer coefficient they were treated as vertical plates. The heat transfer coefficient of these surfaces can be computed from the correlation [7]

$$Nu^{0.5} = 0.825 + \frac{0.387\ Ra^{1/6}}{[1 + (0.492/Pr)^{9/16}]^{8/27}} \qquad (2)$$

where Ra is the Rayleigh number. However, COMMIX accepts only heat transfer correlations of the form

$$Nu = a + b\ Re^{c}$$

where a, b, and c are constants. Equation (2) was transformed into this form by making the following approximations. The Rayleigh number is given by the product

$$Ra = Gr\ Pr$$

where Gr is the Grashof number. Since

$$Gr \propto Re^2 \qquad (3)$$

the Rayleigh number is approximated by

$$Ra \approx Re^2\ Pr$$

and Eq. (2) is written as

$$Nu^{0.5} = 0.825 + \frac{0.387\ Pr^{1/6}\ Re^{1/3}}{[1 + (0.492/Pr)^{9/16}]^{8/27}}$$

or

$$Nu \approx 0.681 + \frac{0.1498\ Pr^{1/3}\ Re^{2/3}}{[1 + (0.492/Pr)^{9/16}]^{16/27}}$$

Finally, using an average Prandtl number value of 0.00519 for sodium this correlation becomes

$$Nu \approx 0.681 + 0.00544\ Re^{2/3} \qquad (4)$$

For horizontal surfaces (bottom of the primary tank, reactor vessel cover, etc.) the heat transfer coefficient can be computed from the correlation [6]

$$Nu \approx 0.58\ (Gr\ Pr)^{0.2}$$

For $Gr \propto Re^2$ and $Pr \approx 0.00519$ this correlation is transformed to

$$Nu = 0.203\ Re^{0.4}$$

The heat transfer coefficient for the argon filled space between the primary tank and the guard vessel can be computed from the correlation [6]

$$Nu = 0.197\ (Gr\ Pr)^{1/4}\ \left(\frac{L}{\delta}\right)^{-1/9}$$

where L is the height of the argon filled gap and δ its thickness. For $Gr \propto Re^2$, $Pr \approx 0.673$, $L \approx 8.6$ m, and $\delta = 0.18$ m the above correlation becomes

$$Nu \approx 0.1123\ Re^{0.5}$$

For the IHX and the inner surface of the Z-pipe the correlation [8]

$$Nu = 4.55 + 0.016\ (Pr\ Re)^{0.86}$$

was used. For $Pr \approx 0.00519$ this correlation becomes

$$Nu = 4.55 + 0.000173\ Re^{0.86}$$

For the heat transfer coefficient of the outer surface of the Z-pipe Eq. (4) was used. As mentioned earlier, the Z-pipe was represented by an equivalent thermal structure of slab geometry. For this equivalency, the correlations that give the heat transfer coefficients for the surfaces of the Z-pipe were multiplied by the ratio of the actual heat transfer area over the area of the slab that simulated the pipe.

The dominant mode of heat transfer from the primary tank and the guard vessel to the shield cooling system is radiation. To simulate this mode, the thermal radiation model of COMMIX was used with the following radiating surfaces: outer surface of the primary tank, inner surface of the guard vessel, outer surface of the insulation covering the guard vessel, and inner surface of the baffle tank. An emissivity of 0.65 was used for all these surfaces.

Model Tuning

Due to the modeling approximations, the constant C_1 of Eq. (1) has to be properly adjusted for the computed pressure drops to match corresponding measured values. This adjustment was made at steady-state conditions, and due to the lack of a better alternative, the assumption was made that the adjustment is also good for transient analyses. For this adjustment the steady-state pressure drops given in Table I were used as reference. They are predictions of the EBRFLOW [8] code which is used routinely for the analysis of the EBR-II system.

As mentioned earlier, at steady-state the primary pumps were represented by constant velocity boundary conditions. Thus: (1) the node I = 9, J = 4, K = 15 was treated as external to the computational domain, (2) an inflow velocity was defined on the -K surface of the node, and (3) an equal outflow velocity was defined on the +K surface of the same node. However, with this set of boundary conditions the code did not generate any flow out of the computational space. This problem was bypassed by defining the outflow boundary condition on the -I surface of the node and by introducing a small artificial pipe having this surface as an outlet and defined by four surfaces of the node I = 8, J = 4, K = 15.

TABLE I. EBRFLOW Steady-State Pressure Drop Predictions

	Pressure Drop Pascal
From Pump Discharge to High-Pressure Plenum	2.54×10^4
From Pump Discharge to Low-Pressure Plenum	2.25×10^5
From High-Pressure Plenum to Upper Plenum	2.47×10^5
From Low-Pressure Plenum to Upper Plenum	4.75×10^4
From Upper Plenum to IHX Inlet	2.96×10^4
From IHX Inlet to IHX Outlet	1.32×10^4
Net Pump Head	3.15×10^5

To conserve the primary pipe cross-sectional flow area, proper permeabilities and porosities were determined for the pipe nodes defined by the θ-nodes J = 4 and J = 5. However, for homogeneous porosities and permeabilities across J = 4 and J = 5, the code was channelling the flow mainly through the nodes defined by J = 4. This lead to very high local velocities and very high pressure drops. This problem was minimized by setting the porosities and permeabilities of the nodes defined by J = 4 equal to one and properly adjusting the same quantities for J = 5.

The form losses computed by the code for the flow from the pump to the high pressure plenum as well as from the upper plenum to the IHX inlet are higher than the corresponding actual total pressure drops. However, with proper adjustment of the constants C_1 (Eq. 1) the computed major pressure drops in the system match their actual values (Table I).

The detailed COMMIX input used for the steady-state analysis is given in Appendix I.

2.0 REFERENCES

1. EBR-II System Design Descriptions (June 1971).

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3. W. L. Baumann, et al., "EBR-II In-Vessel Natural-Circulation Analysis," NUREG/CR-2821, ANL-82-66 (September 1982).

4. J. G. Knudsen and D. L. Katz, "Fluid Dynamics and Heat Transfer," McGraw-Hill Book Company, Inc. (1958).

5. W. M. Rohsenow, J. P. Hartnett, and E. N. Ganic, "Handbook of Heat Transfer Fundamentals," McGraw-Hill Book Company (1985).

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7. S. W. Churchill and H. H. S. Chu, "Correlating Equations for Laminar and Turbulent Free Convection from a Vertical Plate," Int. J. Heat Mass Transfer, 18, 1323 (1975).

8. A. Gopalakrishnan and J. L. Gillette, "EBRFLOW: A Computer Program for Predicting the Coolant Flow Distribution in EBR-II," Nucl. Technol. 17, 205 (1973).

Appendix I

```
+---------------------------------------------+
|             COMMIX-1A EBR-II SHRS            |
|          SIMULATION WITH COVER ON            |
|                STEADY-STATE                  |
|                 JUNE, 1986                   |
+---------------------------------------------+

 &GEOM
  IGEOM=-1,NL1=2000,  NM1=2200,
  ISYMCH=5,IFITEN=3,IFHTX=2,
  IFREB=5000,IFRES=1, ITURKE=0, NFORCE=32,
  ISTRUC=1, IBSBUG=0,
  IMAX=14, JMAX=9,  KMAX=17,
  NSURF=50,  LMPRNT=0,
  DX=.321532, .187795, .335223, .295275, .657225, .559816,
     .366205, .366204, .472059, .413766, .28575, .2159, .0762,
     .62676,
  DY=.244126, .38442, .916013, .052475, .078421, .686639,
     .511805, .14847, .119222,
  DZ=.2667,  1.3843, .46355, .46355, .623888, .3429, .55151,
     .314325, .46355 ,2* .434975, 3*.4572, .576072, .894791,
     .050,
  XNORML= 13*0,-1,0, -1, 6*0, 1, -1,  5*0,
          -1, 1, 4*0, 0,  0, -1, 3*0, 1, 2*0 ,-1, 1, 3*0, 1,
  YNORML= 1,-1, 1,-1, 1,-1, 1,-1, 8*0, 1, -1,  8*0,
          0,1,-1, 2*0, 1, -1, 5*0, 1, -1, 2*0, 1,-1,2*0,2*-1,2*0,
  ZNORML= 8*0, 5*-1, 0, 1, 3*0, -1, 1, 1, -1, 2*0, 1, -1,
          -1, 6*0, -1, 1, -1,1,3*0, -1, 0, 6*0,-1, 0,
  &END
REG         -1.   1  13   1   1   1   1   1    BOTTOM GAP
REG         -1.   1  13   9   9   1   1   2    BOTTOM GAP
REG         -1.   1  13   1   1   2   2   3    BOTTOM AIR FLOW
REG         -1.   1  13   9   9   2   2   4    BOTTOM AIR FLOW
REG         -1.   1   4   1   1   3   4   5    PLANE OF SYMMETRY SODIUM
REG         -1.   1   3   1   1   5   7   5    PLANE OF SYMMETRY SODIUM
REG         -1.   1   4   1   1   8   9   5    PLANE OF SYMMETRY SODIUM
REG         -1.   6  10   1   1   3  16   5    PLANE OF SYMMETRY SODIUM
REG         -1.   1   5   1   1  12  16   5    PLANE OF SYMMETRY SODIUM
REG         -1.   2   2   1   1  17  17   5    ARTIFICIAL NODE
REG         -1.   1   4   9   9   3   4   6    PLANE OF SYMMETRY SODIUM
REG         -1.   1   3   9   9   5   7   6    PLANE OF SYMMETRY SODIUM
REG         -1.   1   4   9   9   8   9   6    PLANE OF SYMMETRY SODIUM
REG         -1.   6  10   9   9   3  16   6    PLANE OF SYMMETRY SODIUM
REG         -1.   1   5   9   9  12  16   6    PLANE OF SYMMETRY SODIUM
REG         -1.  11  11   1   1   3  17   7    ARGON
REG         -1.  11  11   9   9   3  16   8    ARGON
REG         -1.   3  10   1   9  16  16   9    SODIUM AT TOP OF POOL
REG         -1.   1   1   1   9  16  16   9    SODIUM AT TOP OF POOL
REG         -1.   2   2   2   9  16  16   9    SODIUM AT TOP OF POOL
REG         -1.   2   2   1   1  17  17  10    ARTIFICIAL NODE
REG         -1.  11  11   2   9  16  16  11    ARGON GAP
```

```
REG        -1.  12  12   1   9  16  16  12   AIR OUT
REG        -1.  13  13   1   9  16  16  13   AIR IN
REG        -1.  13  13   1   6   1  16  14   OUTSIDE RADIAL SURFACE
REG        -1.  13  13   8   9   1  16  14   OUTSIDE RADIAL SURFACE
REG        -1.  13  13   7   7   1  11  14   OUTSIDE RADIAL SURFACE
REG        -1.   1  13   1   9   1   1  15
REG        -1.  14  14   7   7  12  16  16     IHX SIDE(RAD)
REG        -1.  14  14   7   7  12  16  17     IHX(+TH)
REG        -1.  14  14   7   7  12  16  18      IHX (-TH)
REG        -1.  14  14   7   7  16  16  19      IHX (OUT)
REG        -1.  14  14   7   7  12  12  20      IHX (INLET)
REG        -1.   1   5   1   9  12  12  21    TOP OF REACTOR COVER
REG        -1.   1   4   1   9   9   9  22    BOTTOM OF R. COVER
REG        -1.   6   6   1   9  10  11  23    OUTSIDE OF R.SHIELD
REG        -1.   6   6   1   9   5   8  23     OUTSIDE OF REAC. SHIELD
REG        -1.   6   6   1   3   3   4  23     OUTSIDE OF REAC. SHIELD
REG        -1.   6   6   6   9   3   4  23     OUTSIDE OF REAC. SHIELD
REG        -1.   6   6   1   8   9   9  23     OUTSIDE OF REAC. SHIELD
REG        -1.   4   4   1   9   8   8  24    INSIDE OF R. SHIELD
REG        -1.   4   4   1   8   9   9  24     INSIDE OF R. SHIELD
REG        -1.   3   3   1   9   5   7  24     INSIDE OF R. SHIELD
REG        -1.   4   4   1   3   3   4  24     INSIDE OF R. SHIELD
REG        -1.   4   4   6   9   3   4  24     INSIDE OF R. SHIELD
REG        -1.   4   4   1   9   8   8  25    IN.R.SHIELD HORIZ.+Z
REG        -1.   4   4   1   9   4   4  26    IN.R.SHIELD HORIZ.-Z
REG        -1.   5   5   4   5   4   4  27    HP LP PIPES IN-Z
REG        -1.   5   5   4   4   3   4  28    HP LP PIPES IN+TH
REG        -1.   5   5   5   5   3   4  29    HP LP PIPES IN -TH
REG        -1.   8   8   4   4  15  15  30    PRIM.PUMP-R
REG        -1.  10  10   4   4  15  15  31    PRIM.PUMP+R
REG        -1.   9   9   5   5  15  15  32    PRIM.PUMP+TH
REG        -1.   9   9   3   3  15  15  33    PRIM.PUMP-TH
REG        -1.   9   9   4   4  14  14  34    PRIM.PUMP-Z
REG        -1.   9   9   4   4  16  16  35    PRIM.PUMP+Z
REG        -1.   5   5   9   9   9   9  36    Z-PIPE -Z
REG        -1.   5   5   9   9   9   9  37    Z-PIPE  +Z
REG        -1.   2   2   1   1  17  17  38   ARTIFICIAL NODE
REG        -1.  12  13   1   1   3  16  39   AIR IN OUT
REG        -1.  12  13   9   9   3  16  40   AIR IN OUT
REG        -1.   5   5   1   3   2   2  41    BOTTOM OF R.SHIELD
REG        -1.   5   5   6   9   2   2  41    BOTTOM OF R.SHIELD
REG        -1.   1   1   1   9   1   9  42     CENTER LINE
REG        -1.   1   1   1   9  12  16  42      CENTER LINE
REG        -1.   5   5   9   9   9   9  43     Z-PIPE +TH
REG        -1.   5   5   9   9   9   9  44     Z-PIPE -TH
REG        -1.  11  11   1   1  17  17  45    ARGON ARTIF NODE
REG        -1.  11  11   1   1  17  17  46    ARGON ARTIF NODE
REG        -1.  11  11   1   1  17  17  47    ARGON ARTIF NODE
REG        -1.   2   2   1   1  17  17  48     ARTIF NODE
REG        -1.  11  11   1   1  17  17  49     ARGON ARTIF NODE-Z
REG        -1.   2   2   1   1  17  17  50     ARTIF NODE+R
END
 &DATA
  IDTIME=0,IFENER=1,ISTATE=0,NEWTS=1,IFRAD=2,NRAD=4,
```

```
FVIEW=0.0   ,.9559, 97*0.0,
      1.0,   .0208, 97*0.0,
      0.0,   .0,      0.0,   .9341 , 95*0.0,
      0.0,   .0,      1.0,   .0417 , 95*0.0,9497*0.0,
OMR=0.03,
EMITS=4*0.65,
DT=.05, 1.0, LASTDT=25,
NEWREB=1,NEWFOR=1,IENBUG=-2,ITIBUG=0,RDTIME=10.,
NTHCON=-1
NTMAX=200,TREST=40.,
IT=1,ITMAXP=100, ITMAXE=100,
 OMEGAV=0.8,OMEGA=1.5,OMEGAE=0.8,
EPS1=1.E-4,EPS5=1.E-5,DDDHMX=0.,
KFLOW=8*-3, 3*1,  -5, 6*1, -5, 10*1, -5, 8*1,2*-3, 1, -3,6*1, -5,
       1,
KTEMP=12*400,1,6*400,1, 9*400, 4*400,1, 3*400, 4*400, 400,8*400,
KPROP=4*3, 2*1, 2*2, 2*1, 2, 4*3, 23*1, 3*3, 1, 2*1,3*2,1, 2, 1,
VELOC=11*0.0, -3.4573, 3.4573, 5*0.0,-.1092815,.10655,  9*0.0,
     -3.5089, 3*0.0,  3.1083, 0.0,      9*0.0, 6*0.0,
TEMP=2*50., 2*35., 2*371.1,2*371.1,3*371.1, 35., 31.667, 2*35.,
     5*308.72, 13*371.10, 371.11, 371.10, 472.78,
      371.1, 381.0, 2*35.0 , 2*371.,371.1, 7*371.1,
TEMPO=371.0, PRESO=0.841E5,   ZPRESO=8.580, TEMP2=371.,
TAIR=35.0, GRAVZ=-9.8,  NTPRNT=-9999,
ISTPR=-01201, -01209, -02201, -02209, -03201,-03209,
      -05201, -05209,
       -15201, -15209,
       -17201,-17209,
       90112,90113,90119,90120,-90134,
      -90137, 90512,90513,90519,90520,-90534,-90537,
       90812,90813,90819,90820,-90834,-90837,
NTHPR=-01201, -01209, -02201, -02209, -03201, -03209,
      -05201, -05209,
       -05301, -05317,  -17201, -17209,
       -80003,-80005,
       90112,90113,90119,90120,-90134,
      -90137, 90512,90513,90519,90520,-90534,-90537,
       90812,90813,90819,90820,-90834,-90837,
IREBIT=9,
FCOR02=1.23033, FC1R02=-1.2702E-3,
FCOMU2=2.40866E-5, FC1MU2=4.5E-8,
FCOK2=1.8459E-2, FC1K2=3.6686E-5,
FCOH2=1.42042E5, FC1H2=520.571,
FCOMU3=1.9E-5,FC1MU3=3.22E-8,
FCOK3=2.56E-2,FC1K3=6.28E-5,
FCOH3=2.72E5,FC1H3=1.03E3,
NHEATC=8,
HEATC1=4.5, .681, .0001, .0001, .0001, 19.395, 2.935, 4.55,
HEATC2=0.0052,0.005444,0.203  ,0.019942,0.1138, .022412, .02346,
       0.000173,
HEATC3=0.3,0.666,0.4,0.8,0.5, .3, .666, .86,
NMATER=11,
COK=23.36, 14.176, 31.15, 104.675, 0.080716, 92.948, 1.5,
    .1, .2, .048, 187.55,
```

```
C1K= 0.0, 0.0137, 0.0, 0., 0., -5.809E-2, 0., 0., 0., 0., 0.,
C2K= 0.0, 0.0, 0.0, 0., 0., 1.1727E-5, 0., 0., 0., 0., 0.,
COCP= 188.41, 504.4, 188.41, 1.43605E3, 0.465E3, 1.43605E3, 900.,
     900., 900., 2000., 1.436E3,
C1CP= 0.0, 0.1130, 0.0, 0., 0.,-5.802E-1, 0., 0., 0., 0., -5.802E-1,
C2CP= 0.0, 0.0, 0., 0.,  0., 4.62506E-4, 0., 0., 0., 0., 4.625E-4,
CORO= 15506.0, 8041.3, 17940.7, 1.7E3, 160., 0.9504E3, 2220.,
     400., 800., 224., 950.4,
C1RO= 0.0, -0.4634, 0.0, 0., 0., -2.2976E-1, 0., 0., 0., 0.,-.22976,
C2RO=0.0, 0.0, 0.0,0., 0., -1.46049E-5, 0., 0., 0., 0., -1.46049E-5,
  NREBRT=6,  NREBM=29, 56, 4*27,
NREBX=4*0, 2*9,        NREBZ=29, 4*27,
CLENTH=  -1.,   -1.,   -1.,   -1., .0316,  0.182,
      .0029, .0036, .0014,   -1.,   -1.,   -1.,
      .18843,-1.0,  -1.0,    -1.,   -1., .000210,
      -1.0,  -1.0,  -1.0, .1524, .2159, .4064, .4191,
       .127, -1.,    -1., -1., -1., .0029, .10716,
REYLEN= .138, .1024, .1650, .5000, .1700,  0.270,
      .0029, .0036, .0014, .2548, .1024, 2.84,
      .3048, 6.9, 4.33, .66, 1.95, .154,
      1.83, 6.9, 4.1, .1524, .2159, .4064, .4191, .127,
       .0087147, 2.35, 2.35, .66, .0029, .33655,
ICORR = 1,2,3,4,5,5,6,7,8,9,10,11,12,11,11,11,11,12,11,11,
       11, 13,13,13,13,13,14,11,11,6,12,12,
FORCEF=6*0.5, .689, 2*.283, 1.D-10, 2*.5, .106, 5*.5,  8*0.5,
      .097, 4*.5, 0.0388
NCORR =14,
ACORRL=    0.,    0.,    0.,    0.,  180.,
       26.33,  6.48, 2.574, 61.75,    0., 1.328,   64.0,
       96.,  987.0E3,
BCORRL=    1.,    1.,    1.,    1.,   -1.,
        -.85,  -.03, -.269,   -.2,    1.,  -.5, -1.,
        -1., -1.,
CCORRL=  .370,  .312,  .164, .2500,    0.,
          0.,    0.,    0.,    0.,  27.0, .0, 0.0,
          0., 0.,
ACORRT=    0.,    0.,    0.,    0.,  1.92,
       .1922,  6.48, 2.574, 61.75,    0., .0306,   0.3164,
       .34, 509.7,
BCORRT=    1.,    1.,    1.,    1., -.145,
       -.072,  -.03, -.269,   -.2,    1., -.14286,  -.25,
       -.25, -.25,
CCORRT=  .370,  .312,  .164, .250,    0.,
          0.,    0.,    0.,    0.,  100., 0.0, 0.,
          0.,
REYTRN=  1.E9,  1.E9,  1.E9,  1.E9, 202.5,
       557.6,  1.E9,  1.E9,  1.E9,  1.E9, 5.E5,  2.2E3,
       3.0E3,  1.45E3,
TURBV=0.02, TURBC=6.0,
&END
REBM   1   1   1   1   9   4   4       REB FOR CELLS
REBM   1   2   4   4   6   4   4
REBM   1   5   5   4   5   4   4
REBM   1   1   1   1   9   3   3
```

REBM	2	2	4	1	9	3	3	
REBM	2	5	5	4	5	3	3	
REBM	2	1	3	1	9	5	5	
REBM	3	1	3	1	9	6	6	
REBM	4	1	3	1	9	7	7	
REBM	5	1	3	1	9	8	8	
REBM	6	1	3	1	9	9	9	
REBX	5	3	3	1	9	8	8	
REBX	6	3	3	1	9	9	9	
REBZ	1	5	5	4	5	3	3	
REBZ	1	1	3	1	9	4	4	
REBZ	2	1	3	1	9	5	5	
REBZ	3	1	3	1	9	6	6	
REBZ	4	1	3	1	9	7	7	
REBZ	5	1	3	1	9	8	8	
END								
HTEX	2	11	11	1	9	3	16	ARGON GAS IN 5 IN.VER. GAP
HTEX	2	11	11	1	1	17	17	ARGON GAS IN 5 IN.VER. GAP
HTEX	3	12	13	1	9	1	16	FLOWING AIR IN VER. CHANNELS
HTEX	3	1	13	1	9	1	2	FLOWING AIR IN HOR. CHANNELS
END								
ZFOR	1	1	1	1	9	4	4	HPP BAFFLE 40 HOLES
XFOR	2	3	3	1	9	3	3	LPP BAFFLE 50 HOLES
ZFOR	3	2	3	1	9	3	3	LPP BAFFLE 592 HOLES
XFOR	4	4	4	1	9	9	9	RADIAL SKIRT(REACTOR COVER)
XFOR	5	1	1	1	9	4	4	TRANSV. RESIST. LOWER ADPTR
YFOR	5	1	1	1	9	4	4	
XFOR	6	1	1	1	9	9	9	S/A TOP END
YFOR	6	1	1	1	9	9	9	
ZFOR	7	1	1	1	9	5	8	DRIVER
ZFOR	8	2	2	1	9	5	8	REFLECTOR
ZFOR	9	3	3	1	9	5	8	BLANKET
ZFOR	10	11	11	3	3	14	14	HP - INLET
ZFOR	11	5	5	4	5	3	3	LP - INLET
ZFOR	12	7	9	7	7	11	16	HEAT X VERT.SIDE(OUTSIDE)
ZFOR	13	9	9	4	4	4	14	HP PIPE INSIDE
ZFOR	14	10	10	1	9	3	16	PRIMARY TANK VERT.SIDE
YFOR	14	10	10	1	9	3	16	
XFOR	15	6	10	1	9	3	3	PRIMRY TANK HORH.BASE
YFOR	15	6	10	1	9	3	3	
XFOR	16	7	9	1	2	3	3	STORAGE BASKET HORIZ. BOTTOM
YFOR	16	7	9	1	2	3	3	
ZFOR	17	7	9	1	9	3	7	STORGE BASKET VERT.SIDE
ZFOR	18	5	5	4	5	3	3	LP PIPE INSIDE
XFOR	19	6	9	7	7	10	10	HX- HORIHONTAL BASE
YFOR	19	7	9	6	7	10	10	
ZFOR	20	9	9	6	6	3	16	SHUT DOWN COOLER OUTSIDE
ZFOR	21	6	6	1	9	3	11	REACTOR VESSEL SHIELD
ZFOR	22	13	13	1	9	1	16	AIR FLOW DOWN
XFOR	23	1	13	1	9	1	1	AIR FLOW INWARDS
XFOR	24	1	12	1	9	2	2	AIR FLOW OUTWARDS
ZFOR	25	12	12	1	9	2	16	AIR FLOW UP
ZFOR	26	11	11	1	9	3	16	ARGON BLANKET
ZFOR	27	7	9	7	7	12	16	IHX PRIMARY SIDE

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XFOR  28   1   5   1   9  12  12     REACTOR COVER (TOP)
YFOR  28   1   5   1   9  12  12
XFOR  29   1   4   1   9   9   9     REACTOR COVER(BOTTOM)
YFOR  29   1   4   1   9   9   9
XFOR  30   6   9   2   2   8   8     STORAGE BASKET(TOP)
YFOR  30   7   9   1   2   3   3
ZFOR  31   7   9   2   2   3   7     STORAGE BASKET TUBES
ZFOR  32   8   8   9   9   9  16     Z-PIPE
END
 &STRUCT ITSBUG=1,&END
 &T   N=1,  IXYZ=13,  RODFR=-1,         &END
 &F   IHT=4,  HYD=0.2159,               &END
 &M  MI=2, NP=1, DR=0.0127, Q=0., SGAP=0., HGAP=1.E9, &END
 &M  MI=7, NP=4, DR=0.4572, Q=0.,                     &END
 &T   N=2,  IXYZ=3,   RODFR=-.010927, OUTR=7.0612,    &END
 &F   IHT=4, HYD=0.1524,                              &END
 &M   MI=2, NP=1, DR=0.0127, Q=.0,                    &END
 &M   MI=8,NP=1,  DR=.22225, Q=.0,                    &END
 &M   MI=9, NP=1, DR=.22225, Q=.0,                    &END
 &M   MI=10, NP=1, DR=.22225, Q=.0,                   &END
 &M   MI=7, NP=1, DR=1.8288 , Q=0.,                   &END
 &T   N=3, IXYZ=3, RODFR=-.46262, OUTR=4.47675,         &END
 &F   IHT=4,  HYD=0.1524,                            &END
 &M   MI=2, NP=1, DR=0.00635, Q=0., KRAD=4,          &END
 &F   IHT=4,  HYD=0.4191,                            &END
 &T   N=4,  IXYZ=3, RODFR=-.168735, OUTR=4.26085,         &END
 &F  IHT=4, HYD=0.4191,                                &END
 &M  MI=5, NP=3, DR=0.0508, Q=0., KRAD=3,            &END
 &M  MI=2, NP=1, DR=0.00635, Q=0., KRAD=2,     &END
 &F   IHT=5,  HYD=0.127,                              &END
 &T   N=5,  IXYZ=3, RODFR=-.13525,  OUTR=3.9751,          &END
 &F   IHT=5,  HYD=0.127,                               &END
 &M   MI=2,   NP=2,   DR=0.00635,   Q=0., KRAD=1,      &END
 &F   IHT=2,  HYD=6.94,                                &END
 &T   N=6,  IXYZ=13,  RODFR=-1.,                        &END
 &F   IHT=3, HYD=2.11,                                 &END
 &M   MI=2,  NP=3,  DR=0.29422, Q=0.,                  &END
 &F   IHT=3,   HYD=2.11,                               &END
 &T   N=7,  IXYZ=3,   NT=1, RODFR=-.164911 , OUTR=1.79705, &END
 &F   IHT=2,  HYD=4.09,                                   &END
 &M   MI=4,  NP=3, DR=0.198173, Q=0.,SGAP=0., HGAP=1.E9, &END
 &M   MI=6,  NP=1, DR=0.043656, Q=0.,  SGAP=0., HGAP=1.E9,&END
 &M   MI=2,  NP=1, DR=0.019505, Q=0.,       &END
 &F   IHT=2,  HYD=1.648,                                  &END
 &T   N=8,  IXYZ=3,   NT=1, RODFR=0.038854 , OUTR=1.79705, &END
 &F   IHT=2,  HYD=4.09,                                   &END
 &M   MI=4,  NP=3, DR=0.198173, Q=0.,SGAP=0.,HGAP=1.E9, &END
 &M   MI=6,  NP=1, DR=0.043656, Q=0.,  SGAP=0., HGAP=1.E9,&END
 &M   MI=2,  NP=1, DR=0.01905, Q=0.,  SGAP=0., HGAP=1.E9,&END
 &M   MI=6,  NP=1, DR=0.04445, Q=0.,  SGAP=0., HGAP=1.E9,&END
 &M   MI=4,  NP=2, DR=0.098425, Q=0.,SGAP=0.,HGAP=1.E9,  &END
 &M   MI=6,  NP=1, DR=0.04445, Q=0.,  SGAP=0., HGAP=1.E9,&END
 &M   MI=2,  NP=1, DR=0.009525, Q=0.,                    &END
 &F   IHT=2,  HYD=1.5,                                    &END
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&T   N=9,  IXYZ=3,   NT=1, RODFR=0.061182 , OUTR=1.79705, &END
&F   IHT=2,  HYD=4.09,                                    &END
&M   MI=4,  NP=3, DR=0.198173, Q=0.,SGAP=0.,HGAP=1.E9, &END
&M   MI=6,  NP=1, DR=0.043656, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=2,  NP=1, DR=0.01905, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=6,  NP=1, DR=0.04445, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=4,  NP=2, DR=0.098425, Q=0.,SGAP=0.,HGAP=1.E9,  &END
&M   MI=6,  NP=1, DR=0.04445, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=2,  NP=1, DR=0.009525, Q=0.,                    &END
&F   IHT=2,  HYD=1.5,                                     &END
&T   N=10, IXYZ=3,   NT=1, RODFR=0.145788 , OUTR=1.79705, &END
&F   IHT=2,  HYD=4.09,                                    &END
&M   MI=4,  NP=3, DR=0.198173, Q=0.,SGAP=0.,HGAP=1.E9, &END
&M   MI=6,  NP=1, DR=0.043656, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=2,  NP=1, DR=0.01905, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=6,  NP=1, DR=0.04445, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=4,  NP=2, DR=0.098425, Q=0.,SGAP=0.,HGAP=1.E9,  &END
&M   MI=6,  NP=1, DR=0.04445, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=2,  NP=1, DR=0.009525, Q=0.,                    &END
&F   IHT=2,  HYD=1.5,                                     &END
&T   N=11, IXYZ=3,   NT=1, RODFR=0.008352 , OUTR=1.79705, &END
&F   IHT=2,  HYD=4.09,                                    &END
&M   MI=4,  NP=3, DR=0.198173, Q=0.,SGAP=0.,HGAP=1.E9, &END
&M   MI=6,  NP=1, DR=0.043656, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=2,  NP=1, DR=0.01905, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=6,  NP=1, DR=0.04445, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=4,  NP=2, DR=0.098425, Q=0.,SGAP=0.,HGAP=1.E9,  &END
&M   MI=6,  NP=1, DR=0.04445, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=2,  NP=1, DR=0.009525, Q=0.,                    &END
&F   IHT=2,  HYD=1.5,                                     &END
&T   N=12, IXYZ=3,   NT=1, RODFR=0.012481 , OUTR=1.79705, &END
&F   IHT=2,  HYD=4.09,                                    &END
&M   MI=4,  NP=3, DR=0.198173, Q=0.,SGAP=0.,HGAP=1.E9, &END
&M   MI=6,  NP=1, DR=0.043656, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=2,  NP=1, DR=0.01905, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=6,  NP=1, DR=0.04445, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=4,  NP=2, DR=0.098425, Q=0.,SGAP=0.,HGAP=1.E9,  &END
&M   MI=6,  NP=1, DR=0.04445, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=2,  NP=1, DR=0.009525, Q=0.,                    &END
&F   IHT=2,  HYD=1.5,                                     &END
&T   N=13, IXYZ=3,   NT=1, RODFR=0.109282 , OUTR=1.79705, &END
&F   IHT=2,  HYD=4.09,                                    &END
&M   MI=4,  NP=3, DR=0.198173, Q=0.,SGAP=0.,HGAP=1.E9, &END
&M   MI=6,  NP=1, DR=0.043656, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=2,  NP=1, DR=0.01905, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=6,  NP=1, DR=0.04445, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=4,  NP=2, DR=0.098425, Q=0.,SGAP=0.,HGAP=1.E9,  &END
&M   MI=6,  NP=1, DR=0.04445, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=2,  NP=1, DR=0.009525, Q=0.,                    &END
&F   IHT=2,  HYD=1.5,                                     &END
&T   N=14, IXYZ=3,   NT=1, RODFR=0.081456 , OUTR=1.79705, &END
&F   IHT=2,  HYD=4.09,                                    &END
&M   MI=4,  NP=3, DR=0.198173, Q=0.,SGAP=0.,HGAP=1.E9, &END
&M   MI=6,  NP=1, DR=0.043656, Q=0.,  SGAP=0., HGAP=1.E9,&END
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&M   MI=2,  NP=1, DR=0.01905, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=6,  NP=1, DR=0.04445, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=4,  NP=2, DR=0.098425, Q=0.,SGAP=0.,HGAP=1.E9,  &END
&M   MI=6,  NP=1, DR=0.04445, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=2,  NP=1, DR=0.009525, Q=0.,                    &END
&F   IHT=2,  HYD=1.5,                                    &END
&T   N=15, IXYZ=3,   NT=1, RODFR=0.023630 , OUTR=1.79705, &END
&F   IHT=2,  HYD=4.09,                                   &END
&M   MI=4,  NP=3, DR=0.198173, Q=0.,SGAP=0.,HGAP=1.E9, &END
&M   MI=6,  NP=1, DR=0.043656, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=2,  NP=1, DR=0.01905, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=6,  NP=1, DR=0.04445, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=4,  NP=2, DR=0.098425, Q=0.,SGAP=0.,HGAP=1.E9,  &END
&M   MI=6,  NP=1, DR=0.04445, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=2,  NP=1, DR=0.009525, Q=0.,                    &END
&F   IHT=2,  HYD=1.5,                                    &END
&T   N=16, IXYZ=3,   NT=1, RODFR=0.018975 , OUTR=1.79705, &END
&F   IHT=2,  HYD=4.09,                                   &END
&M   MI=4,  NP=3, DR=0.198173, Q=0.,SGAP=0.,HGAP=1.E9, &END
&M   MI=6,  NP=1, DR=0.043656, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=2,  NP=1, DR=0.01905, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=6,  NP=1, DR=0.04445, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=4,  NP=2, DR=0.098425, Q=0.,SGAP=0.,HGAP=1.E9,  &END
&M   MI=6,  NP=1, DR=0.04445, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=2,  NP=1, DR=0.009525, Q=0.,                    &END
&F   IHT=2,  HYD=1.5,                                    &END
&T   N=17, IXYZ=3,   NT=1, RODFR=-.164911 , OUTR=1.79705, &END
&F   IHT=2,  HYD=4.09,                                   &END
&M   MI=4,  NP=3, DR=0.198173, Q=0.,SGAP=0.,HGAP=1.E9, &END
&M   MI=6,  NP=1, DR=0.043656, Q=0.,  SGAP=0., HGAP=1.E9,&END
&M   MI=2,  NP=1, DR=0.019505, Q=0.,          &END
&F   IHT=2,  HYD=0.46355,                                &END
&T   N=18,  IXYZ=13,   RODFR=-1.0,  &END
&F   IHT=3,  HYD=1.96,                                   &END
&M   MI=2,  NP=2, DR=0.0508, Q=0.,                      &END
&F   IHT=3, HYD=1.96,        &END
&T   N=19,  IXYZ=13,   RODFR=-1.0,  &END
&F   IHT=3,  HYD=1.96,                                   &END
&M   MI=2,  NP=2, DR=0.075565,Q=0.,                     &END
&F   IHT=3, HYD=1.96,        &END
&T   N=20,  IXYZ=13,   RODFR=-1.0,  &END
&F   IHT=3,  HYD=7.13,                                   &END
&M   MI=2,  NP=2, DR=0.04445, Q=0.,SGAP=0.,HGAP=1.E9, &END
&M   MI=6,  NP=3, DR=0.17357,Q=0.,SGAP=0., HGAP=1.E9, &END
&M   MI=2,  NP=1, DR=0.0381,Q=0.,SGAP=0.1016,HGAP=0.279,&END
&M   MI=2,  NP=1, DR=0.01905,Q=0.,SGAP=0.2413,HGAP=0.117,&END
&M   MI=2,  NP=1, DR=0.01905,Q=0.,SGAP=0.,HGAP=1.E9, &END
&M   MI=5, NP=3, DR=0.0508, Q=0.,                       &END
&F   IHT=4,  HYD=0.4064,            &END
&T   N=21,  IXYZ=13,   RODFR=-1.0,  &END
&F   IHT=4,  HYD=0.4064,            &END
&M   MI=2,  NP=1, DR=0.00635,Q=0.,SGAP=0.14605,HGAP=0.274,&END
&M   MI=2,  NP=1, DR=0.00635,Q=0.,           &END
&F   IHT=4,  HYD=0.2159,            &END
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&T  N=22, IXYZ=3,  NT=1,  RODFR=-28966.739, OUTR=0.0022098, &END
&F  IHT=1,  HYD=0.002331,                                  &END
&M  MI=2, NP=1, DR=0.0003048, Q=0., SGAP=0.000254, HGAP=10000.,&END
&M  MI=1, NP=2, DR=0.0008255, Q=1.88685E9,                   &END
&T  N=23, IXYZ=3,  NT=1,  RODFR=-28966.739, OUTR=0.002093,   &END
&F   IHT=1,   HYD=0.002331,            &END
&M  MI=2, NP=1, DR=0.002093, Q=3.5592E5,SGAP=0.0,HGAP=10000., &END
&T  N=24, IXYZ=3, NT=1, RODFR=-28966.739,OUTR=0.02514,    &END
&F  IHT=1,  HYD=0.002331,                               &END
&M   MI=2, NP=1, DR=0.002514,  Q=1.391E5,               &END
&T  N=25,  IXYZ=3, NT=1, RODFR=-332.526,     OUTR=0.029523,  &END
&F   IHT=1,   HYD=0.002912,                                 &END
&M   MI=2,  NP=1,  DR=0.001016, Q=0., SGAP=.0,    HGAP=10000.,&END
&T  N=26,  IXYZ=3, NT=1, RODFR=-332.0705,   OUTR=0.0275,    &END
&F   IHT=1,   HYD=0.003759,                                &END
&M   MI=2,  NP=1,  DR=0.0275, Q=1.43455E6,SGAP=0., HGAP=10000.,&END
&T  N=27,  IXYZ=3, NT=1, RODFR=-332.0705,   OUTR=0.0275,    &END
&F   IHT=1,   HYD=0.003759,                                &END
&M   MI=2,  NP=1,  DR=0.0275, Q=2.3892E3,SGAP=.0,  HGAP=10000.,&END
&T  N=28,  IXYZ=3, NT=1, RODFR=-332.0705,   OUTR=0.0275,    &END
&F   IHT=1,   HYD=0.003759,                                &END
&M   MI=2,  NP=1,  DR=0.0275, Q=2.4868E4,SGAP=.0, HGAP=10000.,&END
&T  N=29, IXYZ=3, NT=1, RODFR=-6317.99, OUTR=0.0062620,  &END
&F  IHT=1,  HYD=0.0012855,                               &END
&M  MI=2, NP=1, DR=0.0004572,Q=0.,SGAP=0.0003048,HGAP=10000.,&END
&M  MI=3,  NP=2,  DR=0.00275,  Q=1.68162E7,          &END
&T  N=30, IXYZ=3, NT=1, RODFR=-6317.99, OUTR=0.0062620,  &END
&F  IHT=1,  HYD=0.0012855,                               &END
&M  MI=2, NP=1, DR=0.0004572,Q=0.,SGAP=0.0003048,HGAP=10000.,&END
&M  MI=3,  NP=2,  DR=0.00275,  Q=8.26E3,             &END
&T  N=31, IXYZ=3, NT=1, RODFR=-6317.99, OUTR=0.0062620,  &END
&F  IHT=1,  HYD=0.0012855,                               &END
&M  MI=2, NP=1, DR=0.0004572,Q=0.,SGAP=0.0003048,HGAP=10000.,&END
&M  MI=3,  NP=2,  DR=0.00275,  Q=5.411E4,            &END
&T  N=32, IXYZ=3, NT=1, RODFR=-332.526, OUTR=0.029523,   &END
&F  IHT=1,  HYD=0.003759,                                &END
&M   MI=2, NP=1, DR=0.001016,  Q=0.0,                    &END
&T  N=33, IXYZ=3, NT=1, RODFR=-332.526, OUTR=0.029523,   &END
&F  IHT=1,  HYD=0.0020906,                               &END
&M   MI=2, NP=1, DR=0.001016,  Q=0.0,                    &END
&T  N=34, IXYZ=3,NT=1, RODFR=-829.43,   OUTR=0.015875, &END
&F  IHT=8, HYD=.0087147,                             &END
&M  MI=2,NP=1, DR=.00153035,  Q=0.0,                 &END
&F  IHT=8, HYD=.0128143,                             &END
&T  N=35, IXYZ=3, NT=1, RODFR=1,  OUTR=.15024,       &END
&F  IHT=2, HYD=6.9,                                  &END
&M  MI=2,  NP=1, DR=.00635, Q=-1.57994E6,            &END
&T  N=36, IXYZ=3,  NT=1,  RODFR=-4981.25,   OUTR=0.0022098, &END
&F  IHT=1,  HYD=0.002331,                                &END
&M  MI=2, NP=1, DR=0.0003048, Q=0., SGAP=0.000254, HGAP=10000.,&END
&M  MI=1, NP=2, DR=0.0008255, Q=42381.95,                   &END
&T  N=37, IXYZ=3,  NT=1,  RODFR=-140.13,    OUTR=0.0381,    &END
&F  IHT=1,  HYD=0.0378,                                     &END
&M  MI=2,  NP=1, DR=.0015875,  Q=0.0,                       &END
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 &F  IHT=1,  HYD=.015,                                              &END
 &T  N=38,  IXYZ=3, NT=1, RODFR=-54.7396,    OUTR=0.029523,  &END
 &F   IHT=1,   HYD=0.002912,                                        &END
 &M   MI=2,  NP=1,  DR=0.001016, Q=0., SGAP=.0,   HGAP=10000.,&END
 &F   IHT=1, HYD=0.015,                                               &END
 &T  N=39,  IXYZ=12, NT=1, RODFR=-1,                                  &END
 &F  IHT=7,HYD=1.2,                                                   &END
 &M  MI=11,NP=1, DR=.05715, Q=0.0,                                    &END
 &F  IHT=6, HYD=.3429,                                                &END
END
OUT   1   1  13   1   9   1   1    CONCREATE BASE
OUT   2  13  13   1   9   1  16    BLAST & BIOLOGICAL SHIELD
OUT   3  13  13   1   9   2  16    AIR BAFFLE OUTSIDE
IN    3  12  12   1   9   2  16    AIR BAFFLE INSIDE
OUT   4  12  12   1   9   4  16    FOAM GLASS INSULATION OUTSIDE
IN    4  11  11   1   9   4  16    INSIDE OF GUARD VESSEL
OUT   5  11  11   1   9   4  16    INNER VESSEL OUTSIDE
IN    5  10  10   1   9   4  16    INNER VESSEL INSIDE
OUT   6   1   4   1   9  12  12    REACTOR VESSEL COVER TOP
IN    6   1   4   1   9   9   9    REACTOR VESSEL COVER BOTTOM
OUT   7   6   6   1   9   8   9    OUTER RADIAL SHIELD OUTSIDE
IN    7   4   4   1   9   8   9    OUTER RADIAL SHIELD INSIDE
OUT   8   6   6   1   1   5   7    INNER & OUTER RADIAL SHIELD
IN    8   3   3   1   1   5   7    INNER & OUTER RADIAL SHIELD
OUT   9   6   6   1   2   5   7    INNER & OUTER RADIAL SHIELD
IN    9   3   3   1   2   5   7    INNER & OUTER RADIAL SHIELD
OUT  10   6   6   1   3   5   7    INNER & OUTER RADIAL SHIELD
IN   10   3   3   1   3   5   7    INNER & OUTER RADIAL SHIELD
OUT  11   6   6   1   4   5   7    INNER & OUTER RADIAL SHIELD
IN   11   3   3   1   4   5   7    INNER & OUTER RADIAL SHIELD
OUT  12   6   6   1   5   5   7    INNER & OUTER RADIAL SHIELD
IN   12   3   3   1   5   5   7    INNER & OUTER RADIAL SHIELD
OUT  13   6   6   1   6   5   7    INNER & OUTER RADIAL SHIELD
IN   13   3   3   1   6   5   7    INNER & OUTER RADIAL SHIELD
OUT  14   6   6   1   7   5   7    INNER & OUTER RADIAL SHIELD
IN   14   3   3   1   7   5   7    INNER & OUTER RADIAL SHIELD
OUT  15   6   6   1   8   5   7    INNER & OUTER RADIAL SHIELD
IN   15   3   3   1   8   5   7    INNER & OUTER RADIAL SHIELD
OUT  16   6   6   1   9   5   7    INNER & OUTER RADIAL SHIELD
IN   16   3   3   1   9   5   7    INNER & OUTER RADIAL SHIELD
OUT  17   6   6   1   9   3   4    OUTER RADIAL SHIELD LOWER
IN   17   4   4   1   9   3   4    OUTER RADIAL SHIELD LOWER
OUT  18   1   4   1   9   4   4     UPPER GRID PLATE
IN   18   1   4   1   9   4   4     UPPER GRID PLATE
OUT  19   1   4   1   9   4   4     LOWER GRID PLATE
IN   19   1   4   1   9   3   3     LOWER GRID PLATE
OUT  20   1   4   1   9   3   3     LOWER SUPPORT STRUCTURE
IN   20   1   4   1   9   2   2     LOWER SUPPORT STRUCTURE
OUT  20   5   5   4   5   3   3     LOWER SUPPORT STRUCTURE
IN   20   5   5   4   5   2   2     LOWER SUPPORT STRUCTURE
OUT  20   6  10   1   9   3   3     LOWER SUPPORT STRUCTURE
IN   20   6  10   1   9   2   2     LOWER SUPPORT STRUCTURE
OUT  21   4  12   1   9   2   2     AIR BAFFLES
IN   21   4  12   1   9   1   1
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OUT   22   1   1   1   9   6   6       FUEL PIN IN REACTOR CORE
OUT   23   1   1   1   9   7   8      DRIVER PIN ABOVE CORE
OUT   24   1   1   1   9   5   5      DRIVER PIN BELOW CORE
OUT   25   1   1   1   9   5   8    DUCT WALL IN DRIVER
OUT   26   2   2   1   9   5   8    REFLECTOR BLOCKS IN CORE
OUT   27   2   2   1   9   7   8    REFL BLOCKS ABOVE CORE
OUT   28   2   2   1   9   5   5    REFL BLOCKS BELOW CORE
OUT   29   3   3   1   9   6   6    RADIAL BLANKET PINS IN CORE
OUT   30   3   3   1   9   7   7    BLANKET PINS ABOVE CORE
OUT   31   3   3   1   9   5   5    BLANKET PINS BELOW CORE
OUT   32   2   2   1   9   5   8    REFL DUCT WALL
OUT   33   3   3   1   9   5   8    DUCT WALL IN RADIAL BLANKET
OUT   34   7   7   7   7  12  16    IHX
IN    34  14  14   7   7  12  16    IHX
OUT   34   8   8   7   7  12  16    IHX
IN    34  14  14   7   7  12  16    IHX
OUT   34   9   9   7   7  12  16    IHX
IN    34  14  14   7   7  12  16    IHX
OUT   35   9   9   6   6   4  16    SHUTDOWN COOLER
OUT   36   7   9   2   2   4   7    STORAGE BASKET PINS
OUT   37   7   9   2   2   4   7    STORAGE BASKET TUBES
IN    37   7   9   2   2   4   7    STORAGE BASKET TUBES
OUT   38   7   9   2   2   4   7    ST.BASK. ASSEM. DUCTS
IN    38   7   9   2   2   4   7    ST.BASKET. ASSEM. DUCTS
OUT   39   8   8   8   8   9  15      Z-PIPE
IN    39   8   8   9   9   9  15      Z-PIPE
END
PB  84756.22    12  12   1   9  16  16  12
PB  84756.22    13  13   1   9  16  16  13
PB  108156.     14  14   7   7  12  12  20
PB  411574.      9   9   4   4  14  14  34
PB  96548.1      9   9   4   4  16  16  35
END
AL    .9706     12  12   1   9   2  16
AL    .4048     12  12   1   9   1   1
AL    .4444     11  11   1   9   3  16
AL    .4048      4  11   1   9   1   1
AL    .1468      1  11   1   9   2   2
AL    .9693     10  10   1   9   3  16
AL    .8858      9   9   4   4   4  14
AL    .0215      8   8   5   5   4   4
AL    .1211      7   7   5   5   4   4
AL    .2973      6   6   5   5   4   4
AL    .6978      5   5   5   5   4   4
AL    .1941      4   4   4   6   4   4
AL    .2092      5   5   4   5   3   3
AL    .6119      5   5   9   9   9   9
AL    .4326      6   6   9   9   9   9
AL    .3538      7   7   9   9   9   9
AL    .3914      8   8   9   9   9  16
AL    .1515      8   8   8   8  16  16
AL    .1663      7   9   7   7  10  16
AL    .3627      1   1   1   9   5   5
AL    .3398      1   1   1   9   6   6
```

AL	.3615	1	1	1	9	7	7
AL	.1177	2	2	1	9	5	7
AL	.1093	3	3	1	9	5	7
AL	.9050	1	3	1	9	8	8
AL	.9050	1	1	1	9	9	9
AL	.9323	9	9	6	6	4	16
AL	.6829	7	9	2	2	4	7
AL	.5000	14	14	7	7	12	16
ALX	0.	13	13	1	9	1	16
ALX	0.	12	12	1	9	2	16
ALX	.4048	12	12	1	9	1	1
ALX	0.	11	11	1	9	3	16
ALX	.4048	3	11	1	9	1	1
ALX	.1468	1	11	1	9	2	2
ALX	0.	10	10	1	9	3	16
ALX	0.	9	9	4	4	4	14
ALX	0.	8	8	4	4	5	14
ALX	.9710	8	8	4	4	4	4
ALX	0.	8	8	5	5	4	4
ALX	.0680	7	7	5	5	4	4
ALX	.1825	6	6	5	5	4	4
ALX	.4478	5	5	5	5	4	4
ALX	0.	1	1	1	3	4	4
ALX	0.	1	1	7	9	4	4
ALX	0.	5	5	4	5	3	3
ALX	.2695	4	4	4	5	3	3
ALX	0.	1	1	1	9	3	3
ALX	.7883	4	4	9	9	9	9
ALX	.5000	5	5	9	9	9	9
ALX	.3812	6	6	9	9	9	9
ALX	.3300	7	7	9	9	9	9
ALX	0.	7	7	9	9	10	16
ALX	0.	8	8	9	9	9	16
ALX	0.	7	8	8	8	16	16
ALX	0.	6	6	7	7	12	16
ALX	.9000	6	6	7	7	11	11
ALX	0.	6	6	7	7	10	10
ALX	0.	9	9	7	7	12	16
ALX	.9000	9	9	7	7	11	11
ALX	0.	9	9	7	7	10	10
ALX	0.	1	3	1	9	5	7
ALX	0.	1	4	1	9	8	8
ALX	.2540	3	3	1	9	9	9
ALX	.5800	6	9	2	2	4	7
ALY	.9706	12	12	1	8	2	16
ALY	.4048	12	12	1	8	1	1
ALY	.4444	11	11	1	8	3	16
ALY	.4048	4	11	1	8	1	1
ALY	.1468	1	11	1	8	2	2
ALY	.9693	10	10	1	8	3	16
ALY	0.	9	9	4	4	4	14
ALY	0.	9	9	3	3	4	14
ALY	0.	2	4	3	3	4	4
ALY	0.	6	8	3	3	4	4

ALY	0.	6	8	5	5	4	4
ALY	0.	2	4	6	6	4	4
ALY	0.	6	7	8	8	9	9
ALY	0.	8	8	8	8	9	15
ALY	0.	8	8	8	8	16	16
ALY	.1515	8	8	7	8	16	16
ALY	0.	7	7	7	7	16	16
ALY	0.	9	9	7	7	16	16
ALY	0.	7	9	6	7	12	15
ALY	0.	7	9	6	6	16	16
ALY	.9000	7	9	6	7	11	11
ALY	0.	7	9	6	7	10	10
ALY	.58	7	9	1	2	4	7
ALY	0.	8	8	3	3	15	15
ALY	0.	8	8	4	4	15	15
ALZ	.9706	12	12	1	9	2	16
ALZ	0.	12	12	1	9	1	1
ALZ	.4444	11	11	1	9	3	16
ALZ	0.	4	11	1	9	1	1
ALZ	0.	1	11	1	9	2	2
ALZ	.9693	10	10	1	9	3	16
ALZ	.8858	9	9	4	4	4	14
ALZ	0.	6	8	4	5	3	4
ALZ	0.	9	9	4	4	3	3
ALZ	0.	2	3	4	6	4	4
ALZ	.3191	1	1	1	9	4	4
ALZ	.1475	5	5	4	5	3	3
ALZ	0.	4	4	1	9	3	3
ALZ	0.	2	3	4	6	3	3
ALZ	.2069	2	3	1	3	3	3
ALZ	.2069	2	3	7	9	3	3
ALZ	.0829	2	3	1	3	4	4
ALZ	.0829	2	3	7	9	4	4
ALZ	0.	6	7	9	9	8	9
ALZ	0.	8	8	9	9	8	8
ALZ	.3914	8	8	9	9	9	15
ALZ	0.	8	8	9	9	16	16
ALZ	0.	8	8	8	8	15	16
ALZ	0.	7	9	7	7	16	16
ALZ	.1663	7	9	7	7	10	15
ALZ	0.	7	9	7	7	9	9
ALZ	.3398	1	1	1	9	5	5
ALZ	.3309	1	3	1	9	6	6
ALZ	.1177	2	2	1	9	5	6
ALZ	.1093	3	3	1	9	5	6
ALZ	.9090	1	3	1	9	7	7
ALZ	.9050	1	1	1	9	8	8
ALZ	.9323	9	9	6	6	4	16
ALZ	.0788	7	9	2	2	7	7
ALZ	.1528	7	9	2	2	4	6
ALZ	.2293	7	9	2	2	3	3
ALZ	.5000	14	14	7	7	12	16
ALZ	0.	8	8	4	4	14	14
ALZ	0.	8	8	4	4	15	15

```
TL     35.        12  13   1   9   1  16
TL     35.         1  11   1   9   1   2
P      370000.     9   9   4   4  14  14
P      365000.     9   9   4   4  13  13
P      360000.     9   9   4   4  12  12
P      355000.     9   9   4   4  11  11
P      350000.     9   9   4   4  10  10
P      345000.     9   9   4   4   9   9
P      340000.     9   9   4   4   8   8
P      335000.     9   9   4   4   7   7
P      330000.     9   9   4   4   6   6
P      325000.     9   9   4   4   5   5
P      320000.     9   9   4   4   4   4
P      315000.     5   8   4   5   4   4
P      310000.     5   5   4   5   3   3
P      289581.     1   4   1   9   3   4
P      166198.     1   3   1   9   5   7
P      42816.3     1   3   1   9   8   9
END
/*
```