BAW-1514

November 1978

SMUD TRANSIENT EVALUATION — RAPID COOLDOWN INCIDENT OF 3/20/78

BABCOCK & WILCOX
Power Generation Group
Nuclear Power Generation Division
P. . Box 1260
Lynchburg, Virginia 24505

8001210554

1. INTRODUCTION

On March 20, 1978, the Sacramento Municipal Utility District's Rancho Seco Nuclear Generating Station, Unit No. 1 experienced a loss of power to a substantial portion of its non-nuclear instrumentation. The plant was operating at approximately 72% of full power at the time. Although the reactor protection system functioned properly, the plant experienced a severe thermal transient. This report addresses the investigation of the effects of that transient on the reactor coolant system and discusses that system's ability to continue unrestricted operation for the remaining design lifetime of the unit.

2. DISCUSSION

On March 23, 1978, B&W concurred with SMUD's intent to return the Rancho Seco plant to power operation at a power level at or below 75% of full power. B&W concurrence with the operation of Rancho Seco above 75% full power was contingent upon QA evaluation of the data input provided by SMUD and of the analyses performed by B&W Engineering. That evaluation was completed to the point at which B&W concurred with operation of the plant at full power on June 14, 1978 (references 1-4, attached). The following steps were involved in the evaluation:

1. Travel to the plant site to gather data for input to the investigation.
2. Determination of the specific cause(s) of the non-nuclear instrumentation (NNI) power failure and development of a list of instrumentation signals that were valid throughout the power failure.
3. Development of a sequence of events for the cooldown incident based on the valid signal list and data input.
4. Development of the probable plant transient response during the cooldown using the sequence of events and valid data. The transient response was displayed in various curves of temperature, pressure, and level versus time.
5. These curves were used to analyze the effects of the transient on the reactor vessel, the pressurizer, the reactor coolant piping, the once-through steam generators, the reactor coolant pumps, the control rod drive mechanisms, the nuclear fuel, and the clamping force on the reactor internals.

3. RESULTS

1. The cause of the power failure in the NNI is described in reference 5 (summary attached).
2. Reference 5 also contains a list of the instrumentation signals that remained valid throughout the transient (summary attached).
3. The integrated control system response to the various false and valid signals is desceibed in reference 6 (summary attached).
4. Reference 6 discusses the most probable sequence of events during the incident (summary attached).
5. The curves showing the reactor coolant system response (major parameters) are developed in references 7-9 (curves attached).
6. The fracture mechanics analysis performed on the reactor vessel using the conservative approach outlined in the ASME Code, Section III, Appendix G, resulted in a calculated factor of safety of 1.8 for the beltline region and 1.2 for the outlet nozzles (reference 10, attached).
7. A review of the transient effects on the reactor coolant pump seals con-concluded that there were no apparent effects on seal performance, and continued operation of the pumps was permissible (reference 11). Cyclic stresses and lifetime usage factor changes for the reactor coolant pump casings are not expected to be affected; however, they are currently being evaluated by the consultant who prepared the original stress report. The report of that evaluation will be filed as an addendum to this document.
8. The transient was found to be less severe than the control rod drive mechanism (CRDM) transient that normally follows a reactor trip. There are no concerns about long-term damage to the CRDMs or about their ability to continue to perform as designed (reference 12, attached).
9. Evaluation of the transient's effects on the nuclear fuel has concluded that it will not adversely affect fuel performance for the remainder of its design life (reference 13, attached).

10. Neutron noise data from SMUD were evaluated to verify that clamping force still existed between the core support assembly and the reactor vessel. This evaluation indicated that a post-transient beam mode existed in the vicinity of 9-11 Hz, strongly suggesting that reactor vessel/core support assembly clamping still exists (references 14, 15, attached).

11. The study of the increase in usage factor for the reactor vessel resulted in a maximum usage factor (in the instrumentation tube area) of 0.58 (reference 16, attached).

12. None of the cumulative usage factors for the components of the pressurizer were increased by the transient except for that of the pressurizer spray nozzle. The new cumulative usage factor for this nozzle is 0.345 (reference 17, attached).

13. The highest cumulative usage factor in the reactor coolant piping is 0.762; this is found in the surge line (reference 18, attached).

14. The OTSG support skirt stress evaluation resulted in a new cumulative usage factor of 0.91 (reference 19, attached).

15. The OTSG lower tubesheet and tube stress evaluation shows that the stresses and usage factors, including the results of the rapid cooldown, remain well within the Code-allowables, and the structural adequacy of these areas has not been impaired (reference 20, attached).

4. CONCLUSIONS

The total effect of the rapid cooldown transient on the reactor coolant system components was not severe enough to reduce the design life of any of the system components.*

- - - - -

*Cyclic stresses and lifetime usage factor changes for the reactor coolant pump casings are not expected to be affected; however, they are being evaluated by the consultant who prepared the original stress report. The results of that evaluation will be reported in an addendum to this document.

5. REFERENCES

1. J. T. Janis (B&W) to R. J. Rodriguez (SMUD), Letter, "Rancho Seco Nuclear Generating Station — Unit No. 1, Evaluation of NSS Cooldown Transient," March 23, 1978.

2. R. P. Oubre (SMUD) to J. T. Janis (B&W), Letter Requesting Evaluation of SMUD Maneuvering Rates During Startup, March 28, 1978.

3. J. T. Janis to R. P. Oubre, Letter, "Rancho Seco Nuclear Generating Station — Unit No. 1, Plant Startup Following 3/20/78 Trip Transient," April 5, 1978.

4. J. T. Janis to R. J. Rodriguez, Letter, "Rancho Seco Nuclear Generating Station — Unit No. 1, Evaluation of NSS Cooldown Transient," June 14, 1978.

5. B. J. Shepherd to J. A. Castanes, Memorandum, "Loss of NNI Power at Rancho Seco," Babcock & Wilcox, May 1, 1978.

6. R. W. Moore to J. J. Kelly, Memorandum, "QA of Cooldown Incident Analysis," Babcock & Wilcox, June 8, 1978.

7. S. G. Shell, Temperatures — SMUD Rapid Cooldown Incident, Calculation No. 32-8053-00, Babcock & Wilcox, May 1, 1978.

8. J. R. Burris to J. J. Kelly, Memorandum, "SMUD March 20, 1978 Cooldown," Babcock & Wilcox, May 8, 1978.

9. B. A. Karrasch to G. M. Olds, Memorandum, "SMUD Cooldown Incident," Babcock & Wilcox, March 29, 1978.

10. Fracture Mechanics Evaluation of the Reactor Vessel of the SMUD Unit at Rancho Seco for the Unanticipated Transient on 3/20/78, Babcock & Wilcox, Document No. 32-9801-00, October 12, 1978.

11. G. G. Anderson to J. J. Kelly, Memorandum, "Effect of Pressure and Cooldown Transient on RC Pumps," Babcock & Wilcox, April 19, 1978.

12. CRDM Evaluation of SMUD Cooldown, Babcock & Wilcox, Document No. 32-9016-00, April 25, 1978.

13. SMUD Depressurization Transient, Babcock & Wilcox, Document No. 86-1863-00, May 10, 1978.

14. D. E. Thoren to D. M. Stevens, Memorandum, "Neutron Noise Data Related to the Cooldown Transient of 3/20/78," Babcock & Wilcox, September 26, 1978.

15. C. W. Mayo/D. M. Stevens to D. E. Thoren, "Neutron Noise Data at SMUD," October 3, 1978.

16. "Rapid Cooldown Transient Fatigue Analysis (Reactor Vessel)," Babcock & Wilcox, Mt. Vernon, Indiana, May 31, 1978.

17. "SMUD Cooldown Incident Justification of Pressurizer for SMUD, B&W Contract No. 620-011-59," Babcock & Wilcox, Mt. Vernon, Indiana, June 7, 1978.

18. "SMUD Cooldown Incident Justification of Primary Piping," Babcock & Wilcox, Mt. Vernon, Indiana, June 9, 1978.

19. "OTSG Support Skirt Stress Evaluation of Rapid Cooldown Event of March 20, 1978," Babcock & Wilcox, Mt. Vernon, Indiana, August 29, 1978.

20. "OTSG Lower Tubesheet Area and Tube Stress Evaluation Due to the Rapid Cooldown Event of March 20, 1978," Babcock & Wilcox, Mt. Vernon, Indiana, June 9, 1978.

Reference 1 – Letter: Janis to Rodriguez, March 23, 1978

Babcock & Wilcox

Power Generation Group

P.O. Box 1260, Lynchburg, Va. 24505

Telephone: (804) 384-5111

March 23, 1978

Mr. R. J. Rodriguez
Manager, Nuclear Operations
Sacramento Municipal Utility District
6201 S. Street
Sacramento, California

Subject: Rancho Seco Nuclear Generating Station – Unit No. 1
Evaluation of NSS Cooldown Transient

Dear Mr. Rodriguez:

B&W has reviewed the data provided by SMUD regarding the March 20, 1978 reactor trip and resulting cooldown transient, and have performed the following evaluations:

1. Evaluation of RCP seal performance data prior, during and subsequent to the transient.

2. Evaluation of transient conditions with respect to RCPs and CRDMs.

3. Evaluation of transient conditions with respect to fuel assemblies.

4. Evaluation of transient conditions with respect to RV, RC piping, pressurizer, and OTSGs.

As a result of these evaluations, B&W concurs with SMUD's intent to return Rancho Seco to power operation at a power level at or below 75% full power with the following recommendations:

1. The following maneuvering limits be applied for this plant startup:

    a. The maximum rate of power increase below 20% full power shall be 10% per hour.
    b. The maximum rate of power increase between 20% and 40% full power shall be 30% per hour.
    c. Above 40% full power, escalation shall be limited to 3% per hour.

2. Increased surveillance of the loose parts monitoring system for at least a one-week period.

3. Performance of an operability check of on-line and redundant NNI instrumentation.

4. Establishment of a procedure for restoring NNI power in the event of a power loss and a commitment to establish by April 7, 1978 operator instructions for immediate action to limit NSS transient if NNI power cannot be immediately restored.

5. Surveillance of primary and secondary radiochemistry on a minimum of a daily basis for at least one week following startup.

B&W NPGD's concurrence with operation of Rancho Seco above 75% full power is contingent upon our QA evaluation of data input provided by SMUD and analyses performed by B&W Engineering, and you will be informed of completion of these activities and our concurrence in a timely manner.

In addition, B&W is performing an evaluation to determine the effects of the transient conditions on the Reactor Coolant System accumulative usage factor and will advise you of those results. As a further measure of verification of OTSG tube integrity, B&W requests additional inspection of the OTSG tubes during your next refueling outage. Those inspection recommendations will be forwarded to SMUD along with B&W's proposed refueling inspection plan prior to the outage.

If you have any questions or require additional information, please advise.

Very truly yours,

Joel T. Janis
Service Manager

JTJ/hh

cc: JJ Mattimoe
DG Raasch
RP Oubré
JH Johnston

bcc: RM Ball
R Berchin
JA Castanes
JC Deddens
BA Karrasch
ER Kane
JH MacMillan
GM Olds
JD Phinney
T Schuler
KE Suhrke
JH Taylor
Record Center NSS-11 T1.2

Reference 2 — Letter: Oubré to Janis, March 28, 1978

SMUD
SACRAMENTO MUNICIPAL UTILITY DISTRICT ☐ 6201 S Street, Box 15830, Sacramento, California 95813; (916) 452-3211

RPO 78-28

March 28, 1978

Mr. Joel Janis
Babcock & Wilcox
P. O. Box 1260
Lynchburg, Virginia 24505

Dear Joel:

Per discussion with you on Monday, March 27, you requested a chronology of our rise to power over the past weekend. Listed below is that chronology showing the rate of change of power level for the three rises in power.

Criticality @ 1607		3/24/78
0-20%	8%/hr	3/24/78
20-42.5%	6%/hr	3/24/78
Turbine/Reactor Trip at 2230		3/24/78
Criticality @ 0112		3/25/78
0-20%	8%/hr	3/25/78
20-40%	26%/hr	3/25/78
40-55%	3%/hr	3/25/78
55-62%	essentially 0%/hr over a 20-hour period extending into 3/26/78	
Reactor reduced to 10^{-8} intermediate range amps		3/26/78
0-20%	10%/hr	3/26/78
20-50%	17%/hr	3/27/78
50-55%	3%/hr	3/27/78
55-72%	12%/hr	3/27/78

You will note that on the rise to power from 55 to 72% on Monday, March 27, the rate of change was at 12% per hour. This exceeded the recommended rate of change given to SMUD in your letter of March 23, 1978. I request B&W review this rate of change and respond to SMUD on any effect which it may have had. I would appreciate your response as soon as possible.

Respectfully,

R.P. Oubre'
Plant Superintendent

RPO:sal

Reference 3 — Letter: Janis to Oubré, April 5, 1978

Babcock & Wilcox

Power Generation Group

P.O. Box 1260, Lynchburg, Va. 24505
Telephone: (804) 384-5111

April 5, 1978

Mr. R. P. Oubre'
Plant Superintendent
Sacramento Municipal Utility District
6201 S. Street
Sacramento, CA

Subject: Rancho Seco Nuclear Generating Station - Unit No. 1
Plant Startup Following 3/20/78 Trip Transient

Reference: SMUD letter, RP Oubre' to JT Janis, RPO 78-28, dated 3/28/78

Dear Mr. Oubre':

The chronology of SMUD's rise to power beginning March 24, 1978, as outlined in the reference, has been reviewed by B&W. The extended period at 55-62% power starting March 25, 1978 served to prepare the fuel for the 12%/hour increase between 55 and 72% power on March 27, 1978. Therefore, the intent of the maneuvering recommendations has been met.

As a precautionary measure, coolant chemistry analysis should be performed frequently until equilibrium conditions are achieved.

If you have any questions or require additional information, please advise.

Very truly yours,

Joel T. Janis
Service Manager

JTJ/hh

cc: DG Raasch
RJ Rodriguez
JH Johnston

bcc: R. Berchin
RV DeMars
GL Knock
BA Karrasch
JD Phinney
GM Olds
Record Center - NSS-11/T1.2

Babcock & Wilcox

Power Generation Group

P.O. Box 1260, Lynchburg, Va. 24505
Telephone: (804) 384-5111

June 14, 1978

Mr. R. J. Rodriguez
Manager, Nuclear Operations
Sacramento Municipal Utility District
6201 S. Street
Sacramento, California

Subject: Rancho Seco Nuclear Generating Station - Unit No. 1
Evaluation of NSS Cooldown Transient

Reference: B&W letter, JT Janis to RJ Rodriguez, dated March 23, 1978

Dear Mr. Rodriguez:

The referenced letter provided B&W's concurrence to operate Rancho Seco at power levels below 75% full power following our evaluation of the March 20, 1978 reactor trip and resulting rapid cooldown transient. This letter also stated that B&W's concurrence with operation above 75% power was contingent upon our QA evaluation of data input provided by SMUD and analysis performed by B&W engineering. These functions have been completed to the point where B&W now concurs with operation of Rancho Seco at full power.

It is recommended that for the initial escalation the maximum rate of power increase above 70% full power shall be 3% per hour with a ten (10) hour hold at the power level cut-off. Above the power level cut-off, the maximum rate of power increase shall continue to be 3% per hour to 100% full power.

If you have any questions or require additional information, please advise.

Very truly yours,

Joel T. Janis
Service Manager

JTJ/hh

cc: JJ Mattimoe
DG Raasch
RP Oubre'
JH Johnston

Reference 5 – Summary

DESCRIPTION OF CAUSE OF POWER FAILURE TO NON-NUCLEAR INSTRUMENTATION

B&W NNI System Design

The NNI system is divided into two sets of cabinets, called X and Y. Power is provided to the X and Y cabinets as shown in Figures A-1 and A-2, respectively. The X cabinets have one 120-V a-c power source, and the Y cabinets have two. One of the two Y cabinet power sources provides power only to signal select switches; this power enables selection of both X and Y sensor signals.

SMUD Modification of NNI System Design

After delivery of the NNI system, SMUD modified the Y cabinet power design as shown in Figure A-3.

Loss of NNI Power

On March 20, 1978, at approximately 0426 hours, an operator in the Rancho Seco control room was changing an indicating light bulb in the signal select switch (SP10-MS) for the turbine throttle pressure transmitters. The bulb was inadvertently dropped into this switch, causing a short on the 24-volt power supply. With the SMUD modification to the NNI power supply, this resulted in loss of all 24-volt power in the Y cabinets.

The Y cabinet power distribution, as shown in Figure A-3, consists of primary and backup positive and negative 24-V d-c power supplies provided with 120-V a-c power via input breakers S1 and S2, located on the 24-volt power auctioneer panel. The primary and backup 24-volt power supplies are current-limited to 7.5 amperes. Upon overload of either positive or negative 24-volt bus, the power supply monitor trips input breakers S1 and S2 to protect the power supplies.

Subsequent measurement of the current load on the negative 24-volt power supplies revealed 2.3 and 3.5 amperes at steady-state conditions. The power source to signal select switch (SP10-MS) was fused with a Bussman CLD 5-amp 125 V (or less) rated fuse.

When the short occurred and current reached 7.5 amps, current-limiting of the power supplies went into effect until the power supply monitor tripped power input breaksers S1 and S2. During this time current through the 5-amp fuse for signal select switch SP10-MS could reach only 4 amps; therefore, it did not blow.

When breakers S1 and S2 opened, all signal select switch functions were inoperative and the 820 auxiliary relay contacts went to the de-energized state because the relay coils were powered from the Y 24-volt power. Sensors that operated from Y 120-V a-c power continued to function although all modules in the NNI cabinets that used 24-volt power were inoperative. These modules provided erroneous outputs over the signal range of -10 to +10 V dc, depending on the characteristics and design of each module. Sensors and modules in the X cabinet were affected by the inoperative Y power signal select auxiliary relays.

LIST OF SIGNALS VALID THROUGHOUT TRANSIENT

Parameter	Cabinet power source	Valid signal available to: Computer	Control room operator	Hot shutdown panel oper	ICS
RC5A-TT1 -- Tc narrow-range (SMUD loop B)	X	Yes	No	No	No
RC5B-TT1 — Tc narrow-range (SMUD loop A)	X	Yes	No	No	No
RC5A-TT2 — Tc wide-range (SMUD loop B)	X	Yes	No	No	No
RC1-LT1 — Pressurizer level	X	Yes	No	Indicator	No
RC1-LT2 — Pressurizer level	X	Yes	No	No	No
RC1-LT3 — Pressurizer level	Y	No	No	Indicator	No
RC2-TT1 — Pressurizer temperature	X	Yes	No	No	No
RC4A-TT1 — Th narrow range (SMUD loop B)	X	Yes	No	No	No
RC3A-PT3 (ESFAS) — RC pressure, wide range (SMUD loop B)	X	None derived from NNI	Recorder	Indicator	No

Parameter	Cabinet power source	Valid signal available to: Computer	Control room operator	Hot shutdown panel oper	ICS
RC3A-PT1 (RPS) — RC pressure, narrow range (SMUD loop B)	X	None derived from NNI	Recorder	No	No
RC3B-PT1 (RPS) — RC pressure, narrow range (SMUD loop A)	Y	None derived from NNI	Recorder	No	No
RC pump seal & brg temperatures (all four RC pumps)	X	No	Recorder	No	No
RC pump seal cavity pressure (all four RC pumps)	X	No	Recorder	No	No
SP1A-LT4 — SG start-up level (SMUD loop B)	X	Yes	No	Indicator	No
SP1B-LT4 — SG start-up level (SMUD loop A)	Y	No	No	Indicator	No
SP1A-LT1 — SG full-range level (SMUD loop B)	X	Yes	Indicator	No	No
SP1B-LT1 — SG full-range level (SMUD loop A)	X	Yes	Indicator	No	No
SP4A-TT — SG outlet temp (SMUD loop B)	X	Yes	Indicator	No	No
SP6A-PT1 — SG outlet pressure (SMUD loop B)	X	Yes	No	Indicator	No
SP3A-TT1 — SG lower downcomer temp (SMUD loop B)	X	Yes	No	No	No
SP1A-LT2 — SG operate level (SMUD loop B)	X	Yes	No	No	No
SP10A-PT — turbine throttle pressure	X	Yes	No	No	No
SP5A-TT1 — FW temp (SMUD loop B)	X	Yes	No	No	No
SP8A-dpT1 — main FW flow (SMUD loop B)	X	Xmtr ΔP & temp-comp FW flow	No	No	No

Parameter	Cabinet power source	Valid signal available to			
		Computer	Control room operator	Hot shutdown panel oper	ICS
SP7A-dpT — startup FW flow (SMUD loop B)	X	Yes	No	No	No
MU42-dpT — RC pump seal injection flow	X	No	Indicator	No	No
MU7-dpT 1-4 — RC pump seal water flow	X	No	Indicator	No	No
MU37-FT1-4 — RC pump seal bleed-off flow	X	Yes	No	No	No
MU23-dpT1 & 2 — HPI flow	X	No	Indicator	No	No
MU14-LT1 — makeup tank level	X	Yes	No	Indicator	No
MU4-dpT — makeup letdown flow	X	Yes	Indicator	No	No
MU5-TT — letdown cooler outlet temp	X	No	Indicator	No	No
MU24-dpT — RC makeup flow	X	No	Indicator	No	No
DH1-dpT1 — LPI flow	X	No	Indicator	No	No
DH6-TT1 — DH pump suction temp	X	No	Indicator	No	No
CF1-PT1 — CFT B press	X	No	Indicator	No	No
CF1-PT3 — CFT A press	X	No	Indicator	No	No
CF2-LT1 — CFT B level	X	No	Indicator	No	No
CF2-LT3 — CFT A level	X	No	Indicator	No	No
DH7-TT1 — DH cooler outlet temp	X	No	Indicator	No	No
DH9-TT1 — DH cooler cooling water outlet temp	X	No	Indicator	No	No

FIGURE A-1

NNI "X" POWER B&W DESIGN

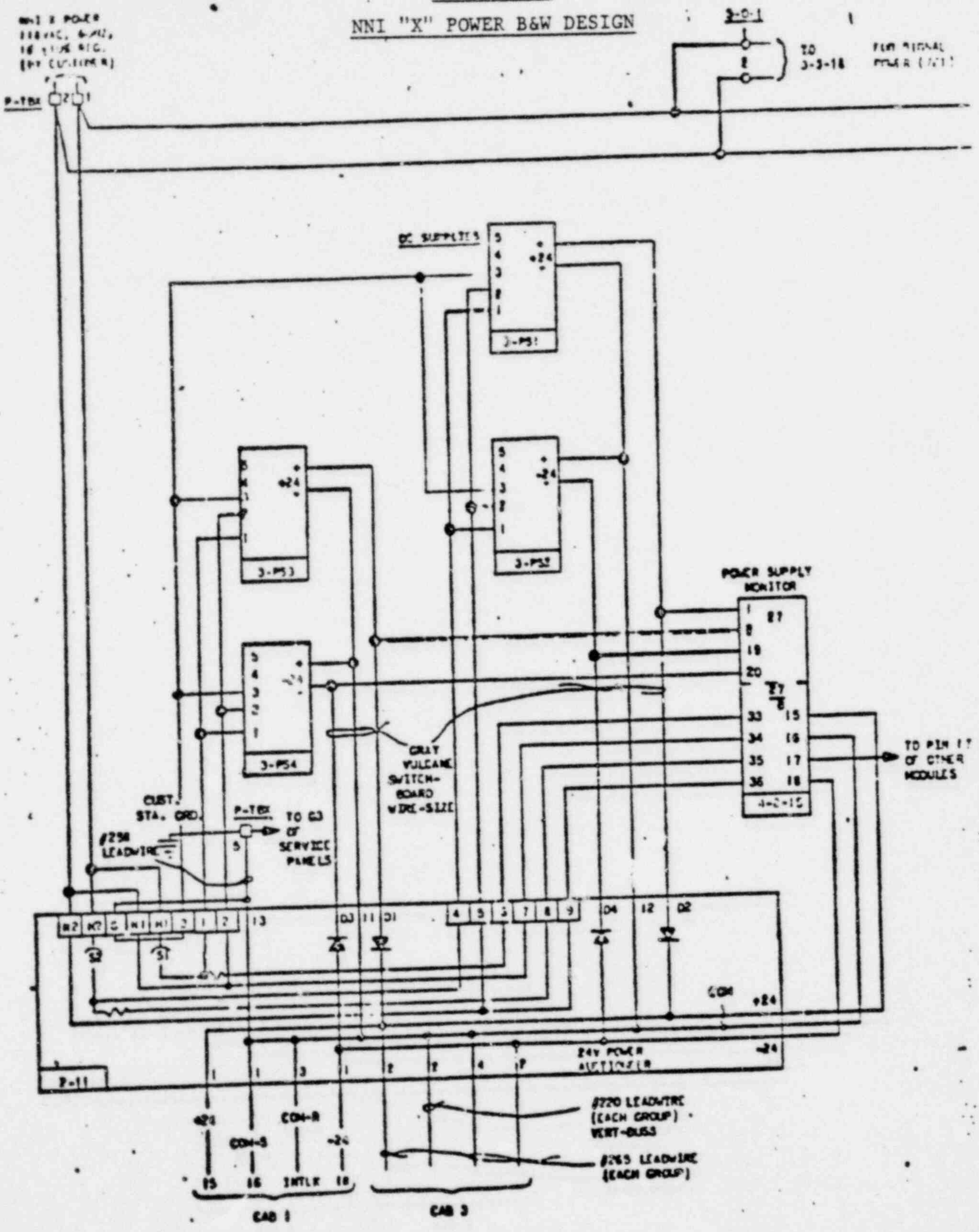


FIGURE A-2

NNI "Y" POWER B&W DESIGN

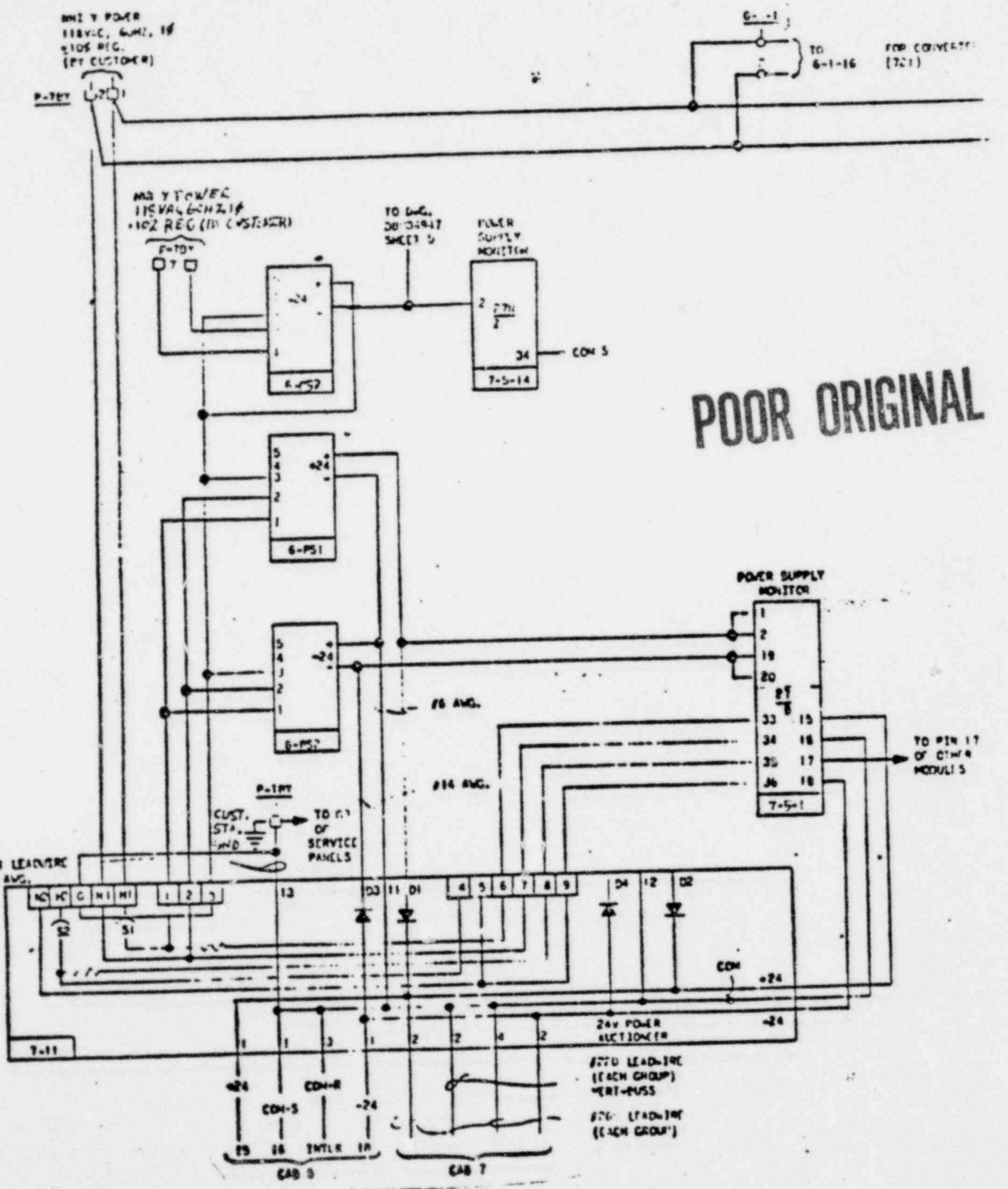
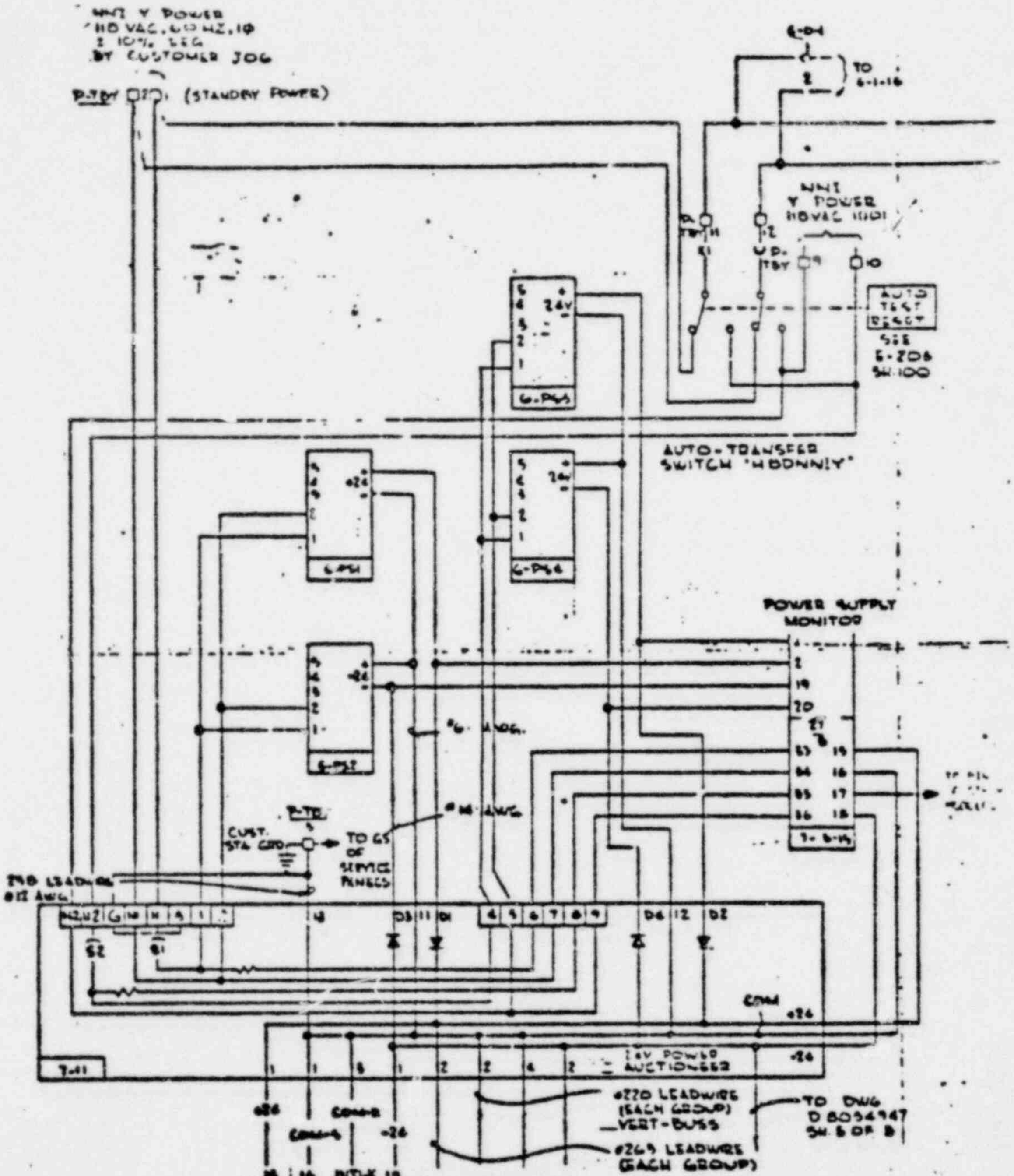


FIGURE A-3

SMUD NNI "Y" POWER DESIGN



POOR ORIGINAL

Reference 6 — Summary

ICS ACTIONS FOLLOWING LOSS OF POWER TO NNI

1. Partial loss of feedwater due to ICS limiting feedwater to SG A on Btu limits.
2. Turbine valve position demand increased.
3. ICS initiates runback in tracking mode.
4. Following reactor trip, ICS runs back FW demand to both generators.
5. Reduction of FW demand and/or invalid feed valve ΔP signal causes runback of main FW pump speed by ICS.
6. Reduction of FW demand by ICS closes SG A and B main FW control valves.
7. Reduction of FW demand by ICS closes SG A and B startup FW control valves to less than 50% open and main block valves receive signals to close.
8. Invalid SG B outlet pressure signal opens B condenser dump valves and/or invalid generator level signal closes B feed valves.*
   - Steam line failure logic closes ICS-controlled SG B startup valve; not an ICS action.
   - Operator takes manual control of the speed of one main feed pump.
9. Following SFAS actuation, ICS continues to influence FW flows to the generators through the startup valves when the valve controls are not overridden by the steam line failure logic.# Also, any ICS actuation of turbine bypass valves continues after SFAS actuation.
10. Upon restoration of NNI power and of valid signals to the ICS, all startup valve and emergency feed valve position demands are returned to zero, and any steam dump valves open to the condenser are closed based on SG level signals and steam line pressure signals.

- - - - -

*Accounts for observed depressurization of SG B.

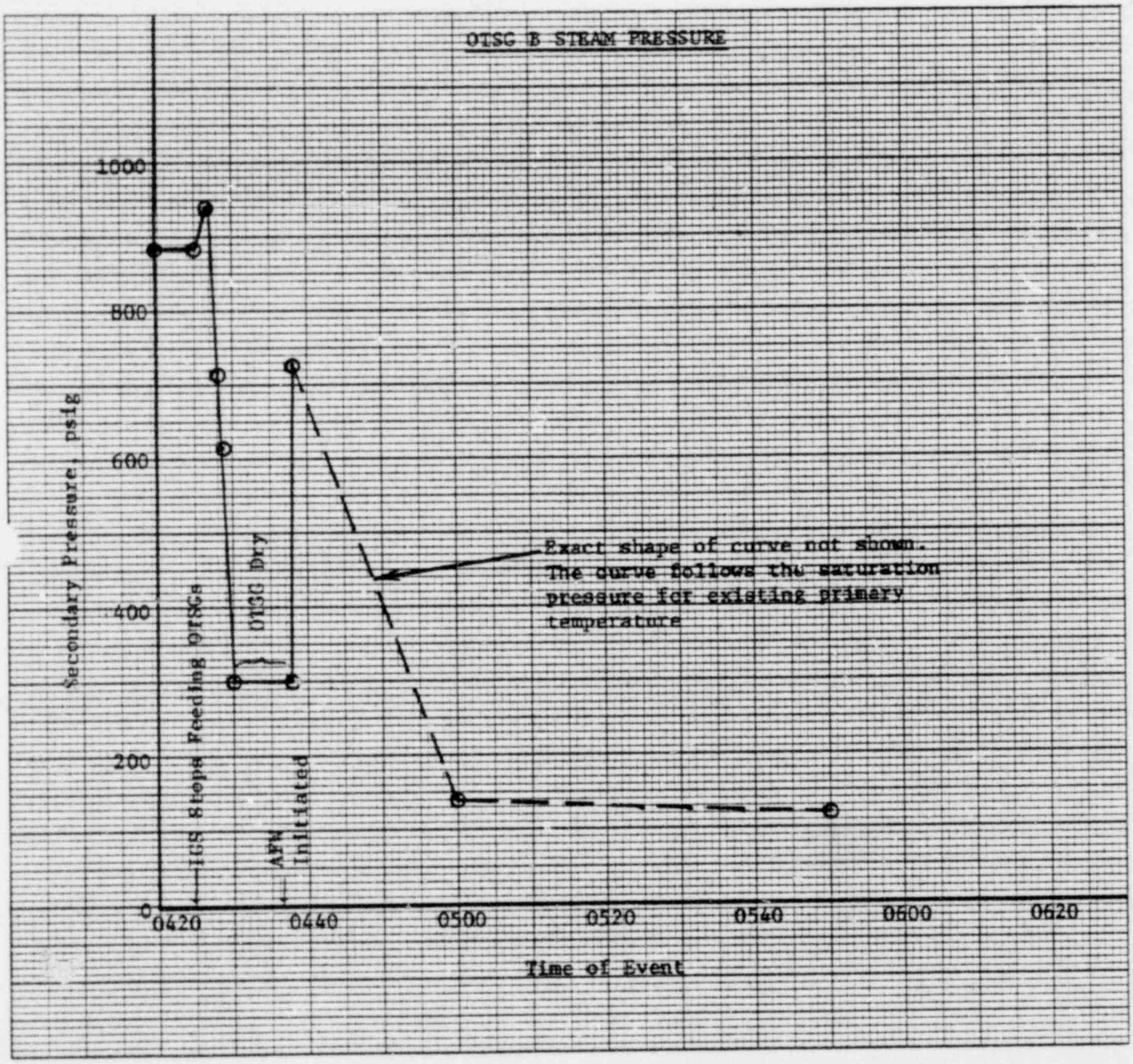
#Steam line failure logic closes loop A (B) main control and startup valves to SG A (B) when A (B) steam line pressure falls below 425 psig.

SEQUENCE OF EVENTS AT RANCHO SECO
MARCH 20, 1978 — 0425 to 0534

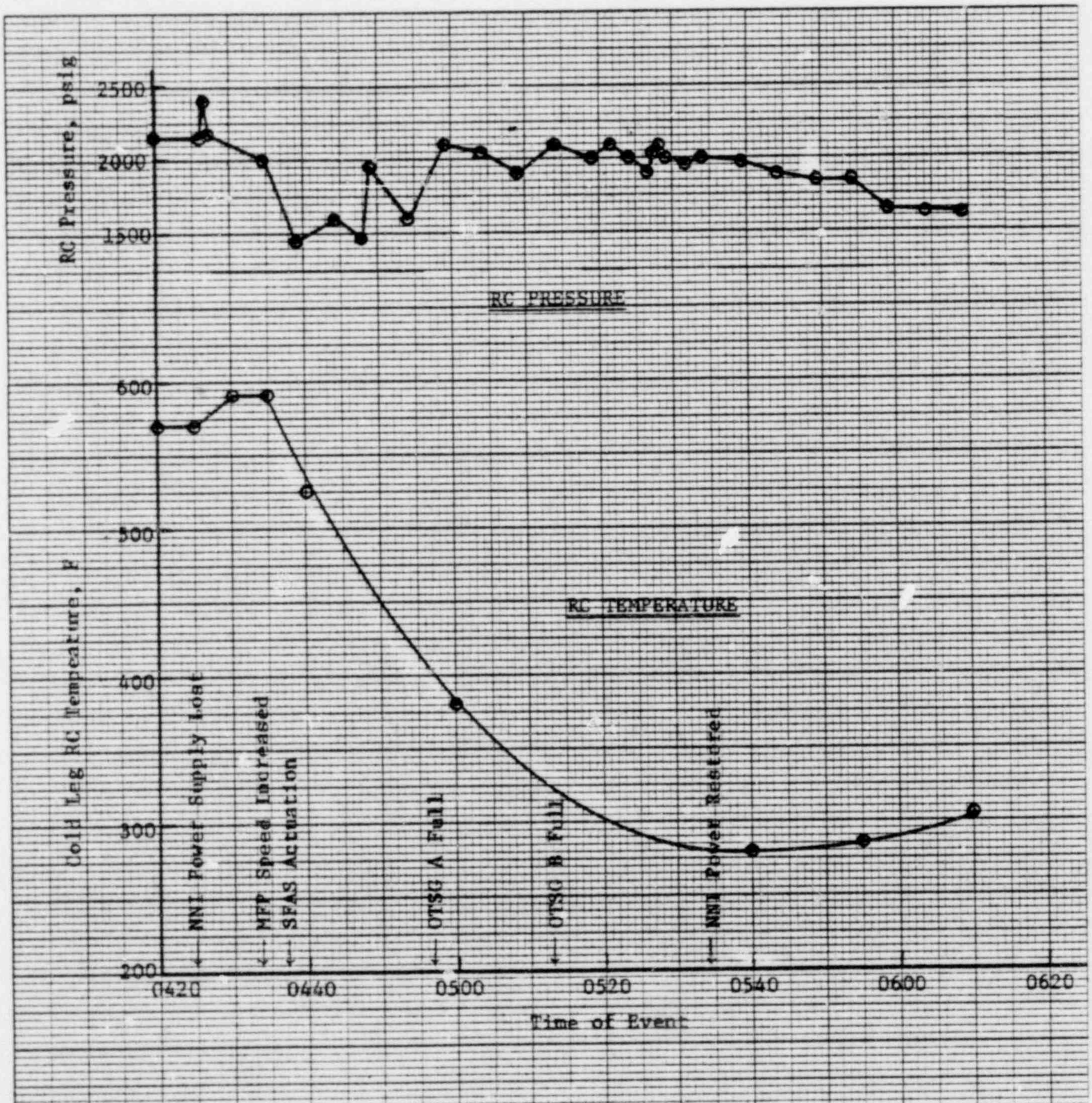
Time	Event
0425:35	Lost NNI power supply cabinets 5, 6, and 7. This caused a loss of valid signals to the ICS. Btu limits ran back feedwater, resulting in a partial loss of feedwater (actual reactor power was 72%). Probable opening of B turbine bypass valves to the condenser (timing uncertain).
0425:44	Reactor trip on high pressure, turbine trip on interlock. Pressurizer code relief setting was known to be low (about 2225 psig). The electromatic relief was isolated due to previous leakage problems. The data indicate primary pressure went ≈2400 psig => code relief valve lifted.
	ICS closes main control and startup feed valves and drives main feed pumps to minimum speed following trip.
	Decay heat and RC pump energy removal accomplished through generators by inventory boiloff and the addition of main feedwater.
0426:15	Pressurizer code relief valve reseats at about 2100 psig.
	Operator starts HPI pump B.
0428:23	Operator stops HPI pump B.
0430	OTSG B pressure reaches 435 psig setpoint of steam line failure logic. OTSG B goes dry.
	Operator increases speed of an MFP and feeds OTSG A, which starts RCS on pressure and temperature decrease.
0434:25	RC pressure ≈ 1900 psi.
0437:16	SFAS actuation at 1600 psig. This starts HPI, LPI and initiates emergency feed. The emergency FW pump is started and the bypass emergency FW valves are opened to full-open position. The system makes no automatic attempt to control SG water level.
0440	RC pressure at 1475 psig. It starts to recover from this point due to HPI. T_{avg} = 528F.
0443:56	HPI pump A secured.
0446:09	LPI secured.
0449:34	HPI A initiated. From this point on, the operator started and stopped HPI pumps as necessary to maintain pressurizer level.
~0450	Steam line failure logic closes ICS-controlled startup feed valves to each OTSG when the corresponding OTSG pressure falls below 435 psig.

Time	Event
0451:25	Secured RCP D (T_{avg} = 435F). This reduced the number of RC pumps to three.
0457:27	OTSG A water level = 599.7 inches. Speculate that about 2 feet of tubes are not flooded (at top) due to steam line arrangement.
0500:00	Hourly computer log printout — steam temp 380F (OTSG B), steam pressure 171 psig (OTSG B), assuming that T_{avg} = T_{sat} = >T_{avg} = 380F.
0513:47	OTSG B level = 599.1 inches.
0534	Power restored to NNI cabinets 5, 6, and 7. T_{avg} = 285F; RCS pressure ≈ 2000 psig; both OTSG full level ranges pegged high.
	Operator begins to reduce RC pressure using pressurizer spray.
	ICS closes turbine bypass valves to condenser.
	Operator stops emergency feedwater flow.
	Operator stops main feedwater pumps.

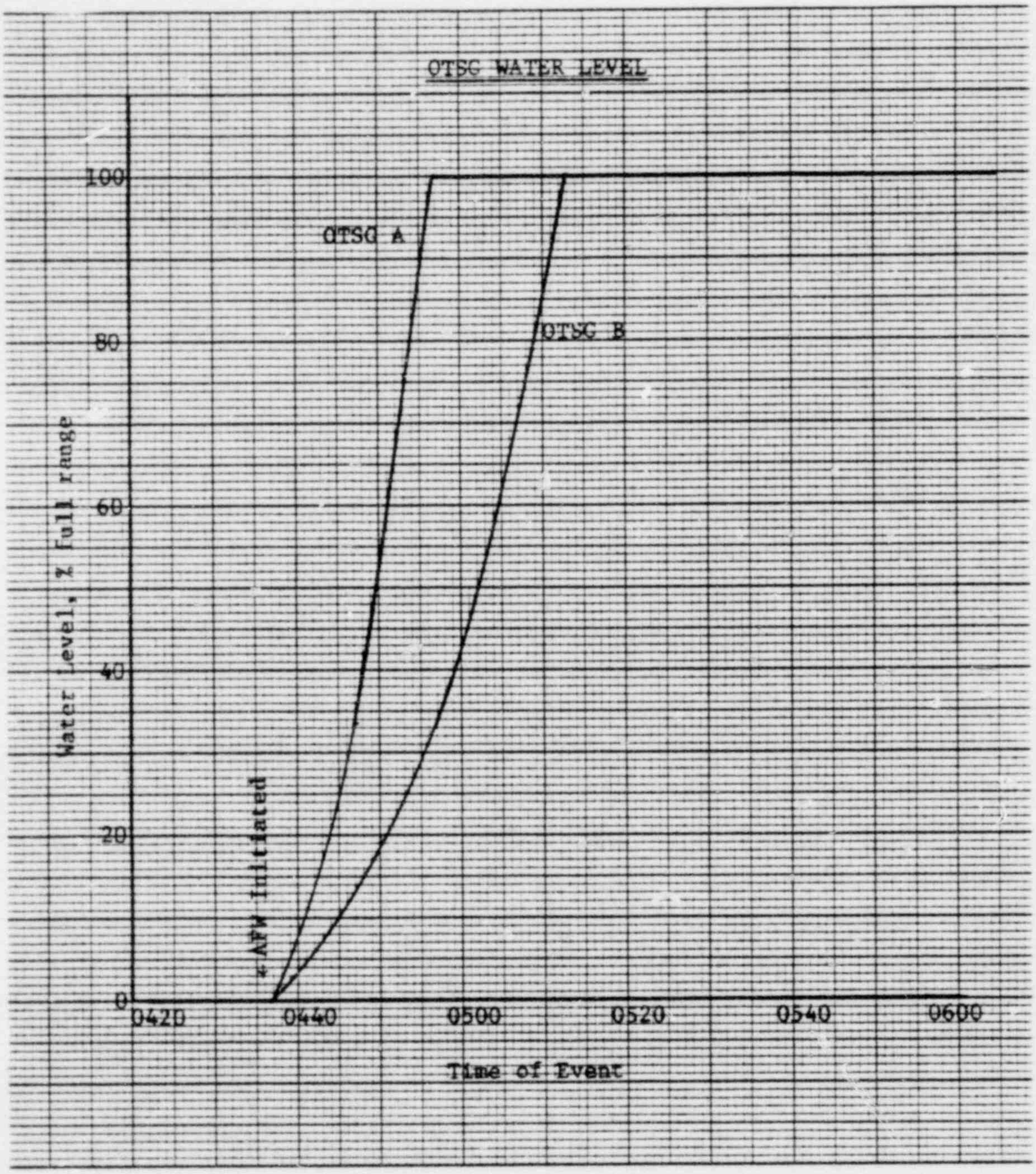
Reference 9 - Pressure, Temperature, Level Vs Time Curves



POOR ORIGINAL



POOR ORIGINAL



POOR ORIGINAL

Reference 10 — Document Release Notice

CONTRACT/STANDARD NO.	DOCUMENT RELEASE NOTICE (DRN)
620-0011	
RELEASE DATE: Oct 12, 197? — PAGE 1 OF 1	

PART/TASK-GROUP-SEQ.	B&W DOCUMENT NO.	DOCUMENT TITLE	PUL STAT.	RRL NO.
62-01-001	32-9801-00	EVALUATION OF RAD... [illegible]		

FILE COPY

POOR ORIGINAL

DISTRIBUTION	NO COPIES DRN	NO COPIES DOC		NO COPIES DRN	NO COPIES DOC
C.E. [illegible]	1	1	RETURN ORIGINAL		
S.B. S[illegible]	1	1			
J.M. B[illegible]	1	1			
J.J. KELLY	1	1			

RELEASED BY: [illegible] — NAME — Oct 12, 197? — DATE

REVIEWED BY: S.B. S[illegible] — NAME — Oct 12, [illegible] — DATE

CALCULATION DATA/TRANSMITTAL SHEET

DOCUMENT IDENTIFIER CALC. 32 - 9801 - 00 ☆

TRANS. 86 - ____ - ____

TYPE: ___RESEARCH & DEVELOPMENT ✓SAFETY ANALYSIS REPORT ___NUC. SERV. INPUT ___DESIGN RQMT. ___DESIGN VERIF. ✓OTHER

TITLE Evaluation of Rancho Seco Transient

PREPARED BY C E Harris REVIEWED BY S. B. Skaar

DATE 10/12/78 TITLE Associate Engineer DATE 10/12/78

TITLE Engineer

PURPOSE:

To analyze Rancho Seco transient from a fracture mechanics viewpoint using guidelines of ASME Code, Section XI, Appendix A.

SUMMARY OF RESULTS (INCLUDE DOC. ID'S OF PREVIOUS TRANSMITTALS & SOURCE CALCULATIONAL PACKAGES FOR THIS TRANSMITTAL)

The beltline region throughout the transient was determined to be fracture-safe with a factor of safety of 1.8, and the outlet nozzle was determined to have a factor of safety of 1.2.

POOR ORIGINAL

DISTRIBUTION

C E HARRIS
S B SKAAR
J M BURNETT

FRACTURE MECHANICS EVALUATION OF THE REACTOR VESSEL OF THE SMUD UNIT AT RANCHO SECO FOR THE UNANTICIPATED TRANSIENT ON 3/20/78

A fracture mechanics analysis of the reactor vessel has been performed using the conservative approach outlined in the ASME Code, Section III, Appendix G. Specific details of the analytical approach are documented in B&W Topical Report BAW-10046A, Rev. 1.

Analyses were performed on the two most critical areas of the reactor vessel - the beltline region and the outlet nozzle region. At the lowest temperature during the transient the material is still in the upper shelf region (ductile behavior). Due to the low level of radiation, degradation to beltline region materials is not significant enough to produce a shift in the transition reference temperature. Consequently, the beltline region materials are also at the upper shelf toughness region.

Factors-of-safety for the beltline region and outlet nozzles have been calculated as follows:

$$\text{F. of S.} = \frac{K_{IR}}{K_{Im} + K_{It}}$$

where K_{IR} is the reference stress intensity factor

K_{Im} is the stress intensity factor due to pressure

K_{It} is the stress intensity factor due to the thermal gradient through the thickness

The factor-of-safety for the beltline region is 1.8.
The factor-of-safety for the outlet nozzles is 1.2.

Detailed calculations are provided on sheet 3 of 3.

It should be recognized that this is a very conservative analysis. A postulated flaw size of 1/4t is assumed for the beltline region and the 3.0" nozzle corner flaw is assumed for the outlet nozzle. The material fracture toughness (reference stress intensity value) used is 200 ksi$\sqrt{\text{in.}}$ Finally, the calculation of the stresses associated with the transient is conservative.

Charles E. Harris

Charles E. Harris, PE
March 23, 1978

Henrik S Palme

Henrik S. Palme
March 23, 1978

ADJUSTED REFERENCE TEMPERATURE OF BELTLINE REGION

WF-70 in the longitudinal seam of the lower shell is the governing weld in the beltline region. Approximately 75% of this weld from the I.D. is WF-70, therefore, the 1/4T and 3/4T RTNDT will be determined for WF-70.

Number of EFPD ACCUMULATED AT TIME OF TRANSIENT 3/20/78 = 567 = 1.55 EFPY

This corresponds to a conservative max fluence at the vessel inner surface = 1.1×10^{18} n/cm² ‡

$$F_{1/4T} = 6.1 \times 10^{17} \text{ n/cm}^2$$

$$F_{3/4T} = 8.1 \times 10^{16} \text{ n/cm}^2$$

For WF-70 %Cu = 0.27 $F_{1/4T} = 4.7 \times 10^{17}$ n/cm²

%P = 0.014 $F_{3/4T} = 6.3 \times 10^{16}$ n/cm²

Note that the longitudinal seam is not at the same azimuthal location as the maximum fluence.

From Reg. G. 1.99 $\Delta RT_{NDT})_{1/4T}$ = 56°F

$\Delta RT_{NDT})_{3/4T}$ = 21°F

RT_{NDT} = 20°F unirradiated

The adjusted reference temperatures are:

1/4T	Adj. RT_{NDT} = 76°F
3/4T	Adj. RT_{NDT} = 41°F

POOR ORIGINAL

‡ Design curve is from the report for Phase Ib of the User's Group Program for the evaluation of Reactor Vessel material properties.

Charles E. Harris, PE
March 22, 1978

BABCOCK & WILCOX

CALCULATIONS: BASIC RELATIONSHIP $2K_{IM} + K_{IT} \le K_{IR}$

BELTLINE REGION $(2K_{Im} + K_{It})_{MAX} = 174.366$ Ksi$\sqrt{in}$ (M13CCAJ LQ41 3/22/78)*

$K_{IM} = P M_m \frac{r_i^2 + r_o^2}{r_o^2 - r_i^2}$ (BAW-10046A, Rev. 1) Removing the F. of S. of 2

time = 40 mins.

temp $_{1/4T}$ = 468°F

P = 2100 Psi

r_i = 85.5 in.

r_o = 94.0 in.

M_m = 2.9 (ASME code Appendix G, Fig G-2214.1)

K_{IM} = 64.45 Ksi$\sqrt{in}$ ✓

K_{It} = 174.366 − 2(64.45) = 45.47 Ksi$\sqrt{in}$ ✓

$$F.\ of\ S. = \frac{200\ Ksi\sqrt{in}}{64.45 + 45.47} = 1.82$$ ✓

F. OF S. = 1.82 ✓

NOZZLE REGION $(2K_{Im} + K_{It})_{max} = 247.286$ Ksi$\sqrt{in}$ (M14CCAH LQ41 3/22/78)*

time = 75 mins

temp $_{1/4T}$ = 392°F

$K_{IM} = P F(a/r_n) \frac{r_i^2 + r_o^2}{r_o^2 - r_i^2} \sqrt{\pi a}$ (BAW-10046A, Rev. Removing F. of S. of ...)

P = 2100 Psi

r_i = 84.1875"

r_o = 96.3130"

$F(a/r_n)$ = 1.74 (WRC Bulletin 175, Fig. AS-1)

a = 3.0" (Appendix G, Section III, ASME Code)

POOR ORIGINAL

K_{IM} = 83.9 Ksi$\sqrt{in}$ ✓

K_{It} = 247.286 − 2(83.9) = 79.49 Ksi$\sqrt{in}$ ✓

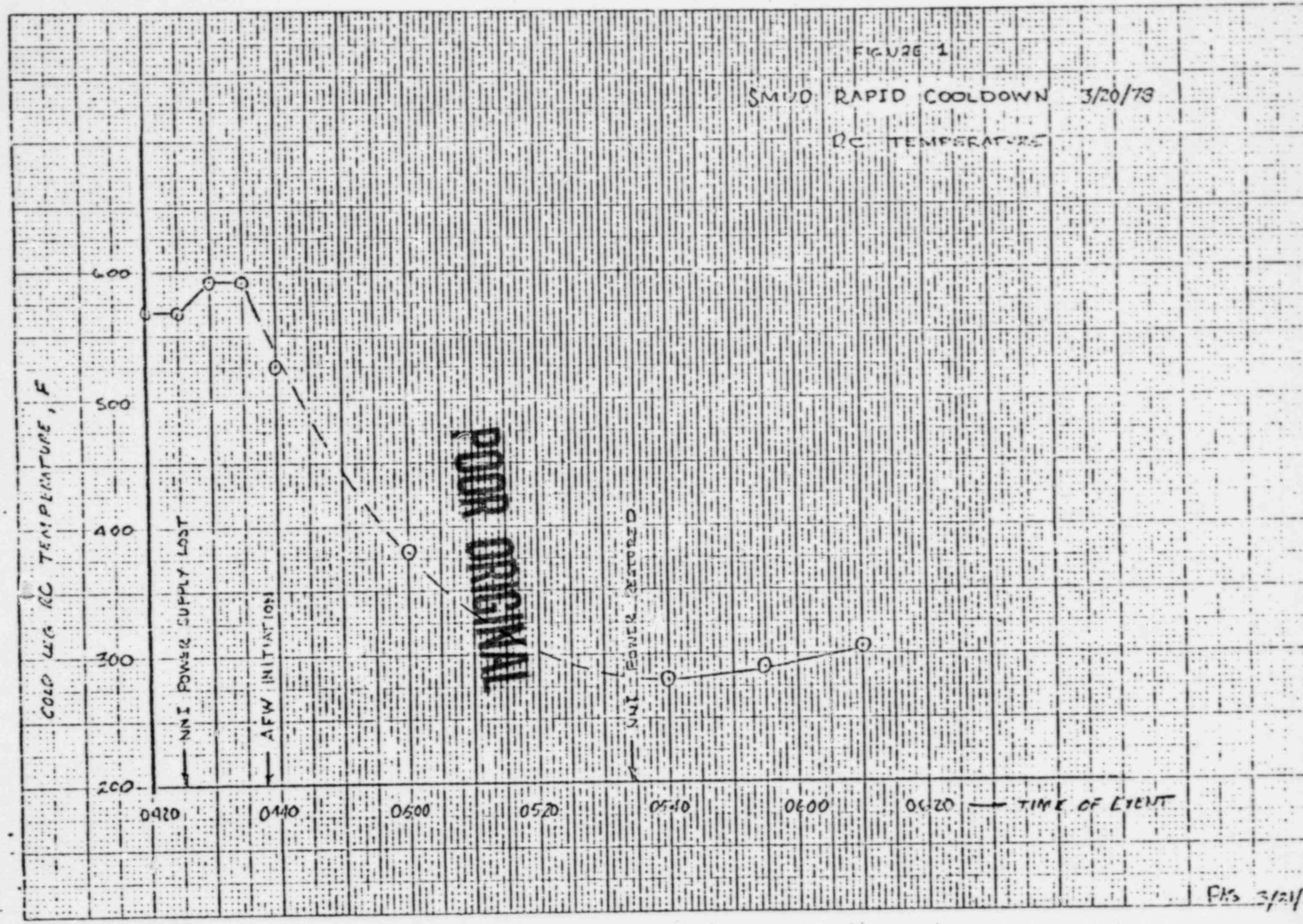
$$F.\ of\ S. = \frac{200\ Ksi\sqrt{in}}{83.9 + 79.49} = 1.22$$ ✓

F. OF S. = 1.22

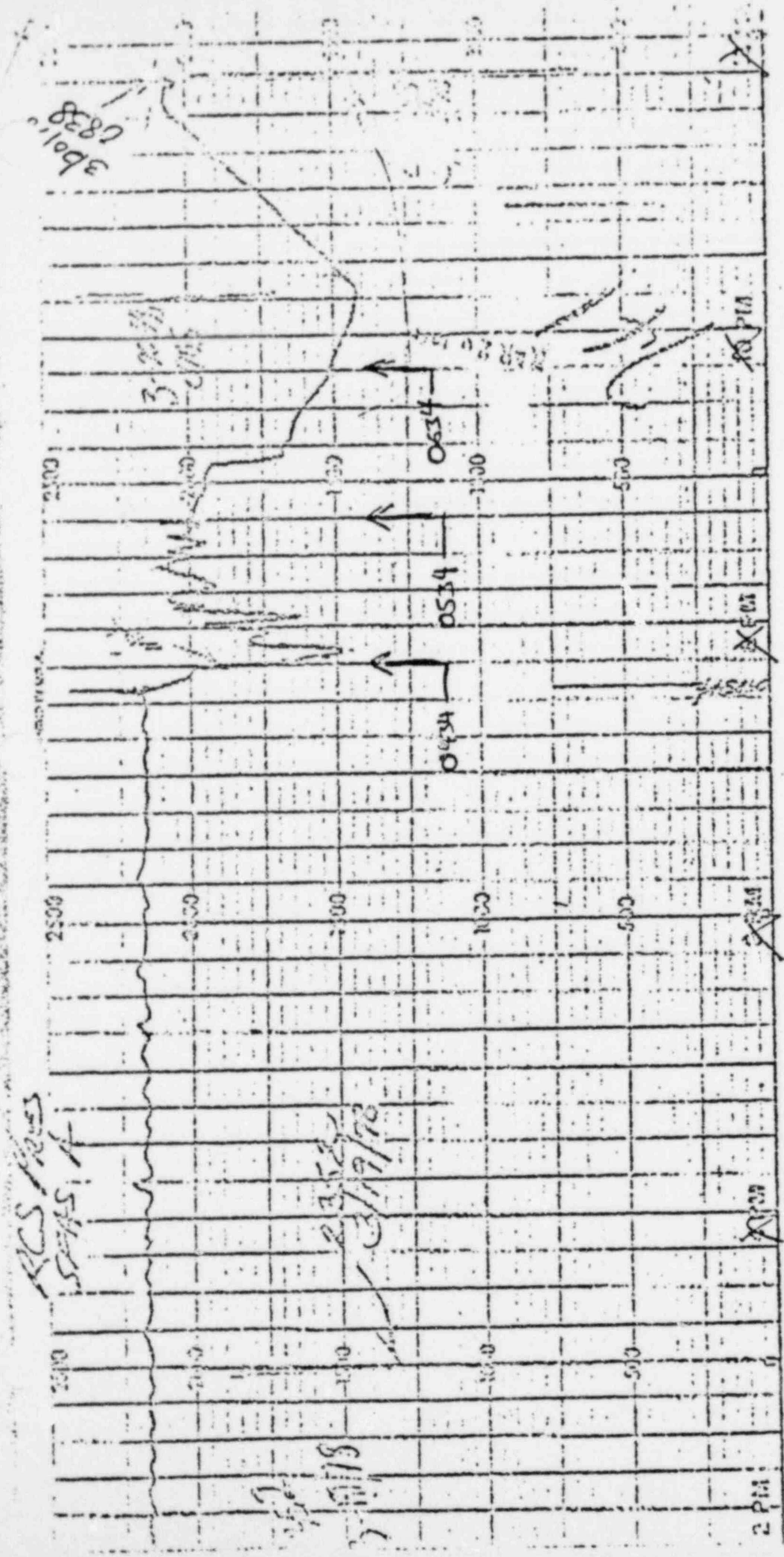
* Computer runs M13CCAJ and M14CCAH are based on a computer code developed to perform the BAW-10046A, Rev. 1 calculations. It should be noted that the thermal stress intensities are calculated based on a predefined temperature distribution through the vessel thickness that may not be the same as for this transient.

Charles E. Harris, PE
March 22, 1978

K+E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. 46 1322



PKS 3/21/78



POOR ORIGINAL

Reference 12 — Document Release Notice

BWNP-20032A-3(10-76)

CONTRACT/STANDARD NO.	DOCUMENT RELEASE NOTICE (DRN)
620-0011	
RELEASE DATE 5/3/78	PAGE 1 OF 15

PART/TASK-GROUP-SEQ.	B&W DOCUMENT NO.	DOCUMENT TITLE	PUL STAT.	RRL NO.
43-53-001	32-9016-00	CRDM EVALUATION OF SMUD COOLDOWN	NO	

POOR ORIGINAL

DISTRIBUTION	NO COPIES DRN	NO COPIES DOC		NO COPIES DRN	NO COPIES DOC
Originator	1	1			
G. E. Rothenberger		1			
J J Kelly	1	1			
J T Janis	1	1			
W R Gray	1	1			
central files	1	1			

RELEASED BY

R. A. Coe — NAME — 5-1-78 — DATE

Asst. Eng.

REVIEWED BY

G.E. Rothenberger — NAME — 5-2-78 — DATE

T.E.

CALCULATION DATA/TRANSMITTAL SHEET

DOCUMENT IDENTIFIER CALC. 32 - 9016 - 00

TRANS. 86 - ______ - ______

TYPE: ___ RESEARCH & DEVELOPMENT ___ SAFETY ANALYSIS REPORT ___ NUC. SERV. INPUT ___ DESIGN RQMT. ___ DESIGN VERIF. X OTHER

TITLE CRDM EVALUATION OF SMUD COOLDOWN

PREPARED BY R.A. Coe REVIEWED BY Gary E. Rothenberger

TITLE Asst. Eng. DATE 4-14-78 TITLE Tech. Eng. DATE 4/25/78

PURPOSE: The purpose of this calculation is to evaluate the CRDM performance during the cooldown transient which occurred at the SMUD site on March 20, 1978.

SUMMARY OF RESULTS (INCLUDE DOC. ID'S OF PREVIOUS TRANSMITTALS & SOURCE CALCULATIONAL PACKAGES FOR THIS TRANSMITTAL)

The RCS cooldown transient of March 20, 1978 was found to be not as severe as the CRDM cooldown transient that normally follows a trip. There are no concerns about long term damage to the CRDMs or about their ability to continue to perform as designed.

POOR ORIGINAL

DISTRIBUTION

The purpose of this calculation is to evaluate the CRDM performance during the cool down transient which occurred at the SMUD site on March 20, 1978. Data from this transient was transmitted to the Mechanical Equipment Unit via letter from J. J. Kelly to Distribution on March 30, 1978. A short summary of the time-history events which affect the CRDMs is presented here:

4:25:44	Drives trip; RCS @ 565°F
4:35:16	RCS Cold leg temp. begins to drop at 119.5°F/hr. Cool down continues until 5:40
5:40	RCS cold leg temp. begins to increase to hot standby.

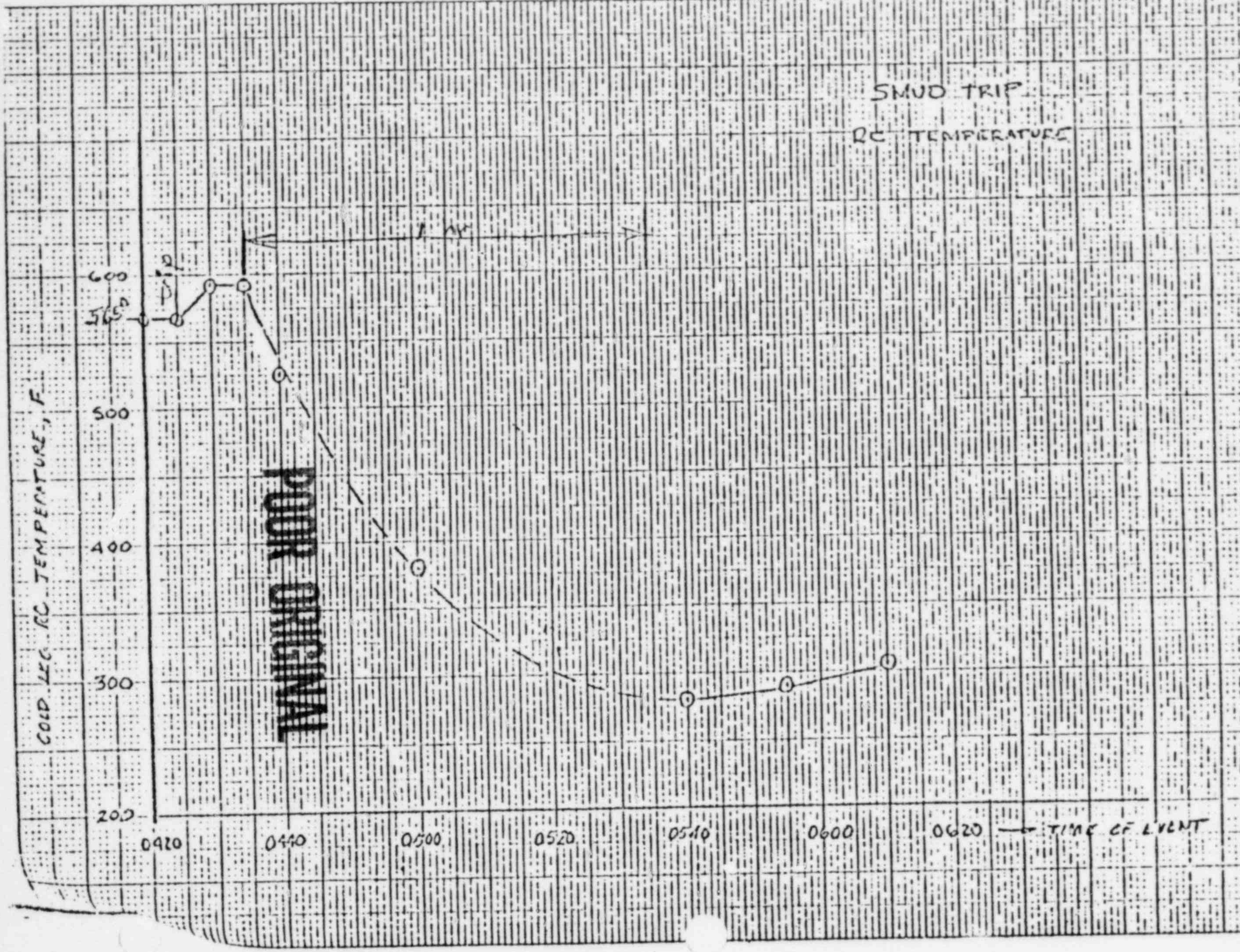
The CRDM temp. history will be evaluated in two parts. The trip transient occurs first followed by the RCS transient after ten minutes.

POOR ORIGINAL

46 1322

32-9016-00

FROM E.W. Swanson 3/21/78



ATTACHMENT 3 of Kelly's letter 3 of 14

RAC 4-17-78

POOR ORIGINAL

The Trip Transient

The RCS temperature before the trip was 565°F. At this RCS temperature, the maximum temperature of the motor tube is about 265°F per Topical Report BAW-10047-01, Figure A-4. The trip, occurring at 4:25, caused the usual hot water (565°F) to be injected into the motor tube. This would cause the motor tube temperature to rise to 350°F max in about one minute. The motor tube temperature then would drop exponentially at a rate determined from Figure A-4 of the above report. This temperature rate is approximated by the following equation:

$$T_{(t)} = (T_{max} - T_{ss})\, e^{-5.5 \times 10^{-3} t} + T_{ss}$$

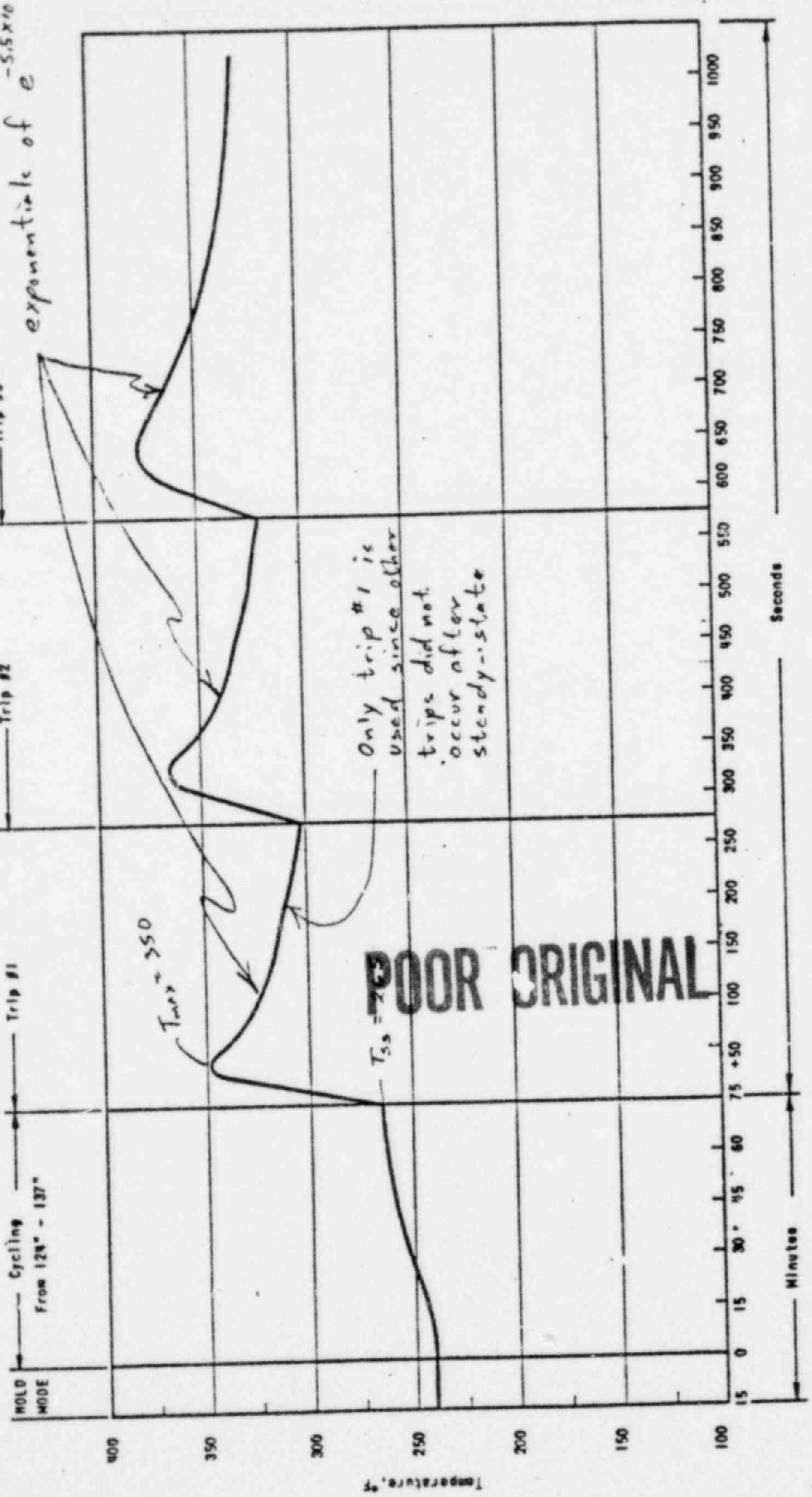
where T_{max} ≡ maximum motor tube temperature

T_{ss} ≡ steady-state motor tube temp.

t ≡ time (seconds)

The above equation was determined from the curves of Figure A-4.

Figure A-4. Maximum Extension Temperature Vs Time for Test D



The maximum motor tube temperature as a function of time for the first ten minutes after a trip is tabulated as follows and shown in Figure 1.

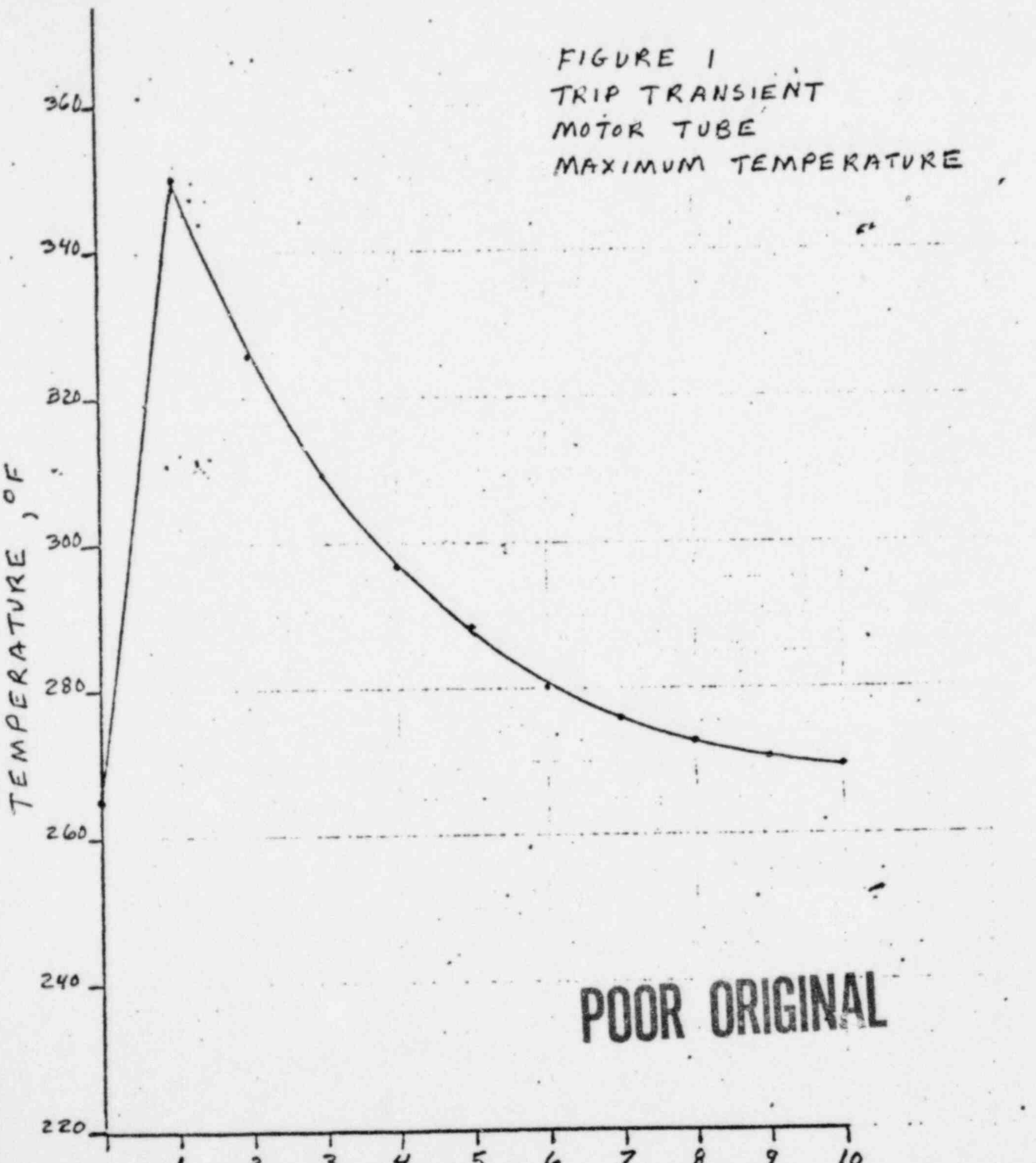
$$T_{(t)} = (350 - 265)\, e^{-5.5\times 10^{-3} t} + 265$$

time	$T_{(t)}$	
0	265	← trip occurs
60	350	← max. temp. reached in 60 sec.
120 (t = 60)	326	
180 (t = 120)	309	
240 (t = 180)	297	
300 (t = 240)	288	
360 (t = 300)	281	
420 (t = 360)	277	
480 (t = 420)	273	
540 (t = 480)	271	
600 (t = 540)	269	← ten minutes after trip

POOR ORIGINAL

It is apparent from the above table that the motor tube temperature has decayed to 95% of the steady-state motor tube temperature after 10 minutes, i.e. the trip transient is nearly dissipated when the RCS cooldown begins.

32-9016-00



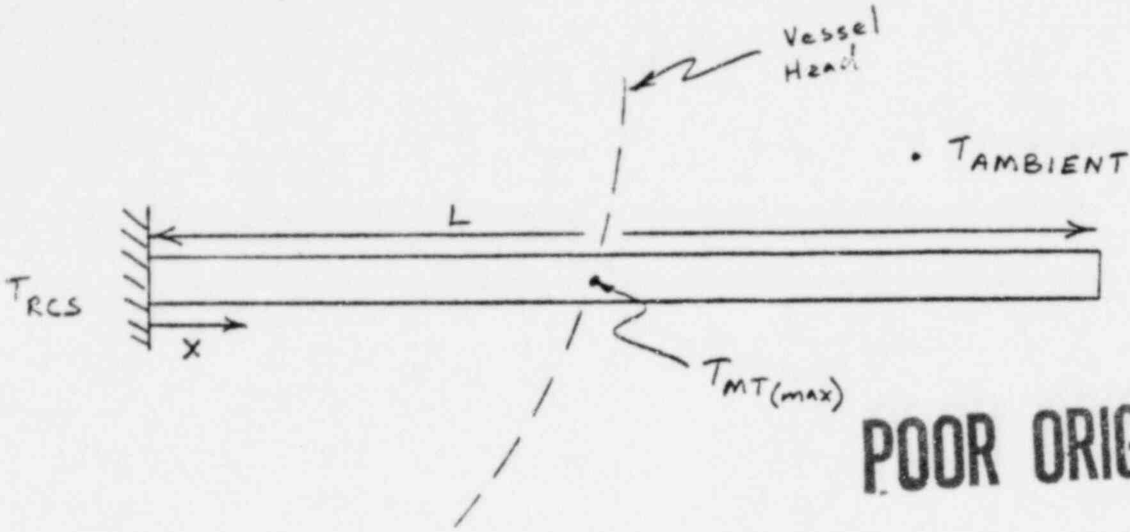
POOR ORIGINAL

BABCOCK & WILCOX		REVISION
DEPARTMENT	DATE 4-17-78 BY RAC	
SMUD RCS COOLDOWN	CHECKED DATE 4-25-78 BY [illegible]	
	JOB NO.	SHEET 7 OF 14

RCS Cooldown Transient

The RCS dropped 325°F in 65 minutes as shown in attachment 3 of Mr. Kelly's letter. The maximum motor tube temperature at the beginning of the RCS cooldown was 270°F. If a conservative ambient temperature of 90°F is assumed to surround the motor tube, the maximum motor tube temperature can not drop more than 270 - 90 = 180°F during the RCS cooldown transient. The rate of motor tube temperature decrease is a determining factor since, if this rate exceeds the normal cooldown rate following a trip, thermal stresses will be greater than the trip transient's. The purpose of the following development is to show that the cooldown rate for the motor tube during the RCS transient does not exceed the cooldown rate following a trip.

POOR ORIGINAL



POOR ORIGINAL

$$T_{(x)} = \left(T_{RCS} - T_{AMB}\right) \frac{\cosh m(L-x)}{\cosh mL} + T_{AMB}$$

The CRDM can be thought of as a fin of some length, L, where L is the distance from the end of the motor tube to the point where the temperature equals the RCS temperature. The above equation describes this physical situation and is taken from Heat Transfer, A.J. Chapman, 3rd ed., Chapter 3, equation 3.54. The hyperbolic cosine term is a function only of (x) and can be evaluated at the point where the motor tube temperature is a maximum, $T_{MT(max)}$.

$$\frac{\cosh m(L-x)}{\cosh mL} = \frac{T_{MT(max)} - T_{AMB}}{T_{RCS} - T_{AMB}}$$

$$= \frac{270 - 90}{600 - 90} = \frac{180}{510} = \underline{\underline{0.353}}$$

where: $T_{MT(max)} = 270°F$ (i.e. motor tube temp. at begin. of RCS transient)

$T_{RCS} = 600°F$ @ begin. of RCS transient

$T_{AMB} = 90°F$ conservative ambient temp

It is now possible to evaluate the maximum motor tube temperature as a function of RCS temperature.

$$\boxed{T_{MT(max)} = (T_{RCS} - 90)\,0.353 + 90}$$

The following table lists maximum motor tube temperatures for various RCS temperatures. The times listed are taken from attachment 3 of Mr. Kelly's letter for RCS temperature versus time. As a comparison, max. motor tube temperatures are also included for an ambient temp of 194°F.

POOR ORIGINAL

for T_{AMB} = 194

$$\frac{\cosh m(L-x)}{\cosh mL} = \frac{270-194}{600-194} = \frac{76}{406} = 0.187$$

$$T_{MT(max)} = (T_{RCS} - 194)\,0.187 + 194$$

RCS TEMP °F	TIME (MIN)	$T_{MT(max)}$ T_{AMB} = 90	$T_{MT(max)}$ T_{AMB} = 194
600	10	270	270
575	12	261	265
550	14	252	261
525	16	244	256
500	18.5	235	251
475	21	226	246
450	24	217	242
425	27	208	237
400	31	199	233
375	35	191	228
350	40	182	223
325	47	173	218

POOR ORIGINAL

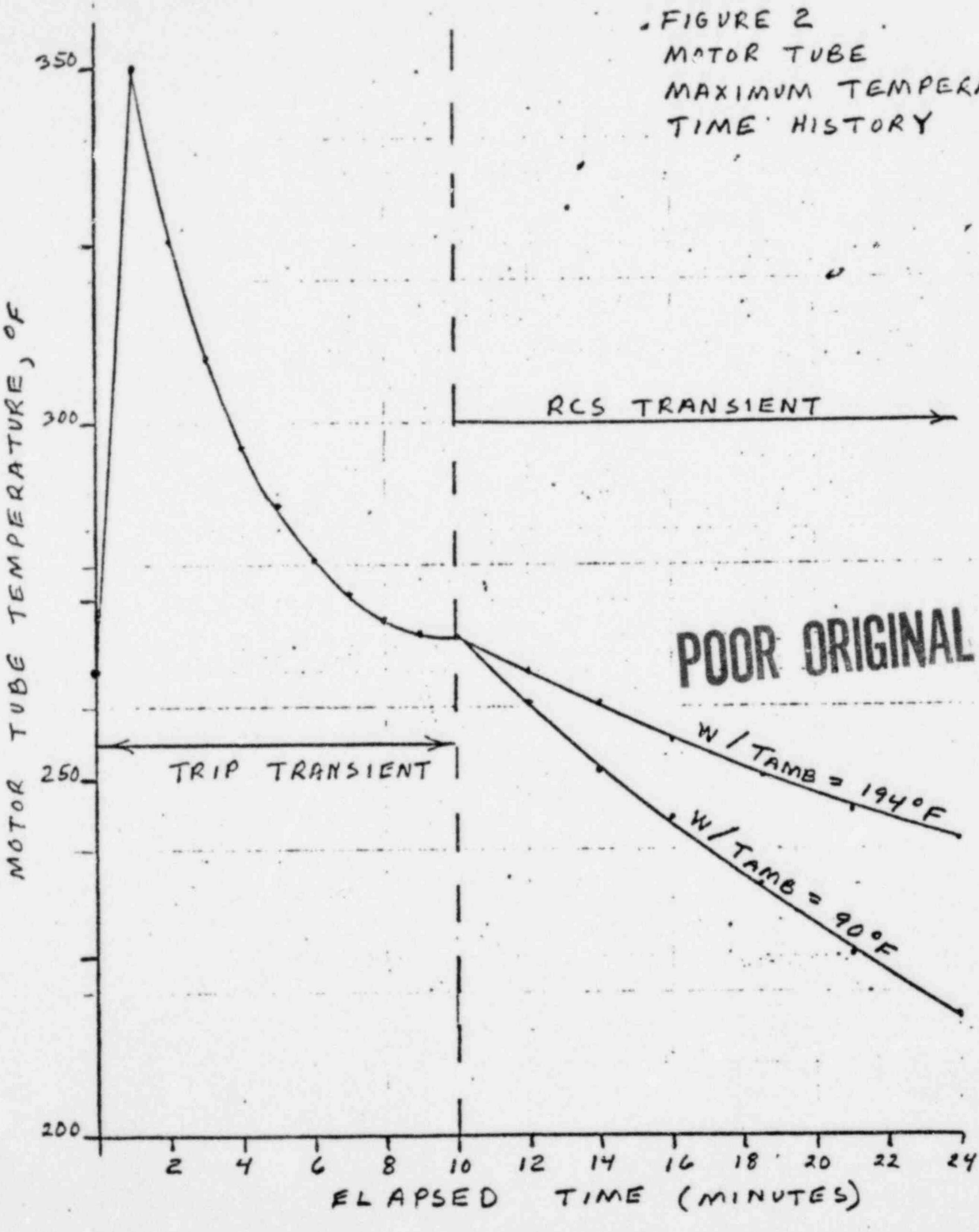
Conclusion

The conclusion of this calculation is that the RCS cooldown transient of March 20, 1978 was not as severe as the cooldown transient that normally follows a trip. Since this transient was less severe than a normal transient, there are no concerns about long term damage to the CRDMS or about their ebility to continue to perform as designed. Figure 2 shows the best estimation of the actual motor tube temperature during the cooldown incident. The ambient temperature surrounding the drive was within the 90-194°F range, but was not precisely known. Figure 3 gives a comparison of the motor tube response to the RCS transient versus the trip transient.

POOR ORIGINAL

5 247-1

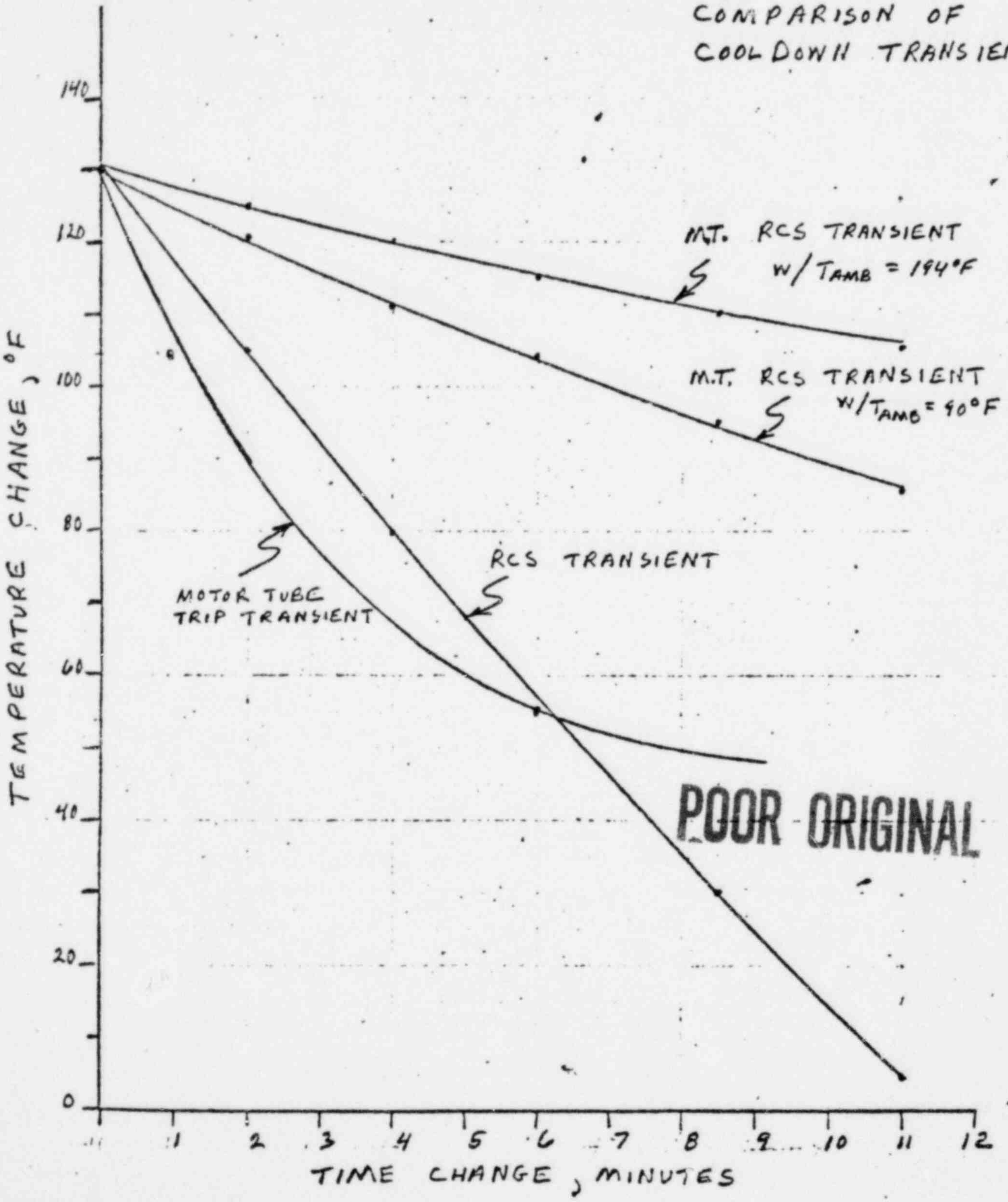
FIGURE 2
MOTOR TUBE
MAXIMUM TEMPERATU
TIME HISTORY



POOR ORIGINAL

BABCOCK & WILCOX		REVISION
DEPARTMENT	DATE 4-17-78 BY RAC	
SMUD RCS COOLDOWN	CHECKED DATE 4/25/78 BY SSR	
	JOB NO.	SHEET 13 OF 14

FIGURE 3
COMPARISON OF
COOL DOWN TRANSIENTS



POOR ORIGINAL

BABCOCK & WILCOX		REVISION
DEPARTMENT	DATE 4-17-78 BY RAC	
SMUD RCS COOLDOWN	CHECKED DATE 4/21/78 BY [illegible]	
	JOB NO.	SHEET 14 OF 14

Reference 13 – Document Release Notice

BWNP-20032A-3(10-76)

CONTRACT/STANDARD NO. 660-018B	DOCUMENT RELEASE NOTICE (DRN)
RELEASE DATE ______ / PAGE 1 OF 1	

PART/TASK-GROUP-SEQ.	B&W DOCUMENT NO.	DOCUMENT TITLE	PUL STAT.	RRL NO.
15-001-001	86-1863-00	SMUD Transient	N	NA

DISTRIBUTION	NO COPIES DRN	NO COPIES DOC		NO COPIES DRN	NO COPIES DOC
J. J. Kelly	1	1	J. R. Smotrel	1	1
For Information Only			R. A. Turner	1	1
G. A. Meyer	1	1	D. D. Shelburne	1	1
J. T. Willse	1	1	S. G. Harris	2	2
A. B. Jackson	1	1	Return Original to me		
J. S. Tulenko	1	1	R. J. Parekh	1	1
W. T. Brunson	1	1	R. V. DeMars	1	1

RELEASED BY Wayne J. West 5/10/78
NAME DATE

REVIEWED BY TLM
J. T. Willse 5/10/78
NAME DATE

CALCULATION DATA/TRANSMITTAL SHEET

DOCUMENT IDENTIFIER

CALC. 32 - ______ - ______

TRANS. 85 - 1863 - 00

TYPE: ___ RESEARCH & DEVELOPMENT ___ SAFETY ANALYSIS REPORT ___ N.C. SERV. INPUT ___ DESIGN RQMT. ___ DESIGN VERIF. X OTHER

TITLE SMUD Depressurization Transient

PREPARED BY W. J. West W.J.W. REVIEWED BY J.T. Willse

TITLE Assistant Engineer DATE 5/10/78 TITLE Sup. Eng. DATE 5/10/78

PURPOSE:

T-H evaluation of SMUD depressurization transient.

SUMMARY OF RESULTS (INCLUDE DOC. ID'S OF PREVIOUS TRANSMITTALS & SOURCE CALCULATIONAL PACKAGES FOR THIS TRANSMITTAL)

See attached memo.

See calculational file 32-9120-00.

DISTRIBUTION

See DRN.

THE BABCOCK & WILCOX COMPANY
P[illegible]R GENERATION GROUP

To: J. J. KELLY, PLANT INTEGRATION	THE-78-227
From: W. J. WEST, T-H ENGINEERING UNIT, EXT. 3243	12E12.04 BDS 663.5
Cust.: SMUD	File No. or Ref. 86-1863-0[illegible] 660-018B
Subj.: DEPRESSURIZATION TRANSIENT/FUEL EFFECTS	Date: MAY 10, 1978

This letter to cover one customer and one subject only.

References: 1) Memo, J. J. Kelly to Distribution, "Q.A. of Cooldown Incident Analysis," March 30, 1978.

2) Calculational file 32-9120-00.

A complete review of the March 30, 1978 SMUD depressurization transient has been completed. The following three areas of concern were evaluated:

I. Fuel Rod Compression Criteria

The fuel rod cladding did not experience a tensile force at any time during the depressurization transient.

II. Transient DNBR

No concern for DNBR magnitudes existed due to the combination of reactor trip with full flow conditions.

III. Fuel Assembly Lift

Review of the sequence of events during the transient indicate that most probably fuel assembly lift off occurred for a period of approximately ten minutes. This condition violated B&W's no lift criteria; however, the liftoff condition is not a safety concern.

Overall, the depressurization incident as outlined in Reference 1 will not adversely effect fuel performance for the remainder of it's design life, provided plant startup subsequent to the transient did follow the attached mechanical maneuvering recommendations.

WJW/sgh

cc: G. A. Meyer
J. T. Willse
A. B. Jackson
J. S. Tulenko
W. T. Brunson
J. R. Smotrel
R. A. Turner
D. D. Shelburne
R. J. Parekh
R. V. DeMars

QA: The conclusions stated in this memo are correct.

John T. Willse Date 5/10/78

MECHANICAL MANEUVERING RECOMMENDATIONS

RANCHO SECO

CONTRACT [illegible]

REVISION 0

DATE JUNE 3, 1977

The following are the recommended maneuvering limits for SMUD, Cycle 2:

1. The maximum rate of power increase below 20% full power shall be 10% per hour.

2. Above 20% power, normal operating procedures (Tech. Spec Limits) will apply unless the reactor has operated at less than 20% power for more than 48 hours.

3. If the power level has been below 20% full power for greater than forty-eight (48) hours, the maximum rate of power increase above 20% full power shall be 30% per hour with a five (5) hour hold at 20% full power below the power level cutoff and a five (5) hour hold at the power level cutoff. These holds can run concurrently with holds required by the Technical Specification.

4. During the initial power escalation at cycle startup or immediately following a control rod interchange, the initial escalation above the 40 ~~75%~~ full power shall be limited to 3% per hour, with a five (5) hour hold at the power level cutoff. This hold can run concurrently with Technical Specification holds where applicable.

5. With the exception of item 4 above, no restrictions are placed on required physics startup tests.

FUEL ENGINEERING SECTION MANAGER

Reference 14 — Memorandum: Thoren to Stevens, 9/26/78

THE BABCOCK & WILCOX COMPANY
POWER GENERATION GROUP

To
D. M. STEVENS, LRC

From
D. E. THOREN, STRUCTURAL MECHANICS UNIT (x2206)

BDS 663-5

Cust.
SMUD

File No. or Ref.

Subj. NEUTRON NOISE DATA RELATED TO THE COOLDOWN TRANSIENT OF 3/20/78

Date
SEPTEMBER 26, 1978

This letter to cover one customer and one subject only.

This memo is in follow up to our telecon of last week about the above subject.

Enclosed are the following:

A. Two (2) sets of data obtained from signals from NI-7 and NI-5. Each set consists of,

- PSD at 100% power before the cooldown transient in November 1977.
- PSD, phase, coherence at 100% power. These results were obtained from signals recorded 5 months after the cooldown transient.

B. A copy of a figure, Nuclear Instrumentation Detector Locations - Plan View, which shows the location of the NIs.

When we briefly examined these 2 sets several weeks ago, I believe we mutually agreed they indicated a beam mode of the core support assembly, in the vicinity of 9-11 Hz, still existed after the cooldown transient.

I request that you re-examine the two (2) sets and briefly document your conclusion derived from them.

D. E. Thoren

DET:jvg

cc: w/o attachments
J. M. Burnett
F. R. Burke

Reference 15 — Memorandum: Mayo/Stevens to Thoren, 10/3/78

Babcock & Wilcox

Research and Development Division
LYNCHBURG RESEARCH CENTER
LYNCHBURG, VIRGINIA

To	D. E. THOREN, STRUCTURAL MECHANICS, NPGD
From	C. W. MAYO/D. M. STEVENS, NUCLEAR PHYSICS, LRC
Cust.	SMUD
File No. or Ref.	
Subj.	NEUTRON NOISE DATA AT SMUD
Date	OCTOBER 3, 1978

This letter to cover one customer and one subject only.

Reference: Memo "Neutron Noise Data Related To the Cooldown Transient of March 20, 1978," D. E. Thoren to D. M. Stevens, September 26, 1978.

We have reviewed the data contained in the above reference and our conclusions are as follows:

1. The general shape of the PSDs of the excore detectors indicate that a beam mode resonance of the core support assembly exists after the cooldown transient. This fact is supported by the presence of high coherence and 180° phase.

2. Because of the arbitrary scaling of the data, changes in the magnitude of the beam mode resonance before and after the transient can not be determined.

3. Identification of detailed spectral features is not possible due to the limited resolution and dynamic range of the data.

C W Mayo / D.M. Stevens

C. W. Mayo/D. M. Stevens

js

cc: T. C. Engelder
R. N. Kubik
R. H. Lewis

CONTRACT NO. 595-7072 620-0011	DOCUMENT COMMENT FORM	RELEASED BY J M Burnett 11/8/78 TASK ENGINEER DATE
SUPPLIER B&W	PREPARED BY: J M Burnett NAME 11/8/78 DATE	REL. DATE 11-17-78
PO. NO.		PAGE 1 OF 1

PART/TGS	B&W DOC. NO.	DOCUMENT TITLE	CUSTOMER/ SUPPLIER DOC. NO.	STATUS	RRL NUMBER
51-01-001	33 0275 00	REACTOR VESSEL RAPID COOLDOWN TRANSIENT FATIGUE ANALYSIS FOR SACRAMENTO MUNICIPAL UTILITY DISTRICT (RANCHO SECO)	620-0011-51 CONTRACT #3075	APPROVED	N/A

DISTRIBUTION:

J.M. BURNETT (W/1 ATTACH)
A.D. McKIM (W/1 ATTACH) - MTV
J.J. Kelly (W/6 ATTACH)
J.T. Janis (W/O ATTACH)

REACTOR VESSEL

Rapid Cooldown Transient

Fatigue Analysis

FOR

Sacramento Municipal Utility District
Ranco Seco

User Contract No. 3075
B&W Contract No. 620-0011-51

Prepared By: Alvin D. McKim 5-15-78
F. L. Boyer 5-15-78

Checked By: Douglas D. Huston 5/16/78

Approved By: H Belcke 5/31/78

B & W DOCUMENT NUMBER
33 0275 00

8001210 554

TABLE OF CONTENTS

	PAGE NO.
Discussion	1
Results	2
References	3
Nomenclature	4
Transient Description	5
Nozzle Belt-Core Shell-Lower Head Analysis	7
Instrumentation Tube Analysis	13
Control Rod Drive Mechanism Housing Write Off	25
Closure Dome-Closure Flange Analysis	26
Closure Stud Write-Off	31
Nozzles-Nozzle Belt Analysis	32
Support Skirt Analysis	44
Core Flooding Venturi Write Off	50

APPENDIX A

Computer Program	Page No.
1) 91232 - Nozzle Belt	A-1 to A-8
2) 91232 - Shell	A-9 to A-16
3) 91232 - Lower Head	A-17 to A-24
4) 91206 - Nozzle Belt -Shell-Lower Head	A-25 to A-39
5) 91232 - Instrumentation Tube	A-40 to A-47
6) 91206 - Instrumentation Tube	A-48 to A-61
7) 91232 - Upper Head (Closure Dome)	A-62 to A-69
8) 91232 - Closure Flange	A-70 to A-77
9) 91232 - Core Flooding Nozzle	A-78 to A-85
10) 91232 - Outlet Nozzle	A-86 to A-91

Discussion:

The upset transient information presented in reference #5 was used to analyze reactor vessel pressure retaining areas that experience high fatiuge usage factors and/or high primary + secondary stress intensity ranges.

Primary + Secondary and the resulting fatigue usage factor are the only concern of this analvis; since, a brittle fracture analysis was previously completed and found to be acceptable and a ductile failure is not a credible mode of failure for pressures less than design pressure.

A conservative fatigue evaluation is performed at these locations assuming that three (3) cycles of this transient can occur over the forty years plant life. Each area that is analyzed will have a discussion of the conservative analysis method utilized.

Below is the list of the pressure retaining areas that are analyzed to account for the fatigue affect of the "cooldown incident":

1) Nozzle belt - core shell - lower head remote from attachments.

2) Instrumentation tube - lower head

3) Nozzles to nozzle belt

4) Support Skirt

Below is the list of areas that are justified by explanation which did not warrant calculations to be made.

1) Control rod drive mechanism housing

2) Closure studs

3) Core flooding venturi

The computer output used in this analysis is contained in Appendix A. The information used in the analysis from this output is easily obtainable by going to the table of contents which indicates where the appropriate computer run is in Appendix A.

SMUD RAPID COOLDOWN

A. D. McKIM

Results - Usage Factor Increases Due to Three Cycles of RCT

	Usage Factor original analysis	Usage Factor w/RCT	Usage Factor Increase
Nozzle belt-shell-lower head	0.0213	0.0219	0.0600
Instrumentation Tube	0.5700	0.5800	0.0100
Closure Dome-Flange	0.0343	0.0643	0.0300
Nozzles - Nozzle Belt	0.3500	0.4360	0.0860
Support Skirt	0.0700	0.2200	0.1500

Conclusion - All usage factors are less than one; therefore, acceptable.

References

1.) Criteria of the ASME Boiler and Pressure Vessel Code for Design by Analysis in Sections III and VIII, Division 2 by The American Society of Mechanical Engineers United Engineering Center, 1969.

2.) Design Report for Sacramento Municipal Utility District, B&W Contract No. 620-0011-51/52, Customer Order No. 3075, dated March 1974.

3.) Computer Program 91232 - "Temperature Distribution In Long Cylinder."

4.) Computer Program 91206 - "Seal Shell Analysis with Axisymmetric Mechanical and Thermal Loading."

5.) J.M. Burnett memo to Distribution dated 4/4/78; Subject: SMUD Cooldown Incident.

6.) 1977 Edition ASME Section III with Addenda through Winter 1977.

7.) Design Report #6 - "Thermal Mechanical Stress Analysis of Reactor Lower Head and Support Skirt", Revision 1 dated 9-73.

8.) Program 91060 - "General Interaction Analysis for Shells of Revolution With Axisymmetric Loading".

9.) Design Report #4 - "Thermal/Mechanical Analysis of Primary Inlet & Outlet Nozzle", revision 1, dated 5-74.

10.) Design Report #5 - "Thermal/Mechanical Analysis of the Core Flooding Nozzle", revision 2 dated 5-74.

11.) Design Report #2 - "Closure Analysis", revision 1 dated 5-74.

12.) Design Report #11 - "Thermal/Mechanical Analysis of the Reactor Vessel Shell", revision 1 dated 5-73.

13.) Design Report #8 "Reactor Vessel Instrumentation Tubes", revision 1 dated 5-73.

14.) Computer Program 91425, B&W Material Properties Standard, Revision 4, June 1976.

15.) J.M. Burnett memo to Distribution dated 4/20/78; Subject SMUD Cooldown Incident.

16.) J.M. Burnett memo to Distribution dated 4/20/78; Subject: SMUD Cooldown Incident.

17.) Calculation Package 32-9801-00, "Fracture Mechanics Evaluation - RV", dated 10/12/78.

SMUD RAPID COOLDOWN

A. D. McKIM

Nomenclature

σ_{disc} = Thermal discontinuity stress intensity

σ_{RGS} = Thermal radial gradient stress intensity

σ^{therm}_{peak} = Thermal peak stress intensity

σ_{P+S} = Total primary + secondary intensity range.

σ_{alt} = Alternating stress as defined in NB3216 of reference #6

σ_{peak} = Peak stress intensity range.

K_e = Correction factor for fatigue evaluation for cases when the 3 S_m limit is not met (NB-3228.3 of ref. #6).

P+S = Primary plus secondary stress intensity

RCT = Rapid Cooldown Transient

P = pressure, psi.

P_1+P_b = Primary membrane plus primary bending stress intensity as defined in NB-3221.3 of reference #6.

OBE = Operational Basis Earthquake

SCF = Stress concentration factor

M = Bending moment, in-lbs./in.

t = Thickness, in.

r_i = Inside radius, in.

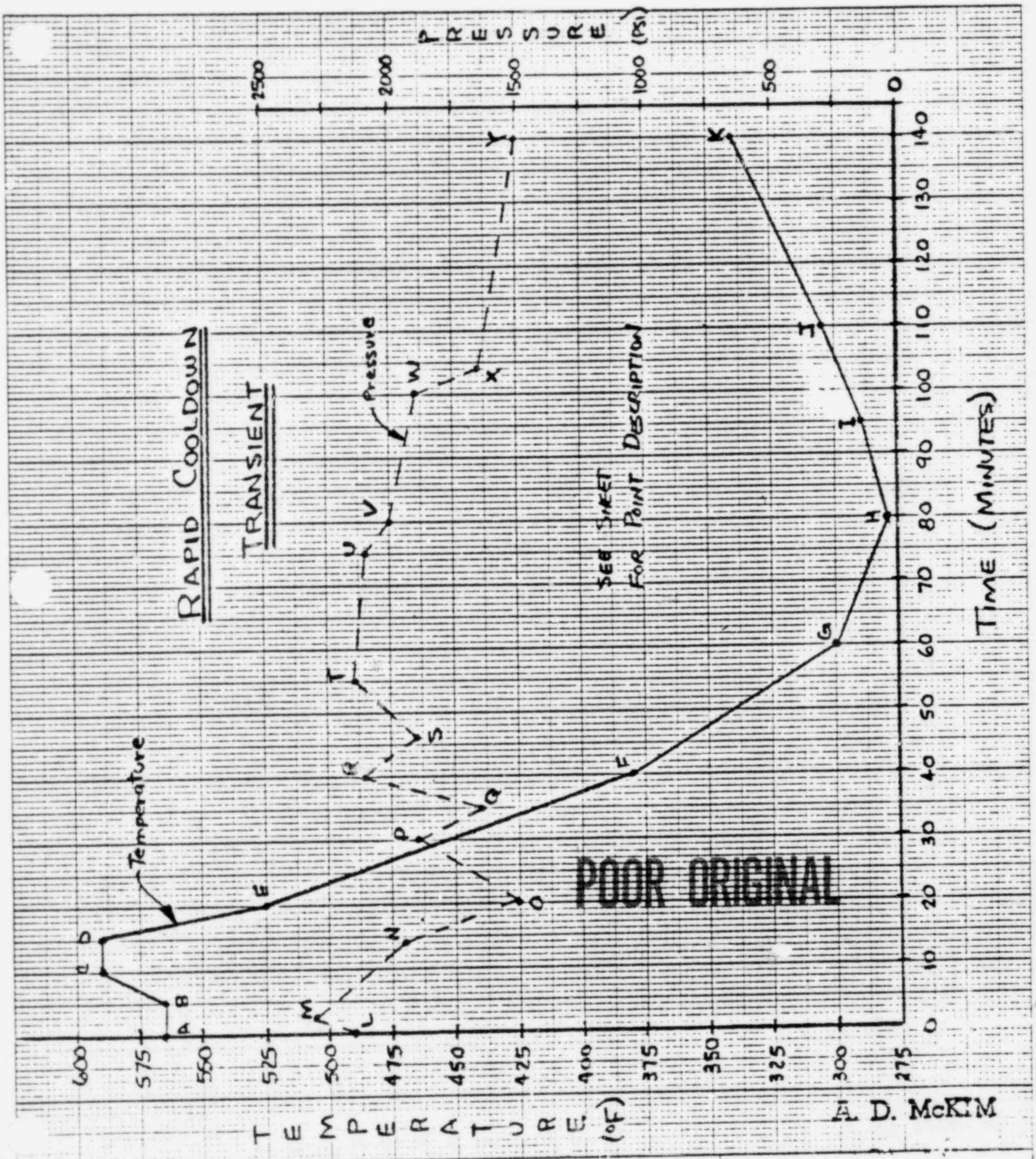
r_o = Outside radius, in.

SMUD RAPID COOLDOWN

A. D. McKIM

BDS 2057 K&E

THE BABCOCK & WILCOX COMPANY



CUSTOMER	JOB NO.
	Sheet 5
SUBJECT SMUD RAPID COOLDOWN	BY
	DATE

TRANSIENT POINT DESCRIPTION

POINT	TIME (MIN.)	TEMP. (°F)
A	0.0	565
B	5.0	565
C	10.0	590
D	15.0	590
E	20.0	525
F	40.0	380
G	60.0	300
H	80.0	280
I	95.0	290
J	110.0	305
K	140.0	340

POINT	TIME (MIN.)	PRESSURE (PSI)
L	0.0	2150
M	2.5	2300
N	14.0	1950
O	20.0	1500
P	30.0	1900
Q	35.0	1650
R	40.0	2100
S	46.0	1900
T	55.0	2150
U	75.0	2100
V	80.0	2000
W	100.0	1900
X	104.0	1650
Y	140.0	1500

POOR ORIGINAL

Time, Temperatures, and pressures are representative of information contained in reference #5.

E. D. McKIM

BABCOCK & WILCOX			REVISION
DEPARTMENT	DATE	BY	
SMUD RAPID COOLDOWN	CHECKED DATE	BY	
	JOB NO.		SHEET 6 OF

Nozzle Belt - Shell - Lower Head

Analysis Discussion

The description of the method used to analyze the nozzle-belt-shell lower head for P + S and fatigue effects of the RCT are described below:

1.) Program 91232 (reference #3) is used to obtain the temperature distribution for the nozzle belt, shell, and lower head.

2.) Times for analysis were chosen using the following criteria:

   a) Maximum σ_{disc} - times in which the ΔT between the midpoint temperatures of the nozzle belt-shell and shell-lower head are a maximum. See the graph on sheet 10 for this determination.

   b) Maximum RGS - times in which the RGS calculated by Program 91232 are a maximum for the different sections.

3.) Program 91206 (reference #4) was run for the times of analysis using the temperatures obtained from 91232 in conjunction with the appropriate pressure to obtain P + S and σ_{peak} for the RCT (See sheet 3 in reference #11 for the 91206 model). The only alteration to this model was at the "N" end. The "N" end was modeled to represent the opening in the head for an instrumentation tube. The motions at this end are used in instrumentation tube analysis in another section of this analysis.

4.) The P + S and peak stress intensities for the RCT are combined with the P + S and peak stress intensities for iterations analyzed in reference #12 (see sheet #53 of reference #12) to obtain maximum σ_{P+S} and σ_{alt}. Segment #13 is the location of maximum stress.

5.) Fatigue analysis is performed in accordance with reference #6.

SMUD RAPID COOLDOWN

A. D. McKIM

BMS 247-1

POOR ORIGINAL

Times of Analysis

Four times from the RCT were chosen to analyze.

Time 40 - maximum RGS in lower head

Time 60 - maximum RGS in shell and maximum ∇_{DISC} between shell and lower head

Time 100 - maximum ∇_{DISC} between nozzle belt and shell

Time 20 - Time necessary to analyze instrumentation tube - lower head (lower head motions used in instrumentation interaction analysis)

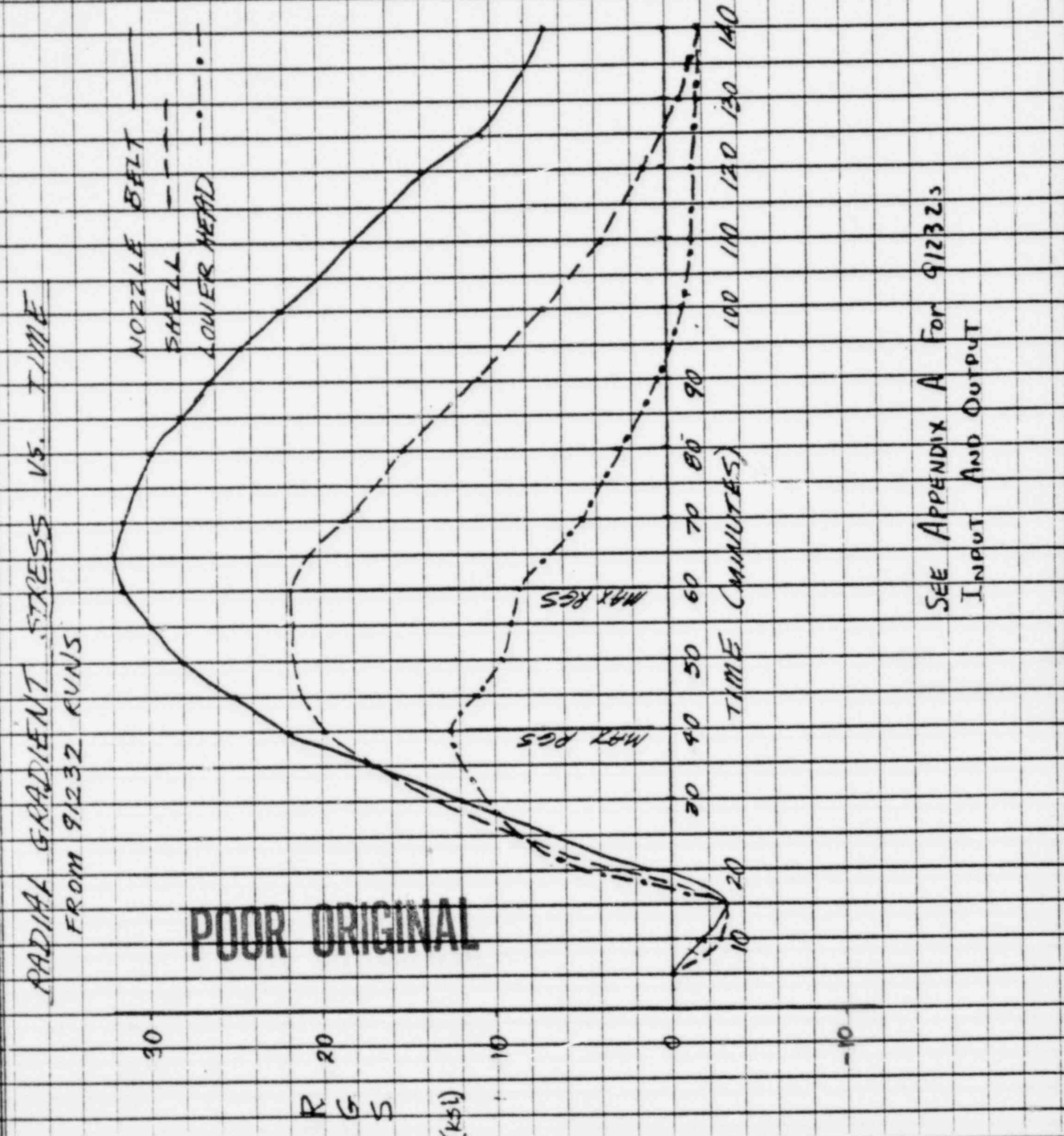
Pressures for times of analysis are listed below

Time (Minutes)	Pressure (psi)
20	2100
40	2050
60	1680
100	1500

A. D. McKIM

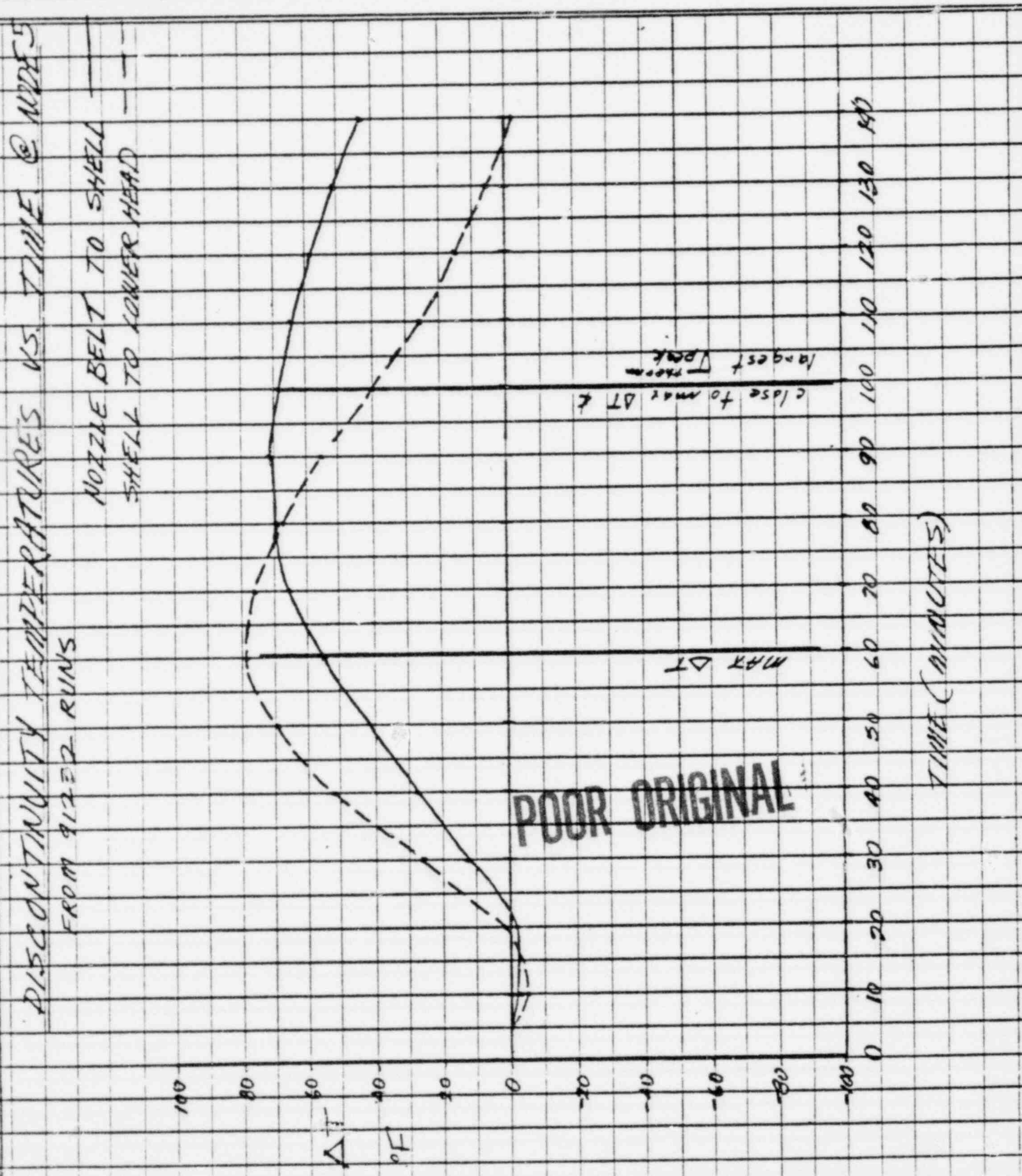
BABCOCK & WILCOX			REVISION
DEPARTMENT	DATE	BY	
SMUD RAPID COOLDOWN	CHECKED DATE	BY	
	JOB NO.		SHEET 8 OF

PMS 247-1



BABCOCK & WILCOX			REVISION
DEPARTMENT	DATE 4-78	BY F.L.B	
SMUD COOLDOWN INCIDENT	CHECKED DATE	BY	
SHELL CALCULATIONS	JOB NO.		SHEET 9 OF

HMS 247-1



BABCOCK & WILCOX		REVISION
DEPARTMENT	DATE 4-78 BY F.L.B.	
SMUD COOLDOWN INCIDENT	CHECKED DATE BY	
SHELL CALCULATIONS	JOB NO.	SHEET 10 OF

σ_{P+S} STRESS CALCULATIONS

COMBINE ITER 20, 40, 60, & 100 WITH THOSE IN SHELL ANALYSIS & OBTAIN MAX σ_{P+S} AT CRITICAL JUNCTURES.

MAXIMUM FROM 91206 @ JUNCTURE 13 = 54.0 KSI ON INSIDE

GAMMA HEATING ON INSIDE = 3.2 KSI (PG 107, ref #11)

TOTAL MAX σ_{P+S} = 54 + 3.2 = 57.2 KSI

$P+S = 57.2 \text{ KSI} < 3S_m = 80 \text{ KSI}$

PEAK STRESS INTENSITY RANGE

MAXIMUM PEAK STRESS @ JUNCTURE 13 = 67.2 KSI ON INSIDE

GAMMA HEATING STRESS ON INSIDE = 3.2 KSI

SKIN STRESS ON INSIDE DUE TO 0-15-0% PWR.

$$\sigma_H = \sigma_L = \frac{E\alpha\Delta T}{1-\mu} = \frac{27.51E{+}6(7.16E{-}6)(86)}{.7} = 24.2 \text{ KSI}$$

$$\text{ALTERNATING STRESS} = \frac{67.2+3.2+24.2}{2} = 47.3 \text{ KSI}$$

$n_1 = 3$ CYCLES

$U_1 = n_1/N_1 = 3/5000 = .0006$

POOR ORIGINAL

$U_2 = n_2 / N_2$

ALTERNATING STRESS = 28.5 PG. 108, ref. #11

n_2 = 640 CYCLES (CONSERVATIVE)

U_2 = 640/30000 = .0213

FOR REMAINING TRANSIENTS USAGE FACTOR U_3 IS 0 PER PG. 109.

$U_T = U_1 + U_2 + U_3$ = .0006 + .0213 + 0.0 = .0219

POOR ORIGINAL

BABCOCK & WILCOX		REVISION
DEPARTMENT	DATE 4-78 BY F.L.B.	
SMUD COOLDOWN INCIDENT	CHECKED DATE BY	
SHELL CALCULATIONS	JOB NO.	SHEET 12 OF

Instrumentation Tube

Analysis Discussion

The analogy and description of the method used to analyze the instrumentation tube for P+S and fatigue effects of the RCT are described below:

1.) Program 91232 (reference #3) is used to obtain the temperature distribution for the instrumentation tube. Film coefficient from reference #13 is used.

2.) Times of analysis for the RCT are determined using the following criteria:

   a.) Maximum σ_{disc} - time of maximum midpoint ΔT between the instrumentation tube and lower head (Program 91232 for the lower head was run for the nozzle-belt - shell-lower head analysis.)

   b.) Maximum RGS - time of maximum RGS calculated by Program 91232.

3.) For times of RCT analysis the following was done to determine the interaction between the tube and lower head.

   a.) Free thermal motions of the tube were determined by using the midpoint temperature of the tube in $\alpha R(\Delta T)$ equation.

   b.) Tube pressure motions were determined by ratioing the pressure motions calculated in reference #13 (sheet B-8-2) by the appropriate pressure for time of analysis.

   c.) Head motions due to thermal and pressure were taken from Program 91206 which was run for the nozzle belt-shell-lower head analysis.

   d.) The "interaction analysis" method in Section B-10 of reference #13 was followed in obtaining "M" and "Q" values.

SMUD RAPID COOLDOWN

A. D. McKIM

4. Program 91206 was run for the tube with the appropriate temperature, pressure, "M", and "Q" for times of analysis to obtain pressure + thermal P+S for tube.

5. Earthquake stresses from reference #13, sheet are added to P+S from 4) to obtain total P+S for RCT.

6. The P+S of 5) are combined with P+S from reference #13 to obtain σ_{P+S}.

7. A conservative S.C.F. of four is multiplied times σ_{P+S} of 6) to obtain the maximum peak stress intensity range to be analyzed for three fatigue cycles. This high S.C.F. is used to make this analysis inclusive of the weld juncture also. The weld is designed to develop more strength than the tube; therefore, this approach is conservative.

8. A fatigue analysis is performed in accordance with reference #6.

SMUD RAPID COOLDOWN

A. D. McKIM

Times of Analysis

Two times from the RCT were chosen to analyze.

Time 20 - maximum RGS in tube

Time 40 - maximum σ_{DISC}, ie maximum ΔT between tube and head

Pressure for times of analysis are listed below with the corresponding 91206 pressure load inputs

Time (Minutes)	Pressure (PSI)	H* (LBS)	L* (LBS)	L/G* (LBS
20	1500	1259.6	4712.4	785.4
40	2100	1763.4	6597.3	1099.5

POOR ORIGINAL

* As defined on sheet B-8-2 of reference # 13

E. D. Motis

BABCOCK & WILCOX

DEPARTMENT

SMUD RAPID COOLDOWN

DATE BY

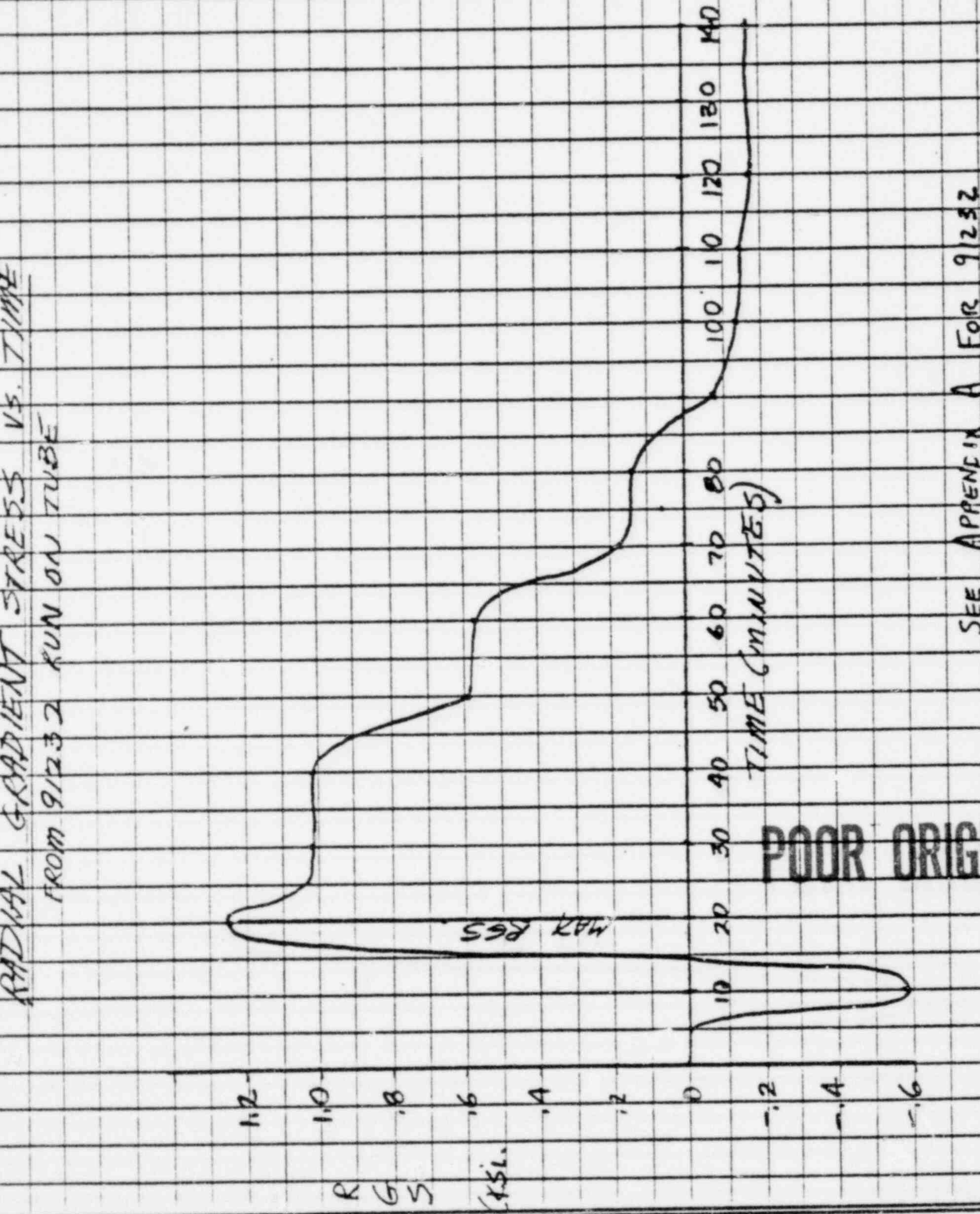
CHECKED DATE BY

JOB NO.

REVISION

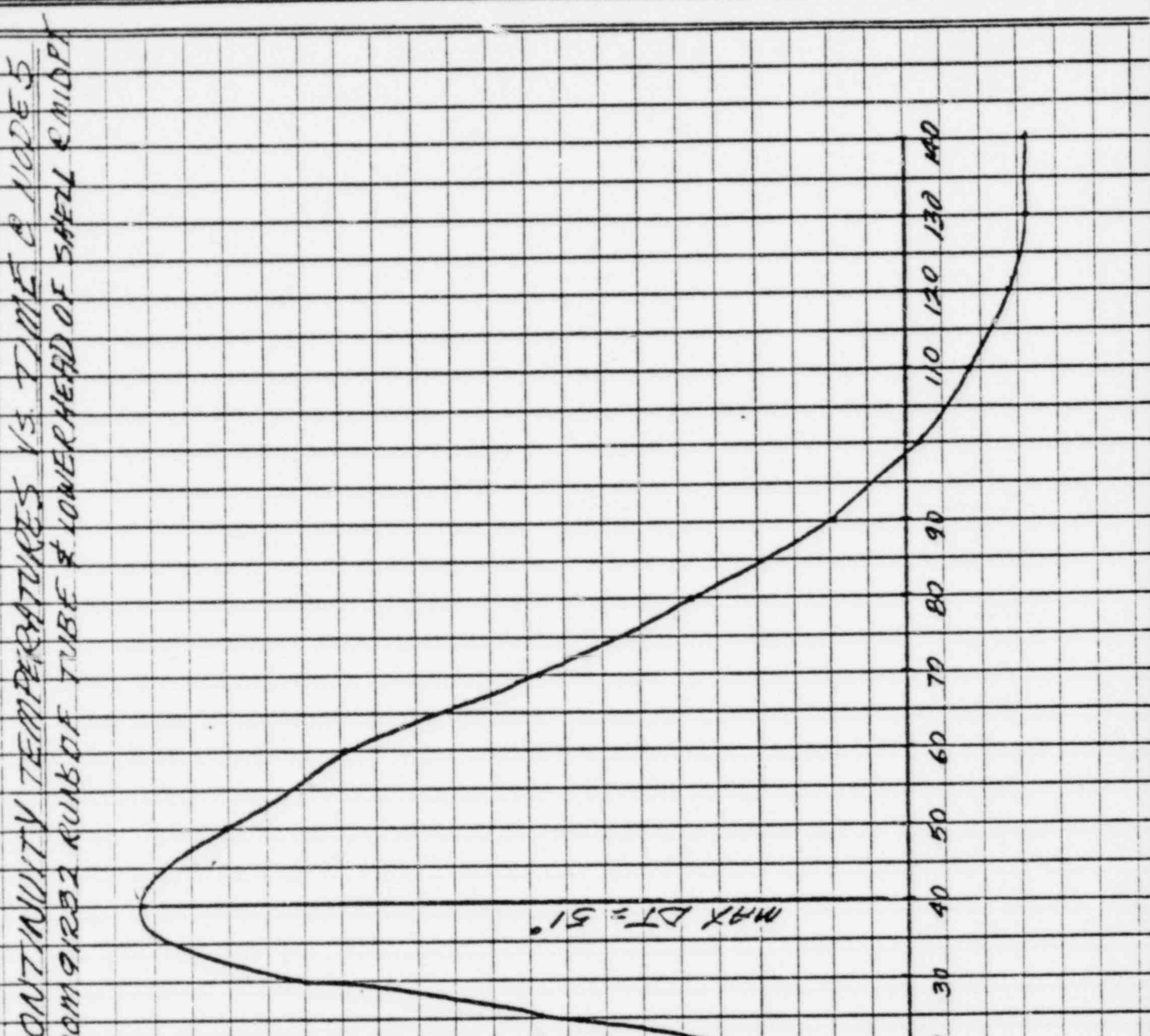
SHEET 15 OF

RMS 247-1



BABCOCK & WILCOX			REVISION
DEPARTMENT	DATE 4-78	BY F.L.B.	
SMUD COOLDOWN INCIDENT	CHECKED DATE	BY	
INSTRUMENTATION CALC.	JOB NO.		SHEET 16 OF

BMS 247-1



BABCOCK & WILCOX

DEPARTMENT

SMUD COOLDOWN INCIDENT

INSTRUMENTATION CALC.

DATE 4-78 BY F.L.B.

CHECKED DATE BY

JOB NO.

REVISION

SHEET 17 OF

MS 247-1

CALCULATION OF LOADS FOR 91206 RUN

COMPATIBILITY EQUATIONS PG. B-10-2 of ref.# 13

$$\delta_P^T + \delta_T^T + Q\left(\frac{\delta}{Q}\right)_T - M\left(\frac{\delta}{M}\right)_T = \delta_P^H + \delta_T^H - Q\left(\frac{\delta}{Q}\right)_H - M\left(\frac{\delta}{M}\right)_H$$

$$\theta_P^T + \theta_T^T + Q\left(\frac{\theta}{Q}\right)_T - M\left(\frac{\theta}{M}\right)_T = \theta_P^H + \theta_T^H + Q\left(\frac{\theta}{Q}\right)_H + M\left(\frac{\theta}{M}\right)_H$$

INFLUENCE COEFFICIENTS - AVE. OF COEF. OF PG. B-2-8 & B-2-12 of reference # 13

TUBE

$(\delta/Q)_T = .00909E-6$ $(\delta/M)_T = .00139E-6$

$(\theta/Q)_T = .00958E-6$ $(\theta/M)_T = .0745E-6$

HEAD

$(\delta/Q)_H = .0123E-6$ $(\delta/M)_H = .0106E-6$

$(\theta/Q)_H = .0106E-6$ $(\theta/M)_H = .0572E-6$

TUBE THERMAL DEFL. δ_T^T PG. B-7-2 of ref.# 13

$\delta_T^T = \alpha R \Delta T$ α @ TEMP OF NODE 5 OF TUBE 91232

$R = .7575''$ $\Delta T = T - 70$

ITER 20 (20 min.)

$\delta_T^T = 7.86E-6(.7575)(490)$ α @ $560° = 7.86E-6$ $\Delta T = 490°$

$= .00292$

POOR ORIGINAL

ITER 40 (40 MIN)

$\delta_T^T = 7.7E-6(.7575)(337) = .00197''$ α @ $407° = 7.7E-6$ $\Delta T = 337°$

BABCOCK & WILCOX	DATE 4-78 BY FLB	REVISION
DEPARTMENT TMI COOLDOWN INCIDENT	CHECKED DATE BY	
INSTRUMENTATION CALC.	JOB NO.	SHEET 18 OF

TUBE PRESSURE MOTIONS B-8-2 of ref. #13

$\delta_P^T = \delta_{PROGRAM}^{91206} \left(\frac{PRES}{1000}\right)\left(\frac{E@70°F}{E@TEMP}\right)$

$\theta_P^T = \theta_{PROGRAM}^{91206} \left(\frac{PRES}{1000}\right)\left(\frac{E@70°F}{E@TEMP}\right)$

ITER 20 P_i = 1500 PSI

E@70 = 31.42E+6

E@ 560 = 29.201E+6

δ^{91206} = 6.1378E-6 IN.

θ^{91206} = -35.674E-6 RAD.

$\delta_P^T = 6.1378E\text{-}6 (1.5)\left(\frac{31.42}{29.201}\right)$
= 9.906 E-6 IN.

$\theta_P^T = -35.674E\text{-}6 (1.5)\left(\frac{31.42}{29.201}\right)$
= -57.577 E-6 RAD

ITER 40 P_i = 2100 PSI

E@ 407 = 29.695E+6

$\delta_P^T = 6.1378E\text{-}6 (2.1)\left(\frac{31.42}{29.695}\right)$
= 13.638E-6 IN.

$\theta_P^T = -35.674E\text{-}6 (2.1)\left(\frac{31.42}{29.695}\right)$
= -79.267 E-6

HEAD MOTIONS DUE TO THERMAL + PRESSURE

USE 91206 RUN OF SHELL ANALYSIS FOR ITER 20 & 40

$\theta_P^H + \theta_T^H = \theta_{91206}^H$ @ SEG. 70 PG. B-8-14

$\delta_P^H + \delta_T^H = \delta_{91206}^H \left(\frac{R_2}{R_1}\right) - \theta_{91206}^H \left(\frac{t_H}{2}\right)$

(SEG. 70)

t_H = 5"

R_2 = .7575"

R_1 = .5175"

POOR ORIGINAL

BABCOCK & WILCOX		REVISION
DEPARTMENT	DATE 4-78 BY F.L.B.	
SMUD COOLDOWN INCIDENT	CHECKED DATE BY	
INSTRUMENTATION CALC.	JOB NO.	SHEET 19 OF

ITER 20

$\theta_P^H + \theta_T^H = -17.55E-6$ RAD.

$\delta_T^H + \delta_P^H = .2120E-2\left(\frac{.7575}{.5175}\right) - (-.1755E-4)(2.5)$
$= 3147.1E-6$ IN.

ITER 40

$\theta_P^H + \theta_T^H = -43.02E-6$ RAD.

$\delta_P^H + \delta_T^H = .1763E-2\left(\frac{.7575}{.5175}\right) - (-.4302E-4)(2.5)$
$= 2688.2E-6$ IN.

BY SUBSTITUTING ALL KNOWN VALUES INTO COMPATIBILITY EQUATIONS AND SOLVE SIMO. EQUATIONS. FOR M & Q.

$\delta^H = \delta^T \qquad \theta^H = \theta^T$

POOR ORIGINAL

ITER 20

$\delta_P^T + \delta_T^T + Q\left(\frac{\delta}{Q}\right)_T - M\left(\frac{\delta}{M}\right)_T = \delta_P^H - \delta_T^H - Q\left(\frac{\delta}{Q}\right)_H - M\left(\frac{\delta}{M}\right)_H$

$9.906E-6 + .00292 - Q(.00909E-6) - M(.00139E-6) = 3147.1E-6 - Q(.0123E-6) - M(.0106E-6)$

$Q(.02139E-6) + M(.00921E-6) = 217.2E-6$ (1)

$\theta_P^T + \theta_T^T + Q\left(\frac{\theta}{Q}\right)_T - M\left(\frac{\theta}{M}\right)_T = \theta_P^H + \theta_T^H + Q\left(\frac{\theta}{Q}\right)_H + M\left(\frac{\theta}{M}\right)_H$

$-57.577E-6 + Q(.00959E-6) - M(.0745E-6) = -17.55E-6 + Q(.0106E-6) + M(.0572E-6)$

$-Q(.00102E-6) - M(.1317E-6) = 40.027E-6$ (2)

ITER 20

SOLVE SIMO. EQU. 1 & 2 FOR M & Q

$Q(.02139E-6) + m(.00921E-6) = 217.2E-6$

MULT. BY $\frac{.02139}{.00702}$ $-Q(.02139E-6) - m(2.76183E-6) = 839.4E-6$

$-m(2.75262E-6) = 1056.6E-6$

$M = -383.9$

$Q(.02139E-6) = 217.2E-6 - (-383.9)(.00921E-6)$

$Q = 10319.6$

POOR ORIGINAL

ITER 40

$13.638E-6 + .00197 + Q(.00909E-6) - m(.00139E-6) = 2688.2E-6 - Q(.0123E-6) - m(.0106E-6)$

$Q(.02139E-6) + m(.00921E-6) = 704.6E-6$ (1)

$-79.267E-6 + Q(.00958E-6) - m(.0745E-6) = -43.02E-6 + Q(.0106E-6) + m(.0572E-6)$

$-Q(.00102E-6) - m(.1317E-6) = 36.247E-6$ (2)

SOLVE SIMO. EQU. 1 & 2 FOR M & Q

$Q(.02139E-6) + m(.00921E-6) = 704.6E-6$

MULT. BY $\frac{.02139}{.00782}$ $-Q(.02139E-6) - m(2.76183E-6) = 760.121E-6$

$-m(2.75262E-6) = 1464.721E-6$

$M = -532.1$

RMS 247-1

ITER 40

$Q(.02139E-6) = 704.6E-6 - (-532.1)(.00921E-6)$

$Q = 33169.7$

DISTRIBUTION OF M & Q LOADS ON WELD FOR 912(?)
REF. PG. B-10-6 SEG. 17→22 (ref. #13)

ITER 20

RATIO = 383.9/217.8 = 1.76263 Q_{LOAD} = Q/6

SEG.#	RAD LOAD	MOD. LOAD	Q LOAD	MOD Q LOAD
17	376.0	662.7	1719.9	2382.6
18	250.67	441.8	↓	2161.7
19	125.33	220.9		1940.8
20	-125.33	-220.9		1499.0
21	-250.67	-441.8		1278.1
22	-376.0	-662.7		1057.2

POOR ORIGINAL

ITER 40

RATIO = 532.1/217.8 = 2.44307

SEG.#	RAD LOAD	MOD. LOAD	Q LOAD	MOD Q LOAD
17	376.0	918.6	5528.3	6446.9
18	250.67	612.4	↓	6140.7
19	125.33	306.2		5834.5
20	125.33	-306.2		5222.1
21	250.67	-612.4		4915.9
22	376.0	-918.6		4609.7

BABCOCK & WILCOX
DEPARTMENT
SMUD RAPID COOLDOWN
DATE 4-78 BY F.L.B.
CHECKED DATE BY
JOB NO.
REVISION
SHEET 22 OF

σ_{P+S} determination

σ_{P+S} is obtained by combining P+S from the RCT with P+S from reference #13 (see sheet B-12-38 of reference #13). Segment 22 is the highest stressed location.

Maximum from 91206 combination = 54.2 ksi

P+S due to earthquake loads = ±3.0 ksi (See sheet B-12-43 of reference #13)

Total P+S = 54.2 + 6 = 60.2 ksi < $3S_m$ = 69 ksi

Fatigue Analysis

POOR ORIGINAL

— Peak earthquake intensity = 17.6 ksi (see sheet B-13-5 of ref #13)

$\sigma_{alt} = [\text{S.C.F.}\,(P+S) + (2)(17.6)][0.5]$

S.C.F. = 4.0 for weld (see discussion)

$$\sigma_{alt} = [(4.0)(60.2) + (2)(17.6)][0.5] = 138 \text{ ksi}$$

Allowable cycles = 300 from ref. #6, Fig I-9.2

Required cycles = 3

Usage factor = 3/300 = .01

Maximum usage factor from ref. # 13 for the weld = 0.57; therefore, maximum cumulative usage factor = 0.57 + 0.01 = 0.58 < 1.0 → acceptable

POOR ORIGINAL

A. D. McKIM

BABCOCK & WILCOX			REVISION
DEPARTMENT	DATE	BY	
SMUD RAPID COOLDOWN	CHECKED DATE	BY	
	JOB NO.		SHEET 24 OF

CRDM DISCUSSION

P + S STRESSES

In analyzing the instrumentation tubes it was determined the max P + S did not increase due to the RCT. Since the CRDM's and instrumentation tubes are thin tubes, in thick heads, it is felt that the CRDM's P + S similarly will not increase significantly.

PEAK STRESSES

Since this incident was a fast transient the only significant affect was on the peak stresses. The cumulative usage factor of the instrumentation tube weld increased from 0.57 to 0.58 (insignificant). By using the similarities of instrumentation tubes and CRDM's, the usage factor for the CRDM would not increase significantly.

<u>Closure Dome - Closure Flange</u>

<u>Analysis Discussion</u>

The analogy and description of the conservative method used to analyze the closure dome - closure flange juncture for P+ S and fatigue effects of the RCT are described below:

1.) Program 91232 (reference #3) is used to obtain the temperature distribution for the closure head dome and flange. A time-temperature graph of the mid-point temperatures is presented on sheet 26a.

2.) The maximum ΔT between the mid-point temperatures of the closure dome and flange is factored into the upper bound discontinuity stress equation, $1.83 E \alpha \Delta T$.

3.) The RGS is taken from Program 91323 (reference #3) at the time of analysis.

4.) By comparing the maximum intensities ranges in which a cooldown iteration contributes to the range (see sheet B-15-2 of reference #11), it was determined that the L-H inside intensity is the controlling intensity.

5.) (P+S) RCT is determined by conservatively adding the absolute values of σ_{disc}, RGS, and the intensity for iteration #1 (boltup + design pressure) in reference #11.

6.) The maximum σ_{P+S} is determined by adding $(P+S)^{RCT}$ To the L-H intensity from iteration 920.

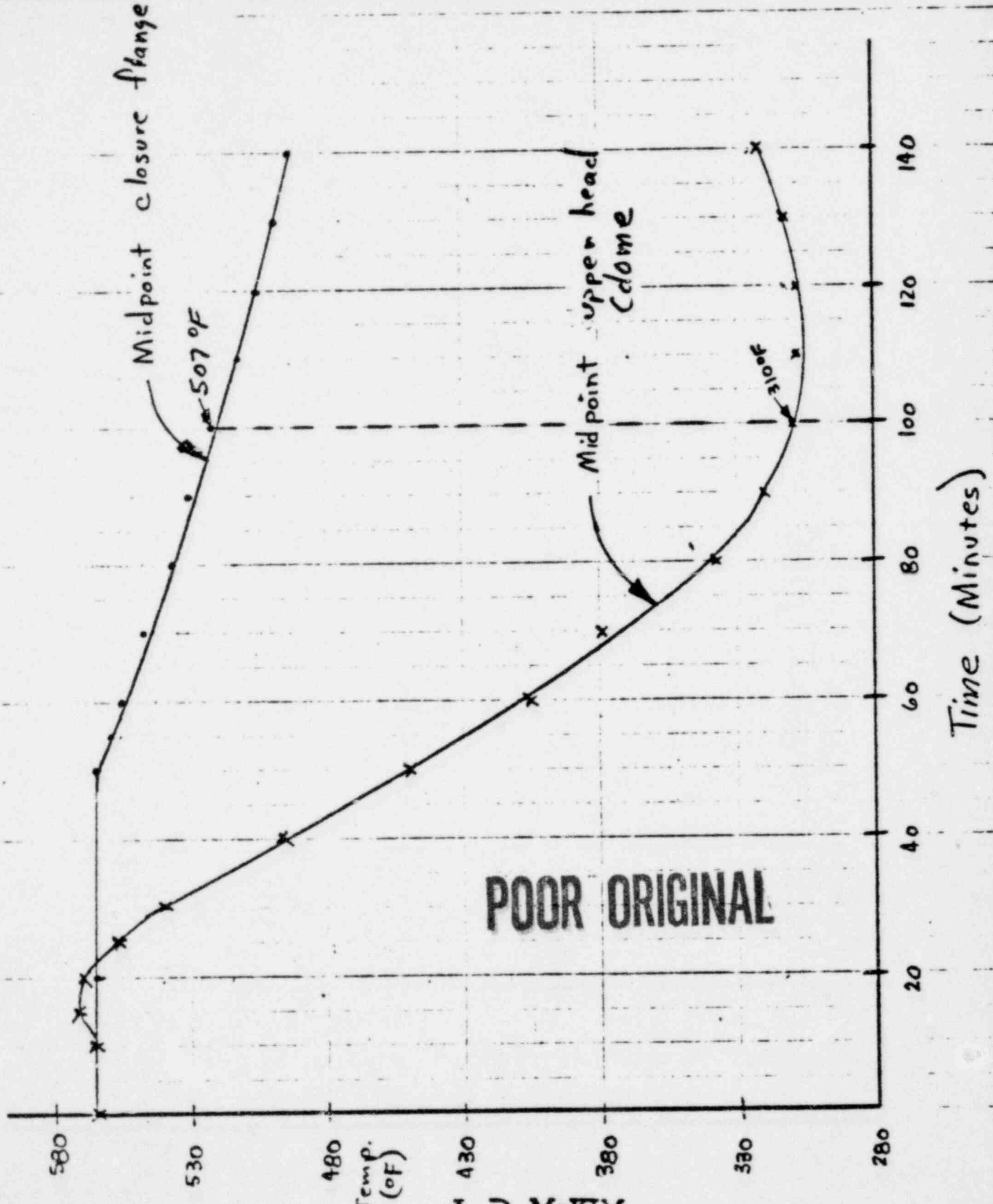
7.) σ^{therm}_{peak} is taken from Program 91232.

8.) Fatigue analysis is performed in accordance with reference #6.

The time in which the maximum RGS occurred for the closure flange and other intensities for the times analyzed in reference #11 were also considered, but yielded a smaller usage factor than the case analyzed.

SMUD RAPID COOLDOWN
A. D. McKIM

BMS 757-1



POOR ORIGINAL

A. D. McKIM

BABCOCK & WILCOX		REVISION
DEPARTMENT	DATE BY	
SMUD RAPID COOLDOWN	CHECKED DATE BY	
	JOB NO.	SHEET 26a OF

Closure Analysis

$\underline{\sigma_{DISC}^{RCT}} = 1.83 E \alpha \Delta T$ (reference #1)

$\Delta T = 197°F$ (See graph on sheet 26a)

$\alpha = 7.04 \times 10^{-6}$
$E = 27.91 \times 10^{6}$ } Mag Moly at 520°F

$\sigma_{DISC}^{RCT} = (1.83)(28.0 \times 10^{6})(7.40 \times 10^{-6})(197) = 74.7$ ksi

$\underline{\sigma_{RGS}^{RCT}} = 3.2$ ksi (from 91232 output for dome)

$\underline{\sigma_{BL+DP}}$: L-H intensity for bolt-up + design pressure

= -17.0 ksi (from sheet B-15-2 of reference #11)

$\underline{(P+S)^{RCT}} = |\sigma_{DISC}^{RCT}| + |\sigma_{RGS}^{RCT}| + |\sigma_{BL+DP}|$

$= 74.7 + 3.2 + 17 = 94.9$ ksi

$\underline{\sigma_{P+S}} = (P+S)^{RCT} + 8.8$*

POOR ORIGINAL

* 8.8 Is the L-H inside stress intensity for iteration 920 (see sheet B-15-2 of reference #11). This is to account for the stress reversal.

BABCOCK & WILCOX	A. D. McKIM	REVISION
DEPARTMENT	DATE BY	
SMUD RAPID COOLDOWN	CHECKED DATE BY	
	JOB NO.	SHEET 27 OF

Closure Analysis (Continued)

$\sigma_{P+S} = 94.9 + 8.8 = 103.7$ ksi $> 3S_m = 80.0$ ksi

The $3S_m$ limit is not met; therefore, the simplified elastic plastic analysis of NB-3228.3 in reference #6 is used for the fatigue analysis.

$\underline{\sigma_{Peak}} = {}^{\pm}S.C.F\,(\sigma_{P+S}) - \sigma_{RGS}^{RCT} + \sigma_{Peak}^{therm\ RCT}$

where: ${}^{\pm}$S.C.F. = 1.77 (See sheet B-16-1 of reference # 11)

$\sigma_{Peak}^{therm\ RCT} = 3.6$ ksi

$= (1.77)(103.7) - 3.2 + 3.6 = 183.9$ ksi

± For conservatism the maximum SCF at the juncture is used.

Fatigue Analysis

Reference #6 NB-3228.3 (a) requirement

$\sigma_{P+S} - {}^{*}\sigma_{DISC}^{RCT} = 103.7 - 74.7 = 29$ ksi $<< 3S_m$

* σ_{DISC}^{RCT} is a thermal bending stress as well as the RGS

POOR ORIGINAL

BABCOCK & WILCOX		REVISION
DEPARTMENT	DATE A. D. McKIM BY	
SMUD RAPID COOLDOWN	CHECKED DATE BY	
	JOB NO.	SHEET 28 OF

Closure Analysis (Continued)

Reference #6 NB-3228.3 (b) & (c) requirements

$$K_e = 1.0 + \frac{1-0.2}{0.2(2-1)}\left(\frac{103.7}{80} - 1.0\right)$$

$K_e = 2.185$

$\sigma_{alt} = (\sigma_{Peak})(K_e)(0.5)$

$\sigma_{alt} = (183.9)(2.185)(0.5) = 200.9$ ksi

Allowable cycles from Figure I-9-1 of reference #6 ≈ 100

Useage factor for 3 cycles of RCT = 3/100 = 0.03

Maximum usage factor from reference #11 (except studs) = 0.0343 (See sheet A-2 of reference #11)

Total cumulative usage factor is 0.0343 + 0.030 = 0.0643 < 1.0

POOR ORIGINAL

BABCOCK & WILCOX	... D. McK...		REVISION
DEPARTMENT	DATE	BY	
SMUD RAPID COOLDOWN	CHECKED DATE	BY	
	JOB NO.		SHEET 29 OF

Closure Analysis (Continued)

Reference #6 NB 3228.3 (d) requirement

Reference #6 NB 3222.5 a)

$x = \left(Pr_i/2t\right)/S_y$ where: $p = 2.500$ ksi, $r_1 = 87.25''$, $t = 6.5''$, $S_y = 41.4$ ksi

$$x = \frac{(2.5)(87.25)}{(2)(6.5)} \Big/ 41.4$$

$x = 0.405$

Case 2 of NB-3222.5 (a) applies because of the severe rate of cooldown

$y' = 3.55$; therefore, allowable range of thermal stress $= (3.55)(41.4) = 146.97$ ksi $> \sigma_{P+S}$ which includes pressure stresses

Thermal stress rachet criteria is met.

Reference #6 NB-3228.3 (e) & (f) requirement

Maximum temperature < 700°F

$\sigma_{yield} / \sigma_{tensile} \approx 50/80 = 0.625 < 0.8$

criterion met.

POOR ORIGINAL

Closure Studs

Discussion

From reference #11, sheet B-15-6 it can be seen that the times of maximum stress for the studs are heatup times. During a cooldown transient the studs are hotter than the flange; therefore, the net stud stresses are lower than the boltup stresses. Consequently, P+S and σ_{P+S} and σ_{peak} are not affected by the RCT.

SMUD RAPID COOLDOWN

A. D. McKIM

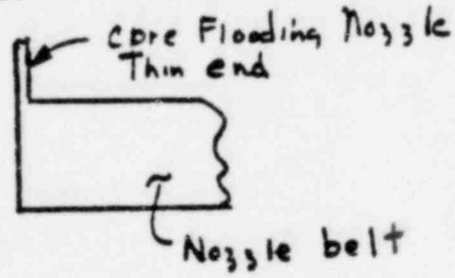
Nozzles - Nozzle Belt Analysis

Discussion

The analogy and description of the conservative method used to analyze the nozzles to nozzle belt for P+S and fatigue effects of the RCT are described below:

Analysis #1 (maximum discontinuity

1.) Program 91232 (reference #3) is used to obtain the temperature distribution for the thin mag moly end of the core flooding nozzle and the nozzle belt. A time-temperature graph of tne midpoint temperatures is presented on sheet 35.



The $\sigma_{disc.}$ resulting from this nozzle attachment conservatively represents all nozzles-nozzle belt attachments.

2.) The maximum Δ_T between the midpoint temperatures of the thin nozzle section and the nozzle belt section is factored into the upper bound discontinuity stress equation, 1.83 $E \alpha \Delta T$.

3.) The maximum RGS is taken from Program 91232 (reference 3) irregardless of time.

4.) The maximum $P_{\ell} + P_b$ from any nozzle at any location for seismic + thermal load + design pressure is used as the mechanical load P + S.

5.) The summation of the absolute values of 2), 3) and 4) is conservatively used as the P+S.

SMUD RAPID COOLDOW

A. D. McKIM

6.) The maximum P+S from program 91060 (reference #8 from reference #9 or #10 for any heatup iteration at any location is added to P+S of 5) to obtain σ_{P+S}.

7.) Maximum σ_{peak}^{therm} is taken from program 91232.

8.) Fatigue analysis is performed in accordace with reference #6 using the maximum S.C.F. of any nozzle.

<u>Analysis #2 (maximum RGS)</u>

1.) Program 91232 (reference #3) is used to obtain the maximum RGS in any nozzle. The thick portion of the outlet nozzle is used for this analysis.

2. σ_{disc} is determined by multiplying the σ_{disc} from analysis #1 by the ratio of the thickness squared of the thin core flooding nozzle to the thickness squared of the thick outlet nozzle. σ_{disc} is a bending stress determined by $6M/t^2$; therefore, the ratio above is correct assuming the ΔT between the thin thickness of nozzle and the thick thickness of nozzle is the same as the ΔT between the thin thickness of the nozzle and the nozzle belt.

3.) The maximum $P_\ell + P_b$ from any nozzle at any location for seismic + thermal load + design pressure is used as the mechanical load P+S.

4.) The summation of the absolute values of 1), 2), and 3) is conservatively used as the P+S.

5.) The maximum P+S from Program 91060 (reference #8 from reference #9 or #10 for any heatup iteration at any location is added to P+S of 5 to obtain σ_{P+S}.

6.) Maximum σ_{peak}^{therm} is taken from Program 91232.

7.) Fatigue analysis is performed in accordance with reference #6 using the maximum S.C.F. of any nozzle.

List of conservatisms in these analyses

1.) Geometries assumed are highly conservative from σ_{disc} standpoint.

2.) Time of maximum RGS is conservatively assumed to occur at the time σ_{disc} is the highest.

3.) Stress intensities are not kept separate when combining the different effects (RGS, σ_{disc}, P_e+P_b).

4.) The absolute values of RGS, σ_{disc}, and $P_\ell+P_b$ are used to obtain P+S.

5.) To obtain σ_{P+S} the maximum stress intensity from references 9 & 10 are used irregardless of sign or intensity to obtain P+S.

6.) The maximum SCF from any nozzle is used.

7.) The usage factor calculated is added to the maximum nozzle usage factor irregardless of nozzle or location.

SMUD RAPID COOLDOWN

A. D. McKIM

BWS 247-1

BABCOCK & WILCOX

DEPARTMENT

SMUD RAPID COOLDOWN

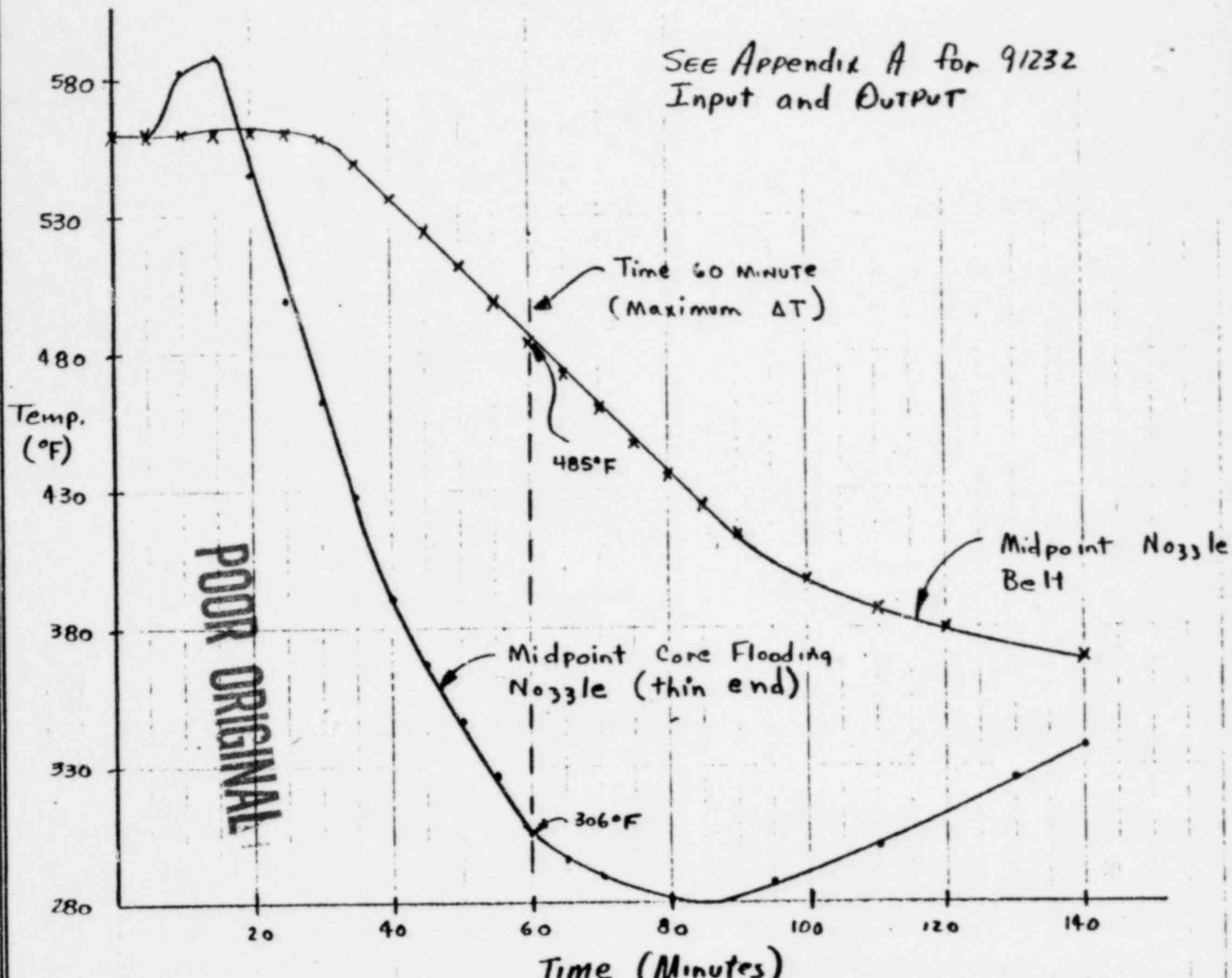
DATE - BY

CHECKED DATE BY

JOB NO.

REVISION

SHEET 35 OF



POOR ORIGINAL

BMS 7-1

Nozzle - Analysis #1

$\underline{\sigma_{DISC} \text{ for RCT} = \sigma_{DISC}^{RCT}}$

$\sigma_{DISC}^{RCT} = 1.83 E \alpha \Delta T$ (reference 1)

$\Delta T = 485 - 306 = 179°F$ (see graph on sheet 35)

$\alpha = 7.21 \times 10^{-6}$
$E = 29.036 \times 10^{6}$ > Mag Moly at 306°F (Code 12, reference #14)

$\sigma_{DISC}^{RCT} = (1.83)(29.036 \times 10^{6})(7.21 \times 10^{-6})(179)$

$\sigma_{DISC}^{RCT} = 68.6$ ksi

$\underline{\sigma_{RGS}^{RCT}} = 2.7$ ksi (from 91232 output for thin section)

$\underline{(P_\ell + P_b)}^{RCT} = 19.7$ksi (from sheet A-1-3 of reference #9)

$\underline{(P+S)}^{RCT} = |\sigma_{DISC}^{RCT}| + |\sigma_{RGS}^{RCT}| + |(P_\ell + P_b)^{RCT}|$

$= 68.6 + 2.7 + 19.7 = 91.0$ ksi

POOR ORIGINAL

BABCOCK & WILCOX	L. D. McKIM		REVISION
DEPARTMENT	DATE	BY	
SMUD RAPID COOLDOWN	CHECKED DATE	BY	
	JOB NO.		SHEET 36 OF

BMS 7-1

Nozzle - Analysis #1 (Continued)

$\underline{\sigma_{P+S}} = (P+S)^{RCT} + 30.1^{*}$

$= 91.0 + 30.1 = 121.1 \text{ ksi} > 3S_m = 80 \text{ ksi}$

* 30.1 ksi is the maximum P+S from program 91060 (reference 8) output in references #9 & #10. See sheet B-14-53 of reference #10 for the 30.1 ksi value.

The $3S_m$ limit is not met; therefore, the simplified elastic plastic analysis of NB-3228.3 in reference #6 is used for the fatigue analysis.

$\underline{\sigma'_{peak}} = S.C.F\,(\sigma_{P+S}) - \sigma^{RCT}_{RGS} + \sigma^{RCT\ therm}_{peak}$

where:

S.C.F. = 1.89 (The maximum S.C.F. from any nozzle. See sheet B-13-4 in reference #9 for 1.89 value)

$\sigma^{RCT\ therm}_{peak} = 3.7 \text{ ksi}$ (from 91232 of thin part)

$= (1.89)(121.1) - 2.7 + 3.7 = 229.8 \text{ ksi}$

POOR ORIGINAL

BABCOCK & WILCOX	DATE E. D. McF... BY	REVISION
DEPARTMENT SMUD RAPID COOLDOWN	CHECKED DATE BY	
	JOB NO.	SHEET 37 OF

Nozzle - Analysis #1 (Continued)

Fatigue Analysis

Reference #6 NB-3228.3 (a) requirement

$\sigma_{P+S} - {}^{*}\sigma_{DISC}^{RCT} = 121.1 - 68.6 = 52.5$ KSI < 80.0 KSI

* σ_{DISC}^{RCT} is a thermal bending stress as well as the RGS

Reference #6 NB-3228.3 (b)+(c) requirements

$$K_e = 1.0 + \frac{(1-0.2)}{0.2(2-1)}\left(\frac{121.1}{80.0} - 1\right)$$ for low alloy steel

$K_e = 3.06$

$\sigma_{alt} = (\sigma_{Peak})(K_e)(0.5)$

$\sigma_{alt} = (229.8)(3.06)(0.5) = 352$ ksi

Allowable cycles from Figure I-9-1 = 35

Usage Factor for 3 cycles of RCT = 3/35 = 0.086

POOR ORIGINAL

BABCOCK & WILCOX	L. D. McKIM	REVISION
DEPARTMENT SMUD RAPID COOLDOWN	DATE BY	
	CHECKED DATE BY	
	JOB NO.	SHEET 38 OF

BMS 7-1

Nozzle - Analysis #1 (Continued)

Maximum usage factor from references #9 and #10 = 0.35 (See sheet A-1-3 of reference #9)

Total cumulative usage factor is
$0.35 + 0.086 = 0.436 < 1.0$

Reference #6 NB-3228.3 (d) requirement

NB 3222.5 (a)

$X = \left(\frac{P r_i}{t}\right) / S_y$ where P = 2500 psi, r_i = 6.3125", t = 1.5", S_y = 41,400 psi at 650°F

$X = \left(\frac{(2500)(6.3125)}{1.5}\right) / 41{,}400$

$X = 0.254$

Case 2 of NB-3222.5 (a) applies because of the severe rate of cooldown

$y' = 4.65$; therefore allowable range of thermal stress = (4.65)(41,400) = 192,510 psi $> \sigma_{Pts}$ which includes pressure stresses

Thermal stress ratchet criteria is met.

POOR ORIGINAL

BABCOCK & WILCOX	... D. McK...		REVISION
DEPARTMENT	DATE	BY	
SMUD RAPID COOLDOWN	CHECKED DATE	BY	
	JOB NO.		SHEET 39 OF

BMS 7-1

Nozzle - Analysis #1 (Continued)

Reference #6 NB-3228.3(e) & (f) requirements

Maximum temperature < 700 °F

$(\sigma_{yield} / \sigma_{tensile}) = 50/80 = 0.625 < 0.8$

criterion met

POOR ORIGINAL

BABCOCK & WILCOX	L. D. McKIM		REVISION
DEPARTMENT	DATE	BY	
SMUD RAPID COOLDOWN	CHECKED DATE	BY	
	JOB NO.		SHEET 40 OF

Nozzle - Analysis #2

$\underline{\sigma_{DISC}^{RCT}} = (\sigma_{DISC}^{RCT}$ from analysis #1$) \times \frac{t^2_{thin}}{t^2_{thick}}$

where: σ_{DISC}^{RCT} from analysis #1 = 68.6 ksi (See Sheet 36)

$t^2_{thin} = 1.5^2 = 2.25 \text{ in}^2$

$t^2_{thick} = 11.6875^2 = 136.6 \text{ in}$ → conservatively use 100 in.^{2}

$\sigma_{DISC}^{RCT} = 68.6 \left(\frac{2.25}{100}\right) = 1.5$ ksi

$\underline{\sigma_{RGS}^{RCT}}$ = 40.3 ksi (from 91232 output for thick section)

$\underline{P_\ell + P_b}$ = 19.7 ksi (same as analysis 1)

$\underline{(P+S)^{RCT}} = |\sigma_{DISC}^{RCT}| + |\sigma_{RGS}^{RCT}| + (P_\ell + P_b)$

POOR ORIGINAL

$= 1.5 + 40.3 + 19.7 = 61.5$ ksi

$\underline{\sigma_{P+S}} = (P+S)^{RCT} + 30.1^*$ * Same as analysis 1

$= 61.5 + 30.1 = 91.6 \text{ ksi} > 3S_m = 80.0$ ksi

∴ elastic plastic analysis (ref. 6, NB3228.3) is performed

BABCOCK & WILCOX	E. D. McKIM	REVISION
DEPARTMENT SMUD RAPID COOLDOWN	DATE BY	
	CHECKED DATE BY	
	JOB NO.	SHEET 41 OF

Nozzle - Analysis #2

$$\underline{\sigma_{peak}} = S.C.F(\sigma_{P+S}) - \sigma_{RGS}^{RCT} + \sigma_{peak}^{RCT\ ther}$$

where: $S.C.F. = 1.89$ (Same as analysis 1)

$\sigma_{peak}^{RCT\ therm} = 64.3$ Ksi (from 91232 thick part)

$\sigma_{RGS}^{RCT} = 40.3$ ksi (from 91232 thin part)

$$\sigma_{peak} = (1.89)(91.6) - 40.3 + 64.3 = 197.1 \text{ ksi}$$

Fatigue Analysis

Reference #6 NB-3228.3 (a) requirement

$$\sigma_{P+S} - \overset{*}{\sigma}{}_{RGS}^{RCT} = 91.6 - 40.3 = 51.3 \text{ ksi} < 3S_m = 80 \text{ ksi}$$

* σ_{RGS}^{RCT} is a thermal bending stress

Reference #6 NB-3228.3 (b) & (c) requirements

$$K_e = 1.0 + \frac{(1-0.2)}{(0.2)(2-1)}\left(\frac{91.6}{80.0} - 1\right) \quad \text{for low alloy steel}$$

$$K_e = 1.58$$

POOR ORIGINAL

BABCOCK & WILCOX

DEPARTMENT SMUD RAPID COOLDOWN

DATE ... D. McKIM BY

CHECKED DATE BY

JOB NO.

REVISION

SHEET 42 OF

BMS 77-1

Nozzle - Analysis #2

$$\sigma_{alt} = (\sigma_{Peak})(K_e)(0.5)$$
$$= (197.1)(1.58)(0.5) = 155.7 \text{ ksi}$$

σ_{alt} for analysis 2 is less than σ_{alt} for case 1; therefore, case 2 cumulative usage factor is less. The remainder of the reference #6 NB 3228.3 requirements are also met for case 2

POOR ORIGINAL

BABCOCK & WILCOX		REVISION
DEPARTMENT	DATE L. D. McELM BY	
SMUD RAPID COOLDOWN	CHECKED DATE BY	
	JOB NO.	SHEET 43 OF

SUPPORT SKIRT ANALYSIS
DISCUSSION

The analogy and description of the conservative method used to analyze the support skirt for P+S and fatigue effects of the RCT are shown below:

1.) Juncture #1 of the 91206 model in reference #7 was determined to be the highest stressed juncture. This determination was made by comparing the stress intensity information shown on page B-16-38 through B-16-47 of reference #7. The maximum σ_{P+S} occurred at the inside (H-L) and was a combination of a heat-up iteration (iteration 5777) and a cooldown iteration (iteration 4709).

2.) The $\sigma_{Disc.}$ at juncture #1 for cooldown (iteration 4709) is determined by subtracting the pressure stress due to 175 psi pressure (pressure for this iteration) from the total stress. The pressure stress is determined by multiplying the hydrotest condition stress intensity by the ratio of the pressures (175/3125). This stress intensity is then subtracted from the stress intensity for iteration 4709 to obtain σ_{Disc}.

3.) σ_{Disc} for RCT is obtained by assuming the σ_{Disc} calculated in 2) above is due to the temperature differential between 91167 nodes 212 and 276 (See reference #7-Sheet B-4.2 for locations and B-7-10 for temperatures) and multiplying σ_{Disc} for iteration 4709. by ratios of the assumed ΔT for RCT (300°F) to this ΔT.

4.) The pressure stress intensity for RCT is obtained by multiplying the stress intensity for hydrotest times the ratio of pressure (2200/3125).

5.) The total P+S for RCT is then obtained by adding the values of the pressure stress, $\sigma_{Disc.}$, and the maximum $P_1 + P_b$ for dead weight plus OBE loads (See sheet B-16-/of reference 7).

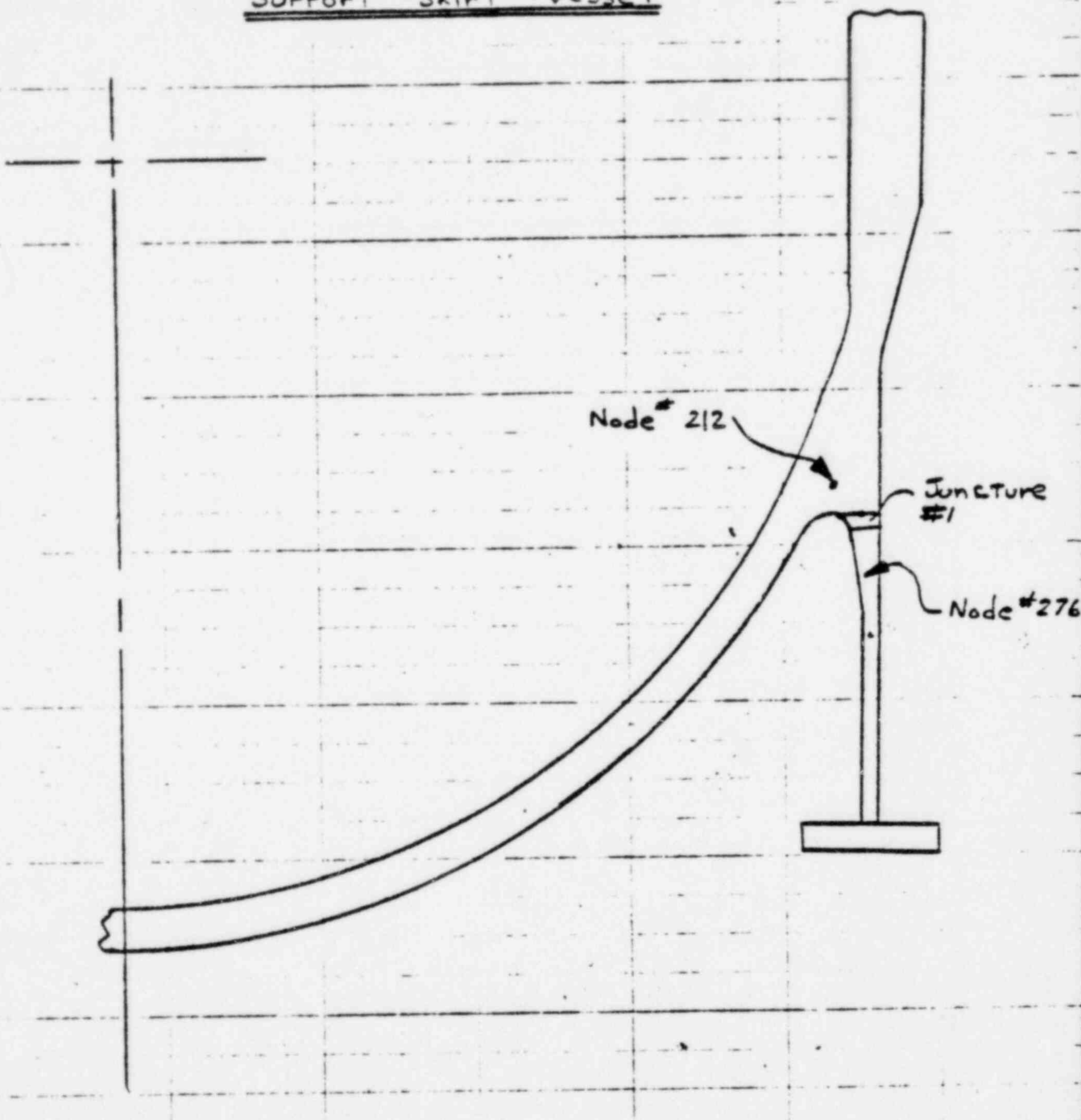
6.) The P+S in 5) above is then combined with P+S for other times (iterations) in the analysis to obtain the maximum σ_{P+S}.

7.) The fatigue analysis is performed assuming 3 cycles of RCT and following the method of reference 6.

A. D. McKIM

BMS 247-1

Support Skirt -Vessel



POOR ORIGINAL

BABCOCK & WILCOX	L. D. McPIM		REVISION
DEPARTMENT SMUD RAPID COOLDOWN	DATE	BY	
	CHECKED DATE	BY	
	JOB NO.		SHEET 45 OF

BMS 7-1

σ_{DISC} at juncture #1 for iteration 4709 = σ_{DISC}^{4709}

Following the method described in 2) of the Support Skirt Analysis Discussion

$$\sigma_{DISC} = -10.5 - {}^{175}/_{3125}\,(17.4) = -11.5 \text{ ksi}$$

σ_{DISC} for RCT = σ_{DISC}^{RCT}

Following the method outlined in 3) of the Support Skirt Analysis Discussion.

Temperature of mode 212 for iteration 4709 = 320 °F

Temperature of mode 276 for iteration 4709 = 373 °F

ΔT_{4709} = temperature differential between modes 211 and 373 = 53

$$\sigma_{DISC}^{RCT} = \frac{300}{53}\left(\sigma_{DISC}^{4709}\right) = \frac{300}{53}(-11.5) = -65.1 \text{ ksi}$$

POOR ORIGINAL

SMUD RAPID COOLDOWN

BABCOCK & WILCOX			REVISION
DEPARTMENT	DATE 5-1-78	BY ADM	
SUPPORT SKIRT	CHECKED DATE	BY	
ANALYSIS	JOB NO. SMUD		SHEET 46 OF

BMS 7-1

Pressure Stress for RCT = σ_p^{RCT}

Following the method described in 4) of the Support Skirt Analysis Discussion

$$\sigma_p^{RCT} = (2200/3125)(17.4) = 12.3 \text{ ksi}$$

P+S for RCT = $P+S^{RCT}$

$$P+S^{RCT} = -\sigma_{DISC}^{RCT} + \sigma_p^{RCT} - (P_\ell + P_b)^*$$

$$= -65.1 + 12.3 - 8.43 = -61.23 \text{ ksi}$$

σ_{P+S} for RCT and iteration

Maximum P+S for 3 cycles is $|P+S^{RCT}| + |P+S^{other\pm}| = 61.23 + 67.70 = 128.95$ ksi $> 3S_m = 80.0$ ksi

POOR ORIGINAL

± $P+S^{other}$ is the maximum intensity for other iterations (See sheet B-16-38 of reference #7 for value

* $P_\ell + P_b$ is the maximum intensity for OBE + dead weight (See sheet B-16-1 of reference #7)

BABCOCK & WILCOX DEPARTMENT SMUD RAPID COOLDOWN	DATE 5-1-78	BY ADM	REVISION
Support Skirt	CHECKED DATE	BY	
Analysis	JOB NO. SMUD		SHEET 47 OF

BMS 7-1

Fatigue Analysis

$\sigma_{P+S} > 3S_m$; Therefore, the simplified elastic plastic analysis of NB-3228.3 in reference 6 is used.

$$K_e = 1.0 + \frac{(1-n)}{(n)(m-1)}\left(\frac{S_n}{3S_m} - 1\right)$$

$n = 0.2$, $m = 2.0$, $S_n = \sigma_{P+S} = 107.23$, and $3S_m = 80.0$ for mag moly

$$K_e = 1.0 + \frac{(1-0.2)}{(0.2)(2-1)}\left(\frac{128.93}{80.0} - 1\right)$$

$$K_e = 3.447$$

$$\sigma_{alt} = (K_e)(SCF^*)(\sigma_{P+S})(0.5) = (3.447)(1.86)(128.93)(0.5)$$

$$\sigma_{alt} = 413.3 \text{ ksi}$$

Allowable cycle for a $\sigma_{alt} = 413.3 = 20$ from Figure I-9.1 of reference #6

Usage factor = 3/20 = 0.150. for RCT

Maximum usage factor from the results of reference #7 is .07

* SCF is from sheet 3-43-3 of reference #7.

BABCOCK & WILCOX		REVISION
DEPARTMENT SMUD RAPID COOLDOWN	DATE 5-2-78 BY ADM	
	CHECKED DATE BY	
	JOB NO.	SHEET 48 OF

Therefore, maximum cumulative usage factor is 0.150 + 0.07 = 0.22 < 1.0 → criteria of reference #6 is met

Note: Below is addtional requirements which must be met to use the simplified elastic plastic analysis of NB-3228.3 in reference 6.

3228.3 (a) - σ_{DISC}^{RCT} is a thermal bending stress.
$|\sigma_{Prs}| - |\sigma_{DISC}^{RCT}| = 128.93 - 65.1 = 63.83$ KSI $< 3S_m = 80$ KSI
∴ requirement is met.

3228.3 (d) - Does not apply since the support skirt does not experience any pressure general membrane stress

3228.3 (e) - Maximum temperature is less than 700°F

3228.3 (f) - For mag moly portion of support skirt, $\sigma_{ys}/\sigma_{ult} = 50/80 = .625 < 0.8$

BABCOCK & WILCOX DEPARTMENT SMUD RAPID COOLDOWN	DATE 5-2-78 BY ADM	REVISION
SUPPORT SKIRT	CHECKED DATE BY	
ANALYSIS	JOB NO. SMUD	SHEET 49 OF

Core Flooding Nozzle Venturi Discussion

The Core Flood Nozzle Venturi Sleeve is not analyzed in detail because reference #10 contains an evaluation of the core flood check valve transient which is more severe thermally that the RCT. The pressure during the RCT is higher than the check valve transients pressure, but pressure stresses in the venturi are insignificant when compared to the thermal stresses. See sheets D-85 through D-94 of reference # 10, for detailed primary plus secondary stresses and fatigue evaluation.

The fatigue analysis of reference # 10 would not be affected significantly by assuming three more cycles of the check valve transients to account for the three cycles of RCT.

SMUD RAPID COOLDOWN

A. D. McKIM

APPENDIX A

Computer Program | Page No.

1) 91232 - Nozzle Belt........ A-1 to A-8
2) 91232 - Shell........ A-9 to A-16
3) 91232 - Lower Head........ A-17 to A-24
4) 91206 - Nozzle Belt - Shell - Lower Head........ A-25 to A-39
5) 91232 - Instrumentation Tube........ A-40 to A-47
6) 91206 - Instrumentation Tube........ A-48 to A-61
7) 91232 - Upper Head (Closure Dome)........ A-62 to A-69
8) 91232 - Closure Flange........ A-70 to A-77
9) 91232 - Core Flooding Nozzle........ A-78 to A-85
10) 91232 - Outlet Nozzle........ A-86 to A-91

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION NOZZLE BELT DATE 04/18/78

DIMENSIONS

INSIDE RADIUS = 84.1875 INCHES OUTSIDE RADIUS = 96.1875 INCHES

NO. OF NODES = 9 RADIAL INCREMENT = 1.5000 INCHES

MATERIAL CODE = 12 POISSON S RATIO = .3000

L = -0.0000

INITIAL CONDITIONS

NODE	RADIUS	TEMPERATURE
1	84.1875	565.0
2	85.6875	565.0
3	87.1875	565.0
4	88.6875	565.0
5	90.1875	565.0
6	91.6875	565.0
7	93.1875	565.0
8	94.6875	565.0
9	96.1875	565.0

SMUD RAPID COOLDOWN

F. L. BOYER A-1

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION NOZZLE BELT DATE 04/18/78

TABULATION OF BOUNDARY CONDITIONS

FLUID TEMP. CURVE APPROXIMATION		FILM COEFF. CURVE APPROXIMATION		PRESSURE CURVE APPROXIMATION	
TIME (MINUTES)	INSIDE FLUID TEMPERATURE	TIME (MINUTES)	INSIDE FILM COEFFICIENT	TIME (MINUTES)	PRESSURE (PSI)
0.0000	565.0	0.0000	900.0	0.0000	0.
5.0000	565.0	140.0000	900.0	0.0000	0.
10.0000	590.0	0.0000	0.0	0.0000	0.
15.0000	590.0	0.0000	0.0	0.0000	0.
20.0000	525.0	0.0000	0.0	0.0000	0.
40.0000	380.0	0.0000	0.0	0.0000	0.
60.0000	300.0	0.0000	0.0	0.0000	0.
80.0000	280.0	0.0000	0.0	0.0000	0.
95.0000	290.0	0.0000	0.0	0.0000	0.
110.0000	305.0	0.0000	0.0	0.0000	0.
140.0000	340.0	0.0000	0.0	0.0000	0.

TEMPERATURE CALCULATION TIMES AND PRINTOUTS

TIME INCREMENT (MINUTES)	TIME LIMIT (MINUTES)	NUMBER OF PRINTOUTS
.5000	20.000	20.
.5000	80.000	120.
1.0000	140.000	60.

SMUD RAPID COOLDOWN

F. L. BOYER A-2

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION NOZZLE BELT DATE 04/18/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
1.0000		0.	-0.	-0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
2.0000		0.	-0.	0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
3.0000		-0.	-0.	0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
4.0000		0.	-0.	-0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
5.0000		0.	-0.	-0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
6.0000		-175.	-965.	60.	558.4	565.4	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
7.0000		-491.	-2111.	190.	572.8	566.7	565.3	565.0	565.0	565.0	565.0	565.0	565.0		
8.0000		-889.	-3270.	339.	577.3	569.6	565.9	565.2	565.0	565.0	565.0	565.0	565.0		
9.0000		-1346.	-4414.	532.	581.8	570.9	566.7	565.4	565.1	565.0	565.0	565.0	565.0		
10.0000		-1649.	-5544.	754.	586.4	573.4	567.9	565.9	565.2	565.1	565.0	565.0	565.0		
11.0000		-2211.	-5714.	941.	587.6	575.7	569.2	566.4	565.4	565.1	565.0	565.0	565.0		
12.0000		-2461.	-5645.	1032.	587.9	577.3	570.4	567.1	565.7	565.2	565.1	565.0	565.0		
13.0000		-2652.	-5569.	1223.	588.1	578.4	571.6	567.8	566.1	565.4	565.1	565.0	565.0		
14.0000		-2802.	-5491.	1340.	588.2	579.3	572.6	568.5	566.4	565.5	565.2	565.1	565.0		
15.0000		-2923.	-5413.	1445.	588.4	580.0	573.4	569.2	566.9	565.7	565.3	565.1	565.1		
16.0000		-2567.	-2881.	1383.	579.6	579.4	574.1	569.8	567.3	566.0	565.4	565.2	565.1		
17.0000		-1823.	229.	1137.	568.3	575.5	574.0	570.3	567.7	566.2	565.5	565.2	565.1		
18.0000		-851.	3317.	817.	556.7	572.0	573.1	570.5	568.1	566.5	565.7	565.3	565.2		
19.0000		290.	6357.	331.	545.0	566.5	571.4	570.4	568.3	566.8	565.8	565.4	565.3		
20.0000		1561.	9377.	-138.	533.1	560.3	568.9	569.8	568.4	567.0	566.0	565.5	565.4		
20.5000		2169.	10427.	-404.	528.6	557.0	567.5	569.3	568.3	567.0	566.1	565.6	565.4		
21.0000		2734.	11253.	-664.	525.0	553.9	565.9	568.8	568.3	567.1	566.2	565.7	565.5		
21.5000		3285.	12049.	-925.	521.5	551.0	564.2	568.1	568.1	567.1	566.2	565.7	565.6		
22.0000		3828.	12835.	-1190.	518.0	549.1	562.6	567.4	567.9	567.1	566.3	565.8	565.6		
22.5000		4364.	13613.	-1458.	514.5	545.4	560.8	566.6	567.6	567.1	566.3	565.8	565.7		
23.0000		4895.	14384.	-1730.	511.0	542.7	559.1	565.7	567.3	567.0	566.4	565.9	565.7		
23.5000		5424.	15149.	-2007.	507.5	540.0	557.4	564.8	567.0	567.0	566.4	566.0	565.8		
24.0000		5950.	15908.	-2288.	504.1	537.3	555.6	563.8	566.6	566.8	566.4	566.0	565.8		
24.5000		6474.	16651.	-2574.	500.6	534.7	553.8	562.8	566.1	566.7	566.4	566.0	565.9		
25.0000		6997.	17408.	-2863.	497.1	532.0	552.0	561.8	565.6	566.5	566.4	566.1	565.9		
25.5000		7519.	18150.	-3156.	493.7	529.4	550.2	560.7	565.1	566.3	566.3	566.1	566.0		
26.0000		8040.	18887.	-3453.	490.2	526.8	548.4	559.6	564.5	566.1	566.3	566.1	566.0		
26.5000		8560.	19619.	-3753.	486.7	524.1	546.5	558.5	563.9	565.8	566.2	566.1	566.1		
27.0000		9079.	20346.	-4055.	483.3	521.5	544.7	557.3	563.3	565.5	566.1	566.1	566.1		
27.5000		9598.	21068.	-4351.	479.8	518.8	542.8	556.1	562.6	565.2	566.0	566.1	566.1		
28.0000		10115.	21785.	-4669.	476.3	516.1	540.9	554.9	561.9	564.9	565.9	566.1	566.1		
28.5000		10631.	22498.	-4978.	472.9	513.5	539.0	553.7	561.2	564.5	565.7	566.0	566.1		
29.0000		11147.	23205.	-5290.	469.4	510.8	537.1	552.4	560.4	564.1	565.6	566.0	566.1		
29.5000		11661.	23909.	-5603.	465.9	508.1	535.1	551.1	559.6	563.7	565.4	565.9	566.0		

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION NOZZLE BELT . DATE 04/18/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
30.0000		12174.	24607.	-5917.	462.5	505.4	533.2	549.8	558.8	563.3	565.2	565.8	566.0		
30.5000		12685.	25301.	-6233.	459.0	502.7	531.2	548.4	558.0	562.8	564.9	565.7	565.9		
31.0000		13196.	25990.	-6549.	455.5	500.0	529.2	547.1	557.2	562.3	564.7	565.6	565.8		
31.5000		13705.	26675.	-6857.	452.0	497.3	527.2	545.7	556.3	561.8	564.4	565.5	565.8		
32.0000		14213.	27356.	-7195.	448.6	494.5	525.2	544.3	555.4	561.3	564.1	565.3	565.7		
32.5000		14719.	28032.	-7503.	445.1	491.8	523.1	542.9	554.5	560.7	563.8	565.2	565.5		
33.0000		15224.	28704.	-7822.	441.6	489.1	521.1	541.4	553.5	560.2	563.5	565.0	565.4		
33.5000		15727.	29372.	-8140.	438.1	486.3	519.0	540.0	552.5	559.6	563.2	564.8	565.2		
34.0000		16228.	30035.	-8459.	434.6	483.5	516.9	538.5	551.6	559.0	562.8	564.6	565.1		
34.5000		16728.	30695.	-8778.	431.2	480.8	514.8	537.0	550.5	558.3	562.4	564.3	564.9		
35.0000		17226.	31350.	-9076.	427.7	478.0	512.7	535.5	549.5	557.7	562.0	564.1	564.7		
35.5000		17722.	32001.	-9415.	424.2	475.2	510.6	533.9	548.5	557.0	561.6	563.8	564.5		
36.0000		18216.	32647.	-9732.	420.7	472.4	508.5	532.4	547.4	556.3	561.2	563.5	564.2		
36.5000		18709.	33290.	-10050.	417.2	469.6	506.3	530.8	546.3	555.6	560.7	563.2	564.0		
37.0000		19199.	33929.	-10366.	413.7	466.8	504.1	529.2	545.2	554.8	560.3	562.9	563.7		
37.5000		19687.	34563.	-10633.	410.2	464.0	502.0	527.6	544.1	554.1	559.8	562.6	563.4		
38.0000		20173.	35194.	-10978.	406.7	461.2	499.8	526.0	542.9	553.3	559.2	562.2	563.1		
38.5000		20657.	35821.	-11313.	403.2	458.3	497.6	524.3	541.8	552.5	558.7	561.8	562.8		
39.0000		21139.	36443.	-11626.	399.7	455.5	495.4	522.7	540.6	551.7	558.2	561.4	562.4		
39.5000		21619.	37062.	-11939.	396.2	452.7	493.1	521.0	539.4	550.9	557.6	561.0	562.1		
40.0000		22095.	37677.	-12251.	392.7	449.8	490.9	519.3	538.2	550.0	557.0	560.6	561.7		
40.5000		22531.	38035.	-12549.	390.1	447.0	488.6	517.6	536.9	549.2	556.4	560.1	[illegible]		
41.0000		22927.	38271.	-12831.	388.0	444.4	486.4	515.9	535.7	548.3	555.8	559.7	[illegible]		
41.5000		23300.	38494.	-13104.	385.9	441.9	[illegible]	514.2	534.4	547.4	555.1	559.2	560.4		
42.0000		23655.	38713.	-13358.	383.8	439.5	482.0	512.5	533.1	546.5	554.5	558.7	560.0		
42.5000		23994.	38930.	-13623.	381.8	437.2	479.9	510.8	531.8	545.5	553.8	558.1	559.5		
43.0000		24319.	39145.	-13872.	379.7	435.0	477.8	509.0	530.5	544.6	553.1	557.6	559.0		
43.5000		24632.	39359.	-14114.	377.7	432.8	475.8	507.3	529.2	543.6	552.4	557.0	558.5		
44.0000		24934.	39571.	-14349.	375.7	430.7	473.8	505.6	527.9	542.6	551.6	556.5	558.0		
44.5000		25227.	39782.	-14578.	373.7	428.6	471.8	504.0	526.6	541.6	550.9	555.9	557.4		
45.0000		25510.	39992.	-14802.	371.7	426.6	469.9	502.3	525.2	540.6	550.1	555.2	556.8		
45.5000		25785.	40201.	-15019.	369.7	424.5	468.0	500.6	523.9	539.6	549.3	554.6	556.2		
46.0000		26052.	40409.	-15232.	367.7	422.5	466.1	499.0	522.6	538.5	548.5	553.9	555.6		
46.5000		26313.	40615.	-15439.	365.7	420.5	464.2	497.4	521.2	537.5	547.7	553.3	555.0		
47.0000		26565.	40821.	-15640.	363.7	418.6	462.4	495.7	519.9	536.4	546.9	552.6	554.4		
47.5000		26813.	41026.	-15837.	361.7	416.6	460.5	494.1	518.5	535.3	546.0	551.9	553.7		
48.0000		27055.	41230.	-16029.	359.7	414.7	458.7	492.5	517.2	534.3	545.2	551.2	553.1		
48.5000		27291.	41433.	-16217.	357.7	412.8	456.9	490.9	515.9	533.2	544.3	550.4	552.4		
49.0000		27521.	41634.	-16400.	355.7	410.8	455.1	489.3	514.5	532.1	543.4	549.7	551.6		
49.5000		27747.	41835.	-16579.	353.7	408.9	453.4	487.8	513.2	531.0	542.5	548.9	550.9		

SMUD RAPID COOLDOWN

F. L. BOYER

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION NOZZLE BELT DATE 04/18/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
50.0000		27968.	42035.	-16753.	351.7	407.0	451.6	486.2	511.8	529.9	541.6	548.1	550.2		
50.5000		28185.	42233.	-16924.	349.8	405.2	449.9	484.6	510.5	528.8	540.7	547.3	549.4		
51.0000		28398.	42431.	-17091.	347.8	403.3	448.1	483.1	509.2	527.6	539.7	546.5	548.7		
51.5000		28606.	42628.	-17254.	345.9	401.4	446.4	481.5	507.8	526.5	538.8	545.7	547.9		
52.0000		28811.	42823.	-17413.	343.8	399.5	444.7	480.0	506.5	525.4	537.8	544.8	547.1		
52.5000		29012.	43017.	-17569.	341.9	397.7	442.9	478.4	505.1	524.2	536.9	544.0	546.2		
53.0000		29207.	43211.	-17722.	339.9	395.8	441.2	476.9	503.8	523.1	535.9	543.1	545.4		
53.5000		29404.	43403.	-17872.	337.9	394.0	439.5	475.4	502.5	521.9	534.9	542.2	544.6		
54.0000		29595.	43594.	-18018.	335.9	392.1	437.8	473.8	501.1	520.8	533.9	541.3	543.7		
54.5000		29783.	43785.	-18162.	333.9	390.3	436.1	472.3	499.8	519.6	532.9	540.4	542.8		
55.0000		29969.	43974.	-18303.	332.0	388.4	434.4	470.8	498.4	518.5	531.9	539.5	541.9		
55.5000		30150.	44162.	-18441.	[illegible]	386.6	432.7	469.2	497.1	517.3	530.8	538.6	541.0		
56.0000		30330.	44348.	-18576.	328.0	384.7	431.0	467.7	495.8	516.1	529.8	537.6	540.1		
56.5000		30507.	44534.	-18709.	326.0	382.9	429.3	466.2	494.4	514.9	528.8	536.7	539.2		
57.0000		30682.	44719.	-18840.	324.1	381.1	427.7	464.7	493.1	513.7	527.7	535.7	538.3		
57.5000		30854.	44902.	-18958.	322.1	379.2	426.0	463.2	491.7	512.6	526.6	534.7	537.3		
58.0000		31024.	45085.	-19074.	320.1	377.4	424.3	461.6	490.4	511.4	525.6	533.7	536.4		
58.5000		31191.	45266.	-19218.	318.2	375.6	422.6	460.1	489.0	510.2	524.5	532.7	535.4		
59.0000		31357.	45446.	-19340.	316.2	373.7	420.9	459.6	487.6	508.9	523.4	531.7	534.4		
59.5000		31520.	45625.	-19460.	314.2	371.9	419.3	457.1	486.3	507.7	522.3	530.7	533.4		
60.0000		31682.	45803.	-19578.	312.3	370.1	417.6	455.6	484.9	506.5	521.2	529.7	532.4		
60.5000		31803.	45743.	-19691.	311.1	368.3	415.9	454.0	483.6	505.3	520.1	528.7	531.4		
61.0000		31889.	45573.	-19770.	310.6	366.7	414.3	452.5	482.2	504.1	519.0	527.6	530.4		
61.5000		31953.	45395.	-19848.	309.7	365.2	412.6	451.0	480.8	502.8	517.9	526.6	529.4		
62.0000		32000.	45216.	-19918.	309.1	363.9	411.1	449.5	479.4	501.6	516.7	525.5	528.4		
62.5000		32033.	45038.	-19930.	308.4	362.6	409.5	448.0	478.1	500.3	515.6	524.4	527.3		
63.0000		32054.	44850.	-20034.	307.8	361.4	408.1	446.6	476.7	499.1	514.4	523.3	526.3		
63.5000		32064.	44684.	-20092.	307.2	360.3	406.7	445.1	475.3	497.9	513.3	522.3	525.2		
64.0000		32064.	44508.	-20124.	306.6	359.2	405.3	443.7	474.0	496.6	512.1	521.2	524.1		
64.5000		32056.	44334.	-20150.	306.0	358.1	404.0	442.3	472.6	495.3	511.0	520.1	523.0		
65.0000		32041.	44161.	-20190.	305.4	357.1	402.7	440.9	471.3	494.1	509.8	519.0	521.9		
65.5000		32019.	43989.	-20215.	304.9	356.1	401.4	439.5	470.0	492.8	508.6	517.8	520.9		
66.0000		31990.	43818.	-20235.	304.3	355.1	400.2	438.2	468.6	491.6	507.4	516.7	519.7		
66.5000		31955.	43649.	-20250.	303.7	354.2	399.0	436.9	467.3	490.3	506.3	515.6	518.6		
67.0000		31917.	43482.	-20260.	303.1	353.2	397.8	435.6	466.0	489.1	505.1	514.4	517.5		
67.5000		31873.	43315.	-20266.	302.6	352.3	396.6	434.3	464.7	487.8	503.9	513.3	516.4		
68.0000		31824.	43150.	-20268.	302.0	351.4	395.5	433.1	463.4	486.6	502.7	512.2	515.3		
68.5000		31771.	42986.	-20266.	301.4	350.5	394.4	431.8	462.2	485.3	501.5	511.0	514.1		
69.0000		31715.	42823.	-20260.	300.9	349.7	393.3	430.6	[illegible]	484.1	500.3	509.8	513.0		
69.5000		31655.	42662.	-20250.	300.3	348.8	392.2	429.4	459.7	482.9	499.1	508.7	511.8		

SMUD RAPID COOLDOWN

F. L. BOYER

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION NOZZLE BELT DATE 04/18/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
70.0000		31593.	42502.	-20237.	299.8	349.0	391.2	428.2	458.4	481.6	497.9	507.5	510.7		
70.5000		31527.	42343.	-20221.	299.2	347.2	390.1	427.0	457.2	480.4	496.7	506.3	509.5		
71.0000		31459.	42185.	-20202.	298.6	346.3	389.1	425.9	456.0	479.2	495.5	505.2	508.3		
71.5000		31397.	42029.	-20179.	298.1	345.5	388.1	424.7	454.8	478.0	494.3	504.0	507.2		
72.0000		31314.	41873.	-20154.	297.5	344.7	387.1	423.6	453.6	476.7	493.1	502.8	506.0		
72.5000		31239.	41719.	-20127.	297.0	343.9	386.1	422.4	452.4	475.5	491.9	501.6	504.8		
73.0000		31161.	41565.	-20097.	296.5	343.2	385.1	421.3	451.2	474.3	490.7	500.4	503.6		
73.5000		31082.	41413.	-20065.	295.9	342.4	384.1	420.2	450.0	473.1	489.5	499.3	502.5		
74.0000		31002.	41262.	-20030.	295.4	341.6	383.2	419.1	448.8	471.9	488.3	498.1	501.3		
74.5000		30919.	41112.	-19994.	294.8	340.8	382.2	418.1	447.7	470.7	487.1	496.9	500.1		
75.0000		30836.	40963.	-19955.	294.3	340.1	381.3	417.0	446.5	469.6	485.9	495.7	498.9		
75.5000		30751.	40815.	-19915.	293.7	339.3	380.4	415.9	445.4	468.4	484.7	494.5	497.7		
76.0000		30665.	40667.	-19873.	293.2	338.6	379.4	414.9	444.2	467.2	483.5	493.3	496.5		
76.5000		30578.	40521.	-19830.	292.7	337.8	378.5	413.8	443.1	466.0	482.4	492.1	495.3		
77.0000		30490.	40376.	-19785.	292.1	337.1	377.6	412.8	442.0	464.9	481.2	490.9	494.1		
77.5000		30402.	40232.	-19739.	291.6	336.4	376.7	411.7	440.9	463.7	480.0	489.7	493.0		
78.0000		30312.	40089.	-19692.	291.0	335.6	375.8	410.7	439.8	462.5	478.8	488.5	491.8		
78.5000		30222.	39946.	-19643.	290.5	334.9	374.9	409.7	438.7	461.4	477.6	487.3	490.6		
79.0000		30131.	39805.	-19594.	290.0	334.2	374.0	408.7	437.6	460.2	476.4	486.2	489.4		
79.5000		30040.	39664.	-19543.	289.4	333.5	373.2	407.7	436.5	459.1	475.3	485.0	488.2		
80.0000		29948.	39525.	-19492.	288.9	332.8	372.3	406.7	435.4	457.9	474.1	483.8	487.0		
81.0000		29701.	38920.	-19355.	289.0	331.5	370.6	404.7	433.2	455.7	471.8	481.4	484.6		
82.0000		29403.	38254.	-19214.	289.4	330.6	369.0	402.8	431.1	453.4	469.4	479.1	482.3		
83.0000		29077.	37595.	-19045.	289.8	329.8	367.5	400.9	429.0	451.2	467.1	476.7	479.9		
84.0000		28730.	36944.	-18866.	290.3	329.2	366.1	399.1	426.9	449.0	464.8	474.4	477.5		
85.0000		28367.	36302.	-18673.	290.7	328.7	364.9	397.4	424.9	446.8	462.5	472.0	475.2		
86.0000		27993.	35668.	-18470.	291.2	328.3	363.7	395.7	422.9	444.6	460.3	469.7	472.8		
87.0000		27610.	35043.	-18259.	291.7	327.9	362.6	394.1	421.0	442.5	458.0	467.4	470.5		
88.0000		27220.	34427.	-18039.	292.2	327.6	361.6	392.6	419.1	440.4	455.8	465.1	468.2		
89.0000		26824.	33819.	-17813.	292.7	327.3	360.7	391.1	417.3	438.3	453.6	462.8	465.9		
90.0000		26425.	33219.	-17581.	293.2	327.1	359.8	389.7	415.5	436.2	451.4	460.5	463.6		
91.0000		26023.	32628.	-17344.	293.8	326.9	358.9	388.3	413.7	434.2	449.2	458.3	461.3		
92.0000		25619.	32044.	-17103.	294.3	326.7	358.1	387.0	412.0	432.3	447.1	456.1	459.1		
93.0000		25215.	31468.	-16858.	294.8	326.5	357.3	385.7	410.4	430.3	445.0	453.9	456.8		
94.0000		24810.	30900.	-16610.	295.4	326.4	356.6	384.5	408.7	428.4	442.9	451.7	454.6		
95.0000		24406.	30339.	-16361.	295.9	326.3	355.9	383.3	407.1	426.6	440.8	449.5	452.4		
96.0000		23991.	29719.	-16105.	296.7	326.2	355.2	382.1	405.6	424.7	438.8	447.4	450.3		
97.0000		23567.	29094.	-15845.	297.5	326.2	354.6	381.0	404.1	422.9	436.8	445.3	448.1		
98.0000		231[illegible]9.	28477.	-15581.	298.4	326.3	354.0	379.9	402.6	421.2	434.8	443.2	446.0		
99.0000		22710.	27868.	-15315.	299.2	326.4	353.5	378.9	401.2	419.4	432.9	441.2	443.9		

SMUD RAPID COOLDOWN

F. L. BOYER A-6

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION NOZZLE BELT DATE 04/18/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
100.0000		22280.	27268.	-15047.	300.1	326.6	353.0	377.9	399.8	417.7	431.0	439.1	441.9		
101.0000		21851.	26675.	-14777.	300.9	326.8	352.6	376.9	398.4	416.1	429.1	437.1	439.8		
102.0000		21423.	26089.	-14507.	301.8	326.9	352.2	376.0	397.1	414.6	427.3	435.2	437.8		
103.0000		20997.	25512.	-14237.	302.7	327.2	351.8	375.1	395.8	412.8	425.5	433.2	435.8		
104.0000		20573.	24942.	-13967.	303.5	327.4	351.5	374.2	394.5	411.3	423.7	431.3	433.9		
105.0000		20152.	24380.	-13697.	304.4	327.6	351.1	373.4	393.3	409.7	421.9	429.4	432.0		
106.0000		19734.	23825.	-13428.	305.3	327.9	350.8	372.6	392.1	408.2	420.2	427.6	430.1		
107.0000		19319.	23277.	-13160.	306.2	328.2	350.6	371.9	390.9	406.8	418.5	425.8	428.2		
108.0000		18907.	22736.	-12894.	307.1	328.5	350.3	371.2	389.8	405.3	416.9	424.0	426.4		
109.0000		18499.	22203.	-12629.	307.9	328.8	350.1	370.5	388.7	403.9	415.3	422.3	424.6		
110.0000		18095.	21676.	-12355.	308.8	329.1	349.9	369.8	387.7	402.5	413.7	420.5	422.8		
111.0000		17688.	21123.	-12101.	309.8	329.5	349.7	369.1	386.6	401.2	412.1	418.8	421.1		
112.0000		17280.	20571.	-11838.	310.9	329.9	349.5	368.5	385.6	399.9	410.6	417.2	419.4		
113.0000		16874.	20026.	-11574.	311.9	330.3	349.4	367.9	384.6	398.6	409.1	415.6	417.7		
114.0000		16470.	19488.	-11312.	313.0	330.7	349.3	367.4	383.7	397.4	407.6	414.0	416.1		
115.0000		16069.	18956.	-11052.	314.0	331.2	349.2	366.8	382.8	396.1	406.2	412.4	414.5		
116.0000		15670.	18432.	-10793.	315.1	331.7	349.2	366.3	381.9	395.0	404.8	410.9	412.9		
117.0000		15275.	17915.	-10535.	316.1	332.1	349.2	365.8	381.0	393.8	403.4	409.4	411.4		
118.0000		14884.	17405.	-10280.	317.2	332.7	349.1	365.4	380.2	392.7	402.1	407.9	409.9		
119.0000		14497.	16901.	-10026.	318.2	333.2	349.2	364.9	379.4	391.6	400.8	406.5	408.4		
120.0000		14113.	16404.	-9775.	319.3	333.7	349.2	364.5	378.6	390.5	399.5	405.1	406.9		
121.0000		13733.	15913.	-9525.	320.4	334.2	349.2	364.2	377.9	389.5	398.2	403.7	405.5		
122.0000		13353.	15429.	-9278.	321.4	334.8	349.3	363.8	377.1	388.5	397.0	402.3	404.1		
123.0000		12986.	14951.	-9034.	322.5	335.3	349.4	363.5	376.5	387.5	395.8	401.0	402.8		
124.0000		12619.	14480.	-8791.	323.6	335.9	349.5	363.1	375.8	386.5	394.7	399.8	401.5		
125.0000		12255.	14015.	-8552.	324.6	336.5	349.6	362.9	375.1	385.6	393.6	398.5	400.2		
126.0000		11897.	13555.	-8314.	325.7	337.1	349.8	362.6	374.5	384.7	392.5	397.3	398.9		
127.0000		11543.	13102.	-8080.	326.8	337.7	349.9	362.3	373.9	383.8	391.4	396.1	397.7		
128.0000		11193.	12655.	-7848.	327.8	338.3	350.1	362.1	373.4	383.0	390.3	394.9	396.5		
129.0000		10846.	12214.	-7618.	328.9	338.9	350.2	361.9	372.8	382.2	389.3	393.8	395.3		
130.0000		10505.	11778.	-7392.	330.0	339.5	350.4	361.7	372.3	381.4	388.3	392.7	394.2		
131.0000		10167.	11349.	-7167.	331.1	340.1	350.6	361.5	371.8	380.6	387.4	391.6	393.1		
132.0000		9834.	10925.	-6946.	332.2	340.8	350.9	361.4	371.3	379.9	386.5	390.6	392.0		
133.0000		9504.	10506.	-6727.	333.2	341.4	351.1	361.2	370.8	379.2	385.6	389.6	390.9		
134.0000		9179.	10093.	-6511.	334.3	342.1	351.3	361.1	370.4	378.5	384.7	388.6	389.9		
135.0000		8859.	9686.	-6298.	335.4	342.7	351.6	361.0	370.0	377.8	383.8	387.6	388.9		
136.0000		8542.	9283.	-6087.	336.5	343.4	351.9	360.9	369.6	377.2	383.0	386.7	387.9		
137.0000		8229.	8886.	-5879.	337.6	344.1	352.2	360.8	369.2	376.6	382.2	385.8	387.0		
138.0000		7920.	8495.	-5673.	338.7	344.7	352.5	360.8	368.9	376.0	381.4	384.9	386.1		
139.0000		7615.	8108.	-5470.	339.7	345.4	352.8	360.8	368.6	375.4	380.7	384.0	385.2		

SMUD RAPID COOLDOWN

F. L. BOYER

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION NOZZLE BELT DATE 04/18/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
140.0000		7314.	7727.	-5270.	340.8	346.1	353.1	360.7	368.2	374.9	380.0	383.2	384.3		

SMUD RAPID COOLDOWN

F. L. BOYER A-S

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION SHELL DATE 04/20/78

DIMENSIONS

INSIDE RADIUS = 85.6875 INCHES OUTSIDE RADIUS = 94.2500 INCHES

NO. OF NODES = 9 RADIAL INCREMENT = 1.0703 INCHES

MATERIAL CODE = 2 POISSON S RATIO = .3000

L = -0.0000

INITIAL CONDITIONS

NODE	RADIUS	TEMPERATURE
1	85.6875	565.0
2	86.7578	565.0
3	87.8281	565.0
4	88.8984	565.0
5	89.9688	565.0
6	91.0391	565.0
7	92.1094	565.0
8	93.1797	565.0
9	94.2500	565.0

SMUD RAPID COOLDOWN

F. L. BOYER A-9

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION SHELL DATE 04/20/78

TABULATION OF
BOUNDARY CONDITIONS

FLUID TEMP. CURVE APPROXIMATION TIME (MINUTES)	INSIDE FLUID TEMPERATURE	FILM COEFF. CURVE APPROXIMATION TIME (MINUTES)	INSIDE FILM COEFFICIENT	PRESSURE CURVE APPROXIMATION TIME (MINUTES)	PRESSURE (PSI)
0.0000	565.0	0.0000	900.0	0.0000	0.
5.0000	565.0	140.0000	900.0	0.0000	0.
10.0000	590.0	0.0000	0.0	0.0000	0.
15.0000	590.0	0.0000	0.0	0.0000	0.
20.0000	525.0	0.0000	0.0	0.0000	0.
40.0000	380.0	0.0000	0.0	0.0000	0.
60.0000	300.0	0.0000	0.0	0.0000	0.
80.0000	280.0	0.0000	0.0	0.0000	0.
95.0000	290.0	0.0000	0.0	0.0000	0.
110.0000	305.0	0.0000	0.0	0.0000	0.
140.0000	340.0	0.0000	0.0	0.0000	0.

TEMPERATURE CALCULATION TIMES AND PRINTOUTS

TIME INCREMENT (MINUTES)	TIME LIMIT (MINUTES)	NUMBER OF PRINTOUTS
.5000	20.000	20.
.5000	80.000	120.
1.0000	140.000	60.

SMUD-RAPID COOLDOWN

F. L. BOYER

A-10

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION SHELL DATE 04/20/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
1.0000		0.	-0.	-0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
2.0000		0.	-0.	-0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
3.0000		0.	-0.	-0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
4.0000		0.	-0.	-0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
5.0000		0.	-0.	-0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
6.0000		-217.	-911.	81.	568.5	565.8	565.2	565.0	565.0	565.0	565.0	565.0	565.0		
7.0000		-613.	-1949.	248.	572.8	567.8	565.9	565.2	565.1	565.0	565.0	565.0	565.0		
8.0000		-1098.	-2968.	474.	577.2	570.4	567.1	565.8	565.2	565.1	565.0	565.0	565.0		
9.0000		-1639.	-3963.	744.	581.7	573.3	568.8	566.6	565.6	565.2	565.1	565.0	565.0		
10.0000		-2215.	-4931.	1052.	586.3	576.4	57[illegible]	567.6	566.1	565.5	565.2	565.1	565.0		
11.0000		-2597.	-4962.	1305.	587.4	578.9	57[illegible]	568.9	566.9	565.8	565.3	565.2	565.1		
12.0000		-2813.	-4840.	1476.	587.7	580.3	574.3	570.2	567.7	566.3	565.6	565.3	565.2		
13.0000		-2945.	-4710.	1642.	588.0	581.2	575.5	571.3	568.6	566.9	565.9	565.5	565.4		
14.0000		-3021.	-4591.	1752.	588.1	581.9	576.5	572.3	569.4	567.5	566.3	565.8	565.6		
15.0000		-3059.	-4455.	1830.	588.3	582.4	577.3	573.2	570.2	568.1	566.8	566.1	565.9		
16.0000		-2505.	-1964.	1671.	579.2	580.8	577.6	573.9	570.9	568.7	567.3	566.5	566.3		
17.0000		-1467.	855.	1259.	568.1	575.9	576.3	574.0	571.4	569.2	567.8	566.9	566.7		
18.0000		-179.	3621.	696.	556.7	569.6	573.6	573.3	571.5	569.7	568.2	567.4	567.1		
19.0000		1268.	6316.	-10.	545.1	562.3	569.7	571.7	571.2	569.9	568.6	567.8	567.5		
20.0000		2817.	8935.	-822.	533.3	554.4	565.1	569.4	570.3	569.8	568.9	568.2	568.0		
20.5000		3531.	9762.	-1231.	529.0	550.5	562.6	568.0	569.7	569.6	568.9	568.3	568.1		
21.0000		4179.	10433.	-1623.	525.4	547.0	560.0	566.5	568.9	569.3	568.9	568.5	568.3		
21.5000		4789.	11081.	-2008.	521.9	543.8	557.5	564.9	568.1	569.0	568.9	568.6	568.4		
22.0000		5373.	11715.	-2397.	518.4	540.7	555.1	563.3	567.1	568.5	568.8	568.6	568.5		
22.5000		5936.	12337.	-2760.	514.9	537.7	552.7	561.6	566.1	568.0	568.6	568.6	568.6		
23.0000		6481.	12949.	-3127.	511.4	534.7	550.3	559.9	565.1	567.5	568.4	568.6	568.6		
23.5000		7011.	13551.	-3497.	507.9	531.7	548.0	558.2	564.0	566.9	568.1	568.5	568.5		
24.0000		7529.	14144.	-3842.	504.5	528.8	545.7	556.5	562.8	566.2	567.7	568.3	568.4		
24.5000		8032.	14729.	-4190.	501.0	525.9	543.3	554.8	561.7	565.5	567.3	568.1	568.3		
25.0000		8525.	15305.	-4531.	497.6	523.0	541.0	553.0	560.4	564.7	566.9	567.9	568.1		
25.5000		9009.	15873.	-4855.	494.1	520.1	538.7	551.2	559.2	563.9	566.4	567.6	567.9		
26.0000		9482.	16432.	-5193.	490.7	517.2	536.4	549.5	557.9	563.0	565.8	567.2	567.6		
26.5000		9946.	16984.	-5515.	487.2	514.3	534.0	547.7	556.6	562.1	565.3	566.8	567.3		
27.0000		10402.	17529.	-5830.	483.8	511.4	531.7	545.8	555.3	561.2	564.6	566.4	566.9		
27.5000		10850.	18065.	-6140.	480.3	508.5	529.3	544.0	553.9	560.2	563.9	565.9	566.5		
28.0000		11289.	18594.	-6443.	476.9	505.6	527.0	542.2	552.5	559.2	563.2	565.3	566.0		
28.5000		11721.	19116.	-6741.	473.4	502.7	524.6	540.3	551.1	558.2	562.5	564.7	565.4		
29.0000		12145.	19630.	-7034.	469.9	499.8	522.2	538.4	549.8	557.1	561.7	564.1	564.9		
29.5000		12564.	20136.	-7322.	466.5	496.9	519.8	536.5	548.2	556.0	560.8	563.4	564.2		

SMUD RAPID COOLDOWN

F. L BOYER

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION SHELL DATE 04/20/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
30.0000		12975.	20636.	-7604.	463.0	494.0	517.4	534.5	546.6	554.8	559.9	562.7	563.6		
30.5000		13379.	21128.	-7892.	459.6	491.0	514.9	532.6	545.1	553.6	559.0	561.9	562.9		
31.0000		13777.	21613.	-8154.	456.1	488.1	512.5	530.6	543.5	552.4	558.0	561.1	562.1		
31.5000		14169.	22092.	-8423.	452.6	485.1	510.0	528.5	542.0	551.1	557.0	560.3	561.3		
32.0000		14554.	22563.	-8697.	449.2	482.2	507.6	526.6	540.3	549.9	556.0	559.4	560.5		
32.5000		14934.	23028.	-8946.	445.7	479.2	505.1	524.5	538.7	548.5	554.9	558.5	559.6		
33.0000		15307.	23485.	-9202.	442.3	476.2	502.6	522.5	537.0	547.2	553.8	557.5	558.7		
33.5000		15675.	23936.	-9453.	438.8	473.2	500.1	520.4	535.3	545.8	552.7	556.5	557.8		
34.0000		16037.	24381.	-9700.	435.3	470.2	497.5	518.3	533.6	544.4	551.5	555.5	556.8		
34.5000		16394.	24819.	-9944.	431.8	467.2	495.0	516.2	531.8	542.9	550.3	554.4	555.7		
35.0000		16745.	25250.	-10183.	428.4	464.2	492.4	514.0	530.1	541.5	549.0	553.3	554.7		
35.5000		17091.	25675.	-10419.	424.9	461.2	489.8	511.9	528.3	540.0	547.7	552.1	553.6		
36.0000		17432.	26093.	-10652.	421.4	458.2	487.3	509.7	526.4	538.4	546.4	550.9	552.4		
36.5000		17767.	26506.	-10890.	417.9	455.1	484.7	507.5	524.6	536.9	545.1	549.7	551.2		
37.0000		18098.	26912.	-11106.	414.4	452.1	482.0	505.2	522.7	535.3	543.7	548.5	550.0		
37.5000		18423.	27312.	-11327.	411.0	449.1	479.4	503.0	520.8	533.6	542.2	547.2	548.8		
38.0000		18744.	27706.	-11546.	407.5	446.0	476.8	500.7	518.9	532.0	540.8	545.9	547.5		
38.5000		19059.	28094.	-11761.	404.0	442.9	474.1	498.4	516.9	530.3	539.3	544.5	546.2		
39.0000		19370.	28475.	-11972.	400.5	439.9	471.4	496.1	514.9	528.6	537.8	543.1	544.8		
39.5000		19676.	28851.	-12181.	397.0	436.8	468.7	493.8	512.9	526.8	536.3	541.7	543.5		
40.0000		19977.	29222.	-12396.	393.5	433.7	466.0	491.5	510.9	525.1	534.7	540.2	542.0		
40.5000		20224.	29328.	-12571.	391.0	430.7	463.3	489.1	508.8	523.3	533.1	538.7	540.6		
41.0000		20421.	29355.	-12733.	388.8	428.0	460.7	486.8	506.8	521.5	531.5	537.2	539.1		
41.5000		20589.	29374.	-12879.	386.7	425.5	458.2	484.4	504.7	519.6	529.8	535.7	537.6		
42.0000		20731.	29391.	-13011.	384.6	423.1	455.7	482.1	502.6	517.8	528.1	534.1	536.1		
42.5000		20856.	29405.	-13130.	382.5	420.8	453.3	479.8	500.5	515.9	526.4	532.5	534.5		
43.0000		20965.	29418.	-13238.	380.5	418.6	451.0	477.6	498.4	514.0	524.6	530.8	532.9		
43.5000		21062.	29430.	-13336.	378.4	416.4	448.7	475.4	496.4	512.1	522.9	529.2	531.2		
44.0000		21147.	29442.	-13424.	376.4	414.2	446.5	473.2	494.3	510.1	521.1	527.5	529.6		
44.5000		21222.	29453.	-13503.	374.4	412.1	444.3	471.0	492.2	508.2	519.3	525.8	527.9		
45.0000		21290.	29464.	-13575.	372.3	409.9	442.2	468.9	490.2	506.3	517.5	524.0	526.2		
45.5000		21350.	29474.	-13639.	370.3	407.8	440.0	466.8	488.2	504.4	515.7	522.3	524.5		
46.0000		21403.	29484.	-13696.	368.3	405.8	437.9	464.7	486.1	502.4	513.9	520.5	522.7		
46.5000		21451.	29493.	-13748.	366.3	403.7	435.8	462.6	484.1	500.5	512.0	518.7	520.9		
47.0000		21494.	29502.	-13794.	364.3	401.6	433.7	460.6	482.1	498.6	510.1	516.9	519.1		
47.5000		21532.	29510.	-13835.	362.3	399.6	431.7	458.5	480.1	496.6	508.2	515.1	517.3		
48.0000		21566.	29518.	-13872.	360.2	397.5	429.6	456.5	478.1	494.7	506.4	513.2	515.5		
48.5000		21597.	29525.	-13905.	358.2	395.5	427.6	454.4	476.1	492.8	504.5	511.4	513.7		
49.0000		21625.	29532.	-13935.	356.2	393.5	425.5	452.4	474.1	490.8	502.6	509.5	511.8		
49.5000		21649.	29538.	-13961.	354.2	391.4	423.5	450.4	472.2	488.9	500.7	507.7	510.0		

SMUD RAPID COOLDOWN

F. L. BOYER

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION SHELL

DATE 04/20/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
50.0000		21672.	29544.	-13985.	352.2	389.4	421.5	448.4	470.2	486.9	498.8	505.8	508.1		
50.5000		21692.	29549.	-14006.	350.2	387.4	419.4	446.4	468.2	485.0	496.9	503.9	506.2		
51.0000		21707.	29554.	-14025.	348.2	385.4	417.4	444.4	466.2	483.0	494.9	502.0	504.3		
51.5000		21726.	29558.	-14042.	346.2	383.4	415.4	442.4	464.2	481.1	493.0	500.1	502.5		
52.0000		21740.	29562.	-14057.	344.2	381.4	413.4	440.4	462.3	479.1	491.1	498.2	500.6		
52.5000		21753.	29565.	-14071.	342.2	379.4	411.4	438.4	460.3	477.2	489.2	496.3	498.6		
53.0000		21764.	29568.	-14083.	340.2	377.4	409.4	436.4	458.3	475.2	487.2	494.4	496.7		
53.5000		21774.	29570.	-14094.	338.2	375.3	407.4	434.4	456.3	473.3	485.3	492.4	494.8		
54.0000		21783.	29572.	-14103.	336.2	373.3	405.4	432.4	454.3	471.3	483.3	490.5	492.9		
54.5000		21791.	29573.	-14112.	334.2	371.3	403.4	430.4	452.4	469.3	481.4	488.6	490.9		
55.0000		21799.	29574.	-14120.	332.3	369.3	401.4	428.4	450.4	467.4	479.4	486.6	489.0		
55.5000		21804.	29574.	-14126.	330.3	367.3	399.4	426.4	448.4	465.4	477.5	484.7	487.1		
56.0000		21807.	29574.	-14132.	328.3	365.3	397.4	424.4	446.4	463.4	475.5	482.7	485.1		
56.5000		21813.	29573.	-14137.	326.3	363.3	395.4	422.4	444.4	461.5	473.6	480.8	483.2		
57.0000		21817.	29571.	-14141.	324.3	361.3	393.4	420.4	442.5	459.5	471.6	478.8	481.2		
57.5000		21819.	29569.	-14145.	322.3	359.3	391.4	418.4	440.5	457.5	469.6	476.9	479.3		
58.0000		21822.	29567.	-14148.	320.3	357.3	389.4	416.4	438.5	455.5	467.7	474.9	477.3		
58.5000		21823.	29564.	-14151.	318.3	355.3	387.4	414.4	436.5	453.6	465.7	472.9	475.3		
59.0000		21824.	29561.	-14153.	316.3	353.3	385.4	412.5	434.5	451.6	463.7	471.0	473.4		
59.5000		21824.	29557.	-14155.	314.3	351.3	383.4	410.5	432.5	449.6	461.7	469.0	471.4		
60.0000		21824.	29553.	-14156.	312.3	349.3	381.4	408.5	430.5	447.6	459.8	467.0	469.4		
60.5000		21777.	29310.	-14140.	311.2	347.5	379.6	406.5	428.5	445.6	457.8	465.[illegible]	467.4		
61.0000		21689.	29002.	-14106.	310.4	345.9	377.5	404.5	426.5	443.6	455.8	463.1	465.5		
61.5000		21574.	28692.	-14050.	309.7	344.4	375.7	402.5	424.6	441.6	453.8	461.1	463.5		
62.0000		21443.	28383.	-14002.	309.0	343.1	374.0	400.6	422.6	439.7	451.8	459.1	461.5		
62.5000		21298.	28078.	-13935.	308.3	341.9	372.4	398.8	420.6	437.7	449.8	457.1	459.5		
63.0000		21142.	27776.	-13861.	307.6	340.7	370.8	397.0	418.7	435.7	447.8	455.1	457.5		
63.5000		20979.	27478.	-13790.	307.0	339.6	369.3	395.2	416.8	433.7	445.9	453.1	455.5		
64.0000		20809.	27184.	-13691.	306.3	339.5	367.8	393.5	415.0	431.8	443.9	451.1	453.5		
64.5000		20634.	26894.	-13598.	305.7	337.4	366.4	391.8	413.1	429.9	441.9	449.1	451.5		
65.0000		20455.	26608.	-13499.	305.1	336.4	365.0	390.2	411.3	428.0	440.0	447.2	449.5		
65.5000		20273.	26326.	-13396.	304.5	335.4	363.7	388.6	409.5	426.1	438.0	445.2	447.6		
66.0000		20088.	26048.	-13299.	303.8	334.4	362.4	387.0	407.8	424.2	436.1	443.2	445.6		
66.5000		19902.	25774.	-13179.	303.2	333.4	361.1	385.5	406.0	422.4	434.1	441.2	443.6		
67.0000		19715.	25503.	-13057.	302.5	332.5	359.8	384.0	404.3	420.5	432.2	439.3	441.6		
67.5000		19527.	25236.	-12953.	302.0	331.5	358.6	382.5	402.7	418.7	430.3	437.4	439.7		
68.0000		19339.	24974.	-12837.	301.4	330.6	357.3	331.0	401.0	416.9	428.5	435.4	437.8		
68.5000		19151.	24714.	-12720.	300.8	329.7	356.1	379.5	399.4	415.1	426.6	433.5	435.8		
69.0000		18964.	24458.	-12602.	300.2	328.8	354.9	378.1	397.7	413.4	424.7	431.6	433.9		
69.5000		18777.	24206.	-12483.	299.6	327.9	353.8	376.7	396.1	411.6	422.9	429.7	432.0		

SMUD RAPID COOLDOWN
F. L BOYER

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION SHELL DATE 04/20/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
70.0000		18592.	23957.	-12364.	299.0	327.0	352.6	375.3	394.6	409.9	421.1	427.8	430.1		
70.5000		18407.	23712.	-12245.	298.4	326.1	351.5	373.9	393.0	408.2	419.3	426.0	428.2		
71.0000		18224.	23470.	-12127.	297.8	325.2	350.3	372.6	391.4	406.5	417.5	424.1	426.3		
71.5000		18042.	23232.	-12009.	297.3	324.4	349.2	371.2	389.9	404.8	415.7	422.3	424.5		
72.0000		17861.	22996.	-11890.	296.7	323.5	348.1	369.9	388.4	403.2	413.9	420.5	422.6		
72.5000		17683.	22764.	-11773.	296.1	322.7	347.0	368.6	386.9	401.5	412.2	418.7	420.8		
73.0000		17506.	22535.	-11657.	295.5	321.8	345.9	367.3	385.4	399.9	410.5	416.9	419.0		
73.5000		17331.	22309.	-11541.	294.9	321.0	344.8	366.0	383.9	398.3	408.8	415.1	417.2		
74.0000		17157.	22086.	-11426.	294.3	320.1	343.8	364.7	382.5	396.7	407.1	413.3	415.4		
74.5000		16986.	21867.	-11312.	293.8	319.3	342.7	363.4	381.0	395.1	405.4	411.6	413.7		
75.0000		16816.	21650.	-11199.	293.2	318.5	341.7	362.2	379.6	393.6	403.7	409.9	411.9		
75.5000		16649.	21436.	-11088.	292.6	317.7	340.6	360.9	378.2	392.0	402.1	408.2	410.2		
76.0000		16483.	21225.	-10977.	292.0	316.9	339.6	359.7	376.8	390.5	400.4	406.5	408.5		
76.5000		16319.	21018.	-10858.	291.5	316.1	338.6	358.5	375.4	388.9	398.8	404.8	406.8		
77.0000		16158.	20812.	-10760.	290.9	315.3	337.6	357.3	374.0	387.4	397.2	403.1	405.1		
77.5000		15998.	20610.	-10653.	290.3	314.5	336.5	356.1	372.7	385.9	395.6	401.5	403.4		
78.0000		15840.	20411.	-10547.	289.7	313.7	335.5	354.9	371.3	384.5	394.0	399.8	401.8		
78.5000		15685.	20214.	-10443.	289.2	312.9	334.5	353.7	370.0	383.0	392.5	398.2	400.1		
79.0000		15531.	20020.	-10340.	288.6	312.1	333.6	352.5	368.7	381.5	390.9	396.6	399.5		
79.5000		15380.	19828.	-10238.	288.0	311.3	332.6	351.4	367.3	380.1	389.4	395.0	396.9		
80.0000		15230.	19640.	-10137.	287.5	310.5	[illegible]	350.2	366.0	378.7	387.9	393.4	395.3		
81.0000		14861.	18968.	-9912.	287.5	309.3	329.7	348.0	363.5	375.8	384.9	390.3	392.2		
82.0000		14441.	18274.	-9661.	287.9	308.5	328.1	345.8	360.9	373.1	381.9	387.3	389.1		
83.0000		13999.	17596.	-9396.	288.2	307.9	326.7	343.8	358.5	370.4	379.0	384.3	386.0		
84.0000		13547.	16938.	-9120.	288.6	307.4	325.4	341.9	356.2	367.8	376.2	381.3	383.0		
85.0000		13092.	16299.	-8838.	289.0	307.0	324.3	340.2	354.0	365.2	373.4	378.5	380.1		
86.0000		12639.	15679.	-8552.	289.4	[illegible]	323.3	338.6	351.9	362.8	370.8	375.7	377.3		
87.0000		12190.	15077.	-8254.	289.8	306.3	322.3	337.0	349.9	360.4	368.2	372.9	374.5		
88.0000		11748.	14493.	-7977.	290.3	306.1	321.4	335.6	348.0	358.2	365.7	370.3	371.8		
89.0000		11313.	13925.	-7693.	290.7	305.9	320.6	334.2	346.2	356.0	363.3	367.7	369.2		
90.0000		10887.	13375.	-7412.	291.2	305.7	319.8	332.9	344.4	353.9	360.9	365.2	366.7		
91.0000		10471.	12840.	-7137.	291.7	305.5	319.1	331.7	342.8	351.9	358.7	362.8	364.2		
92.0000		10065.	12321.	-6866.	292.1	305.4	318.4	330.5	341.2	350.0	356.5	360.5	361.8		
93.0000		9669.	11818.	-6602.	292.6	305.3	317.8	329.4	339.6	348.1	354.4	358.2	359.5		
94.0000		9283.	11329.	-6344.	293.1	305.3	317.2	328.3	338.2	346.3	352.4	356.1	357.3		
95.0000		8908.	10854.	-6092.	293.6	305.2	316.6	327.3	336.8	344.6	350.4	354.0	355.2		
96.0000		8529.	10332.	-5842.	294.4	305.3	316.1	326.4	335.5	343.0	348.5	352.0	353.1		
97.0000		8146.	9818.	-5591.	295.2	305.4	315.7	325.5	334.2	341.4	346.7	350.0	351.2		
98.0000		7769.	9319.	-5344.	296.0	305.6	315.4	324.7	333.0	339.9	345.0	348.2	349.3		
99.0000		7398.	8835.	-5100.	296.8	305.8	315.1	323.9	331.8	338.4	343.4	346.4	347.4		

SMUD RAPID COOLDOWN

F. L. BOYER

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION SHELL DATE 04/20/78

TIME	EQUIV RAD	LIN. TR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
100.0000		7034.	8364.	-4859.	297.6	306.1	314.8	323.2	330.8	337.1	341.8	344.7	345.7		
101.0000		6679.	7908.	-4624.	298.4	305.5	314.7	322.6	329.8	335.8	340.3	343.1	344.0		
102.0000		6333.	7465.	-4393.	299.3	306.7	314.5	322.0	328.8	334.5	338.8	341.5	342.4		
103.0000		5995.	7035.	-4158.	300.1	307.1	314.4	321.5	328.0	333.4	337.5	340.0	340.9		
104.0000		5667.	6619.	-3948.	301.0	307.5	314.3	321.0	327.1	332.3	336.2	338.6	339.4		
105.0000		5347.	6214.	-3734.	301.8	307.9	314.3	320.6	326.4	331.2	334.9	337.2	338.0		
106.0000		5037.	5822.	-3526.	302.7	308.3	314.3	320.2	325.6	330.3	333.8	335.9	336.7		
107.0000		4735.	5441.	-3323.	303.5	308.7	314.3	319.9	325.0	329.3	332.7	334.7	335.4		
108.0000		4442.	5071.	-3126.	304.4	309.1	314.3	319.5	324.4	328.5	331.6	333.6	334.2		
109.0000		4157.	4713.	-2934.	305.3	309.6	314.4	319.3	323.8	327.7	330.6	332.5	333.1		
110.0000		3881.	4365.	-2748.	306.1	310.1	314.5	319.1	323.3	326.9	329.7	331.4	332.0		
111.0000		3605.	3997.	-2564.	307.1	310.6	314.7	318.9	322.8	326.2	328.8	330.5	331.0		
112.0000		3331.	3636.	-2383.	308.2	311.2	314.9	318.7	322.4	325.6	328.0	329.6	330.1		
113.0000		3062.	3286.	-2205.	309.2	311.8	315.1	318.6	322.0	325.0	327.3	328.7	329.2		
114.0000		2799.	2946.	-2031.	310.2	312.5	315.4	318.6	321.7	324.4	326.6	327.9	328.4		
115.0000		2542.	2616.	-1860.	311.3	313.1	315.7	318.6	321.4	323.9	325.9	327.2	327.6		
116.0000		2292.	2297.	-1693.	312.3	313.8	316.0	318.6	321.2	323.5	325.3	326.5	326.9		
117.0000		2049.	1986.	-1530.	313.4	314.5	316.4	318.6	321.0	323.1	324.8	325.8	326.2		
118.0000		1811.	1685.	-1371.	314.4	315.2	316.8	318.7	320.8	322.7	324.3	325.2	325.6		
119.0000		1580.	1393.	-1217.	315.5	315.9	317.2	318.9	320.7	322.4	323.8	324.7	325.0		
120.0000		1355.	1110.	-1067.	316.6	316.7	317.6	319.0	320.6	322.2	323.4	324.2	324.5		
121.0000		1139.	835.	-921.	317.5	317.4	318.1	319.2	320.6	321.9	323.1	323.8	324.0		
122.0000		927.	566.	-779.	318.7	318.2	318.5	319.4	320.6	321.8	322.7	323.4	323.6		
123.0000		722.	309.	-641.	319.8	319.0	319.1	319.7	320.6	321.6	322.5	323.0	323.2		
124.0000		523.	58.	-507.	320.9	319.8	319.6	320.0	320.7	321.5	322.3	322.7	322.9		
125.0000		330.	-185.	-377.	321.9	320.6	320.1	320.3	320.8	321.5	322.1	322.5	322.6		
126.0000		143.	-421.	-251.	323.0	321.4	320.7	320.6	321.0	321.4	321.9	322.3	322.4		
127.0000		-39.	-651.	-128.	324.1	322.2	321.3	321.0	321.1	321.5	321.8	322.1	322.2		
128.0000		-216.	-873.	-9.	325.2	323.0	321.9	321.4	321.3	321.5	321.7	322.0	322.0		
129.0000		-387.	-1089.	106.	326.3	323.9	322.5	321.8	321.5	321.6	321.7	321.9	321.9		
130.0000		-553.	-1298.	218.	327.4	324.7	323.1	322.2	321.8	321.7	321.7	321.8	321.9		
131.0000		-715.	-1501.	327.	328.5	325.6	323.7	322.6	322.1	321.8	321.8	321.8	321.8		
132.0000		-871.	-1698.	432.	329.6	326.5	324.4	323.1	322.4	322.0	321.9	321.8	321.8		
133.0000		-1023.	-1890.	534.	330.7	327.4	325.1	323.6	322.7	322.2	322.0	321.9	321.8		
134.0000		-1170.	-2075.	633.	331.8	328.2	325.8	324.1	323.1	322.5	322.1	322.0	321.9		
135.0000		-1313.	-2255.	729.	332.9	329.1	326.5	324.7	323.5	322.7	322.3	322.1	322.0		
136.0000		-1452.	-2430.	823.	334.0	330.0	327.2	325.2	323.9	323.0	322.5	322.2	322.1		
137.0000		-1587.	-2600.	913.	335.1	331.0	327.9	325.8	324.3	323.3	322.7	322.4	322.3		
138.0000		-1717.	-2764.	1001.	336.2	331.9	328.7	326.4	324.7	323.7	323.0	322.6	322.5		
139.0000		-1844.	-2924.	[illegible]	337.3	332.8	329.4	327.0	325.2	324.0	323.3	322.8	322.7		

SMUD RAPID COOLDOWN
F. L BOYER

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION SHELL DATE 04/20/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
140.0000		-1967.	-3079.	1169.	338.4	333.7	330.2	327.6	325.7	324.4	323.6	323.1	323.0		

SMUD RAPID COOLDOWN
F. L. BOYER

A-16

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION LOWER HEAD   DATE 04/18/78

DIMENSIONS

INSIDE RADIUS = 87.2500 INCHES   OUTSIDE RADIUS = 92.2500 INCHES
NO. OF NODES = 9   RADIAL INCREMENT = .6250 INCHES
MATERIAL CODE = 2   POISSON S RATIO = .3000
L = -0.0000

INITIAL CONDITIONS

NODE	RADIUS	TEMPERATURE
1	87.2500	565.0
2	87.8750	565.0
3	88.5000	565.0
4	89.1250	565.0
5	89.7500	565.0
6	90.3750	565.0
7	91.0000	565.0
8	91.6250	565.0
9	92.2500	565.0

SMUD RAPID COOLDOWN
F. L. BOYER A-17

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION LOWER HEAD DATE 04/18/78

TABULATION OF BOUNDARY CONDITIONS

FLUID TEMP. CURVE APPROXIMATION		FILM COEFF. CURVE APPROXIMATION		PRESSURE CURVE APPROXIMATION	
TIME (MINUTES)	INSIDE FLUID TEMPERATURE	TIME (MINUTES)	INSIDE FILM COEFFICIENT	TIME (MINUTES)	PRESSURE (PSI)
0.0000	565.0	0.0000	900.0	0.0000	0.
5.0000	565.0	140.0000	900.0	0.0000	0.
10.0000	590.0	0.0000	0.0	0.0000	0.
15.0000	590.0	0.0000	0.0	0.0000	0.
20.0000	525.0	0.0000	0.0	0.0000	0.
40.0000	380.0	0.0000	0.0	0.0000	0.
60.0000	300.0	0.0000	0.0	0.0000	0.
80.0000	280.0	0.0000	0.0	0.0000	0.
95.0000	290.0	0.0000	0.0	0.0000	0.
110.0000	305.0	0.0000	0.0	0.0000	0.
140.0000	340.0	0.0000	0.0	0.0000	0.

TEMPERATURE CALCULATION TIMES AND PRINTOUTS

TIME INCREMENT (MINUTES)	TIME LIMIT (MINUTES)	NUMBER OF PRINTOUTS
.5000	20.000	20.
.5000	80.000	120.
1.0000	140.000	60.

SMUD RAPID COOLDOWN
F. L. BOYER
A-18

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION LOWER HEAD DATE 04/18/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
1.0000		0.	0.	-0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
2.0000		0.	0.	-0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
3.0000		0.	0.	-0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
4.0000		0.	0.	-0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
5.0000		0.	0.	-0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
6.0000		-321.	-879.	140.	568.6	566.6	565.6	565.2	565.1	565.0	565.0	565.0	565.0		
7.0000		-849.	-1788.	421.	572.9	569.4	567.3	566.2	565.5	565.2	565.1	565.0	565.0		
8.0000		-1430.	-2639.	771.	577.3	572.7	569.6	567.7	566.5	565.8	565.4	565.2	565.2		
9.0000		-2013.	-3430.	1143.	581.8	576.2	572.3	569.6	567.8	566.7	566.0	565.6	565.5		
10.0000		-2574.	-4164.	1513.	586.4	579.9	575.2	571.8	569.4	567.9	566.9	566.3	566.2		
11.0000		-2785.	-3965.	1729.	587.3	582.2	577.7	574.0	571.3	569.3	568.0	567.3	567.1		
12.0000		-2755.	-3687.	1783.	587.7	583.3	579.2	575.8	573.0	570.8	569.4	568.5	568.3		
13.0000		-2639.	-3420.	1748.	588.0	584.0	580.3	577.1	574.4	572.3	570.8	569.9	569.6		
14.0000		-2487.	-3171.	1668.	588.1	584.5	581.2	578.2	575.6	573.6	572.1	571.2	571.0		
15.0000		-2325.	-2939.	1579.	588.3	585.0	581.9	579.1	576.7	574.8	573.4	572.6	572.3		
16.0000		-1333.	-435.	1106.	579.0	581.3	581.0	579.4	577.6	575.9	574.6	573.8	573.5		
17.0000		193.	2129.	274.	568.1	574.3	577.1	577.7	577.2	576.4	575.5	574.9	574.7		
18.0000		1852.	4526.	-733.	556.7	566.0	571.6	574.5	575.7	575.9	575.7	575.5	575.4		
19.0000		3506.	6750.	-1796.	545.1	557.1	565.1	570.1	573.0	574.5	575.2	575.4	575.5		
20.0000		5097.	8811.	-2847.	533.4	547.8	558.0	564.9	569.4	572.2	573.8	574.6	574.8		
20.5000		5729.	9310.	-3306.	529.3	543.5	554.3	562.1	567.4	570.8	572.8	573.8	574.2		
21.0000		6228.	9708.	-3694.	525.7	539.9	551.0	559.3	565.2	569.1	571.6	572.9	573.3		
21.5000		6652.	10079.	-4028.	522.1	536.5	547.9	556.6	563.0	567.4	570.2	571.8	572.3		
22.0000		7023.	10431.	-4319.	518.6	533.2	544.9	554.0	560.8	565.6	568.7	570.5	571.1		
22.5000		7356.	10767.	-4574.	515.1	529.9	541.9	551.4	558.5	563.7	567.1	569.0	569.7		
23.0000		7659.	11089.	-4802.	511.6	526.7	539.0	548.8	556.2	561.7	565.4	567.5	568.2		
23.5000		7938.	11397.	-5008.	508.1	523.5	536.1	546.2	553.9	559.6	563.5	565.8	566.5		
24.0000		8198.	11693.	-5197.	504.7	520.4	533.2	543.6	551.6	557.5	561.6	564.0	564.8		
24.5000		8442.	11976.	-5372.	501.2	517.2	530.3	540.9	549.2	555.4	559.6	562.1	562.9		
25.0000		8673.	12248.	-5535.	497.7	514.0	527.4	538.3	546.8	553.2	557.6	560.2	561.0		
25.5000		8891.	12508.	-5688.	494.3	510.8	524.5	535.6	544.3	550.9	555.5	558.1	559.0		
26.0000		9099.	12758.	-5833.	490.8	507.6	521.5	532.9	541.8	548.6	553.3	556.1	557.0		
26.5000		9296.	12997.	-5970.	487.3	504.3	518.5	530.1	539.3	546.2	551.0	553.9	554.8		
27.0000		9484.	13226.	-6100.	483.8	501.1	515.5	527.4	536.7	543.8	548.7	551.7	552.6		
27.5000		9664.	13446.	-6224.	480.3	497.8	512.5	524.5	534.1	541.3	546.4	549.4	550.4		
28.0000		9836.	13656.	-6343.	476.8	494.6	509.5	521.7	531.4	538.8	544.0	547.0	548.1		
28.5000		10000.	13857.	-6456.	473.3	491.3	506.4	518.8	528.7	536.3	541.5	544.7	545.7		
29.0000		10157.	14050.	-6564.	469.8	488.0	503.3	515.9	526.0	533.6	539.0	542.2	543.3		
29.5000		10307.	14234.	-6667.	466.3	484.7	500.2	513.0	523.2	531.0	536.5	539.7	540.8		

SMUD RAPID COOLDOWN
F. L BOYER

A-19

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION LOWER HEAD

DATE 04/18/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
30.0000		10451.	14411.	-6766.	462.8	481.4	497.1	510.0	520.4	528.3	533.9	537.2	538.3		
30.5000		10588.	14579.	-6860.	459.2	478.0	493.9	507.0	517.5	525.6	531.2	534.6	535.7		
31.0000		10719.	14740.	-6950.	455.7	474.7	490.7	504.0	514.7	522.8	528.5	532.0	533.1		
31.5000		10844.	14894.	-7036.	452.2	471.3	487.5	501.0	511.8	520.0	525.8	529.3	530.4		
32.0000		10964.	15040.	-7119.	448.7	467.9	484.3	497.9	508.8	517.2	523.1	526.6	527.7		
32.5000		11079.	15180.	-7197.	445.1	464.6	481.1	494.8	505.8	514.3	520.3	523.8	525.0		
33.0000		11187.	15314.	-7272.	441.6	461.2	477.8	491.7	502.8	511.4	517.4	521.0	522.2		
33.5000		11291.	15441.	-7344.	438.0	457.8	474.6	488.5	499.8	508.5	514.6	518.2	519.4		
34.0000		11390.	15562.	-7412.	434.5	454.4	471.3	485.4	496.8	505.5	511.7	515.3	516.5		
34.5000		11485.	15677.	-7477.	430.9	450.9	468.0	482.2	493.7	502.5	508.7	512.4	513.6		
35.0000		11574.	15786.	-7539.	427.4	447.5	464.7	479.0	490.6	499.5	505.7	509.5	510.7		
35.5000		11660.	15890.	-7599.	423.8	444.1	461.3	475.8	487.4	496.4	502.7	506.5	507.8		
36.0000		11741.	15989.	-7654.	420.3	440.6	458.0	472.5	484.3	493.3	499.7	503.5	504.8		
36.5000		11819.	16063.	-7707.	416.7	437.2	454.6	469.3	481.1	490.2	496.7	500.5	501.8		
37.0000		11891.	16171.	-7757.	413.1	433.7	451.3	466.0	477.9	487.1	493.6	497.4	498.7		
37.5000		11961.	16255.	-7805.	409.6	430.2	447.9	462.7	474.7	483.9	490.5	494.4	495.7		
38.0000		12026.	16335.	-7851.	406.0	426.7	444.5	459.4	471.4	480.7	487.3	491.3	492.6		
38.5000		12098.	16410.	-7894.	402.4	423.2	441.1	456.1	468.2	477.5	484.2	488.1	489.4		
39.0000		12147.	16480.	-7935.	398.9	419.8	437.7	452.7	464.9	474.3	481.0	485.0	486.3		
39.5000		12203.	16547.	-7973.	395.3	416.3	434.3	449.4	461.6	471.1	477.8	481.8	483.1		
40.0000		12255.	16609.	-8009.	391.7	412.7	430.8	446.0	458.3	467.8	474.6	478.6	479.9		
40.5000		12229.	16603.	-8014.	389.2	409.6	427.5	442.6	455.0	464.5	471.3	475.4	476.7		
41.0000		12138.	16160.	-7993.	386.9	406.8	424.3	439.4	451.7	461.2	468.0	472.1	473.5		
41.5000		12017.	15918.	-7928.	384.7	404.1	421.4	436.2	448.4	458.0	464.8	468.8	470.2		
42.0000		11879.	15683.	-7855.	382.5	401.6	418.6	433.2	445.3	454.7	461.5	465.6	466.9		
42.5000		11731.	15456.	-7770.	380.3	399.1	415.8	430.2	442.2	451.6	458.3	462.3	463.7		
43.0000		11579.	15235.	-7678.	378.2	396.7	413.1	427.3	439.1	448.4	455.1	459.1	460.4		
43.5000		11424.	15022.	-7581.	376.0	394.3	410.5	424.5	436.1	445.3	451.9	455.9	457.2		
44.0000		11272.	14816.	-7483.	373.9	391.9	407.9	421.7	433.2	442.3	448.8	452.7	454.0		
44.5000		11121.	14618.	-7384.	371.8	389.5	405.3	419.0	430.3	439.2	445.7	449.5	450.8		
45.0000		10973.	14426.	-7287.	369.7	387.2	402.8	416.2	427.4	436.2	442.6	446.4	447.7		
45.5000		10830.	14241.	-7191.	367.6	384.9	400.3	413.6	424.6	433.3	439.6	443.3	444.6		
46.0000		10690.	14063.	-7097.	365.5	382.6	397.8	410.9	421.8	430.4	436.6	440.3	441.5		
46.5000		10554.	13891.	-7005.	363.4	380.3	395.3	408.3	419.0	427.5	433.6	437.3	438.5		
47.0000		10423.	13724.	-6917.	361.3	378.0	392.9	405.7	416.3	424.7	430.7	434.3	435.5		
47.5000		10296.	13564.	-6831.	359.2	375.7	390.4	403.1	413.6	421.8	427.8	431.4	432.6		
48.0000		10174.	13410.	-6748.	357.1	373.5	388.0	400.5	410.9	419.0	424.9	428.5	429.6		
48.5000		10055.	13260.	-6668.	355.0	371.2	385.6	398.0	408.2	416.3	422.1	425.6	426.8		
49.0000		9941.	13116.	-6590.	352.9	369.0	383.2	395.4	405.6	413.6	419.3	422.7	423.9		
49.5000		9830.	12977.	-6516.	350.8	366.8	380.8	392.9	403.0	410.8	416.5	419.9	421.1		

SMUD RAPID COOLDOWN

F. L. BOYER

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION LOWER HEAD DATE 04/18/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
50.0000		9724.	12843.	-6443.	348.8	364.5	378.5	390.4	400.4	408.2	413.8	417.1	418.2		
50.5000		9621.	12714.	-6373.	346.7	362.3	376.1	388.0	397.8	405.5	411.0	414.4	415.5		
51.0000		9522.	12589.	-6306.	344.6	360.1	373.8	385.5	395.2	402.9	408.4	411.7	412.8		
51.5000		9426.	12468.	-6241.	342.5	357.9	371.5	383.1	392.7	400.3	405.7	408.9	410.0		
52.0000		9333.	12352.	-6178.	340.5	355.7	369.1	380.7	390.2	397.7	403.0	406.3	407.3		
52.5000		9244.	12239.	-6117.	338.4	353.5	366.8	378.2	387.7	395.1	400.4	403.6	404.7		
53.0000		9158.	12131.	-6059.	336.4	351.3	364.5	375.9	385.2	392.5	397.8	401.0	402.0		
53.5000		9075.	12026.	-6002.	334.3	349.2	362.3	373.5	382.7	390.0	395.2	398.4	399.4		
54.0000		8994.	11925.	-5948.	332.2	347.0	360.0	371.1	380.3	387.5	392.7	395.8	396.8		
54.5000		8917.	11827.	-5895.	330.2	344.8	357.7	368.8	377.9	385.0	390.1	393.2	394.2		
55.0000		8842.	11733.	-5844.	328.1	342.7	355.5	366.4	375.4	382.5	387.6	390.7	391.7		
55.5000		8769.	11641.	-5795.	326.1	340.5	353.2	364.1	373.0	380.1	385.1	388.1	389.1		
56.0000		8699.	11553.	-5748.	324.0	338.4	351.0	361.8	370.7	377.6	382.6	385.6	386.6		
56.5000		8632.	11468.	-5702.	322.0	336.2	348.8	359.5	368.3	375.2	380.1	383.1	384.1		
57.0000		8567.	11385.	-5658.	319.9	334.1	346.5	357.2	365.9	372.8	377.7	380.6	381.6		
57.5000		8503.	11306.	-5615.	317.9	332.0	344.3	354.9	363.6	370.4	375.2	378.2	379.2		
58.0000		8442.	11228.	-5574.	315.9	329.9	342.1	352.6	361.2	368.0	372.8	375.7	376.7		
58.5000		8384.	11154.	-5534.	313.8	327.7	339.9	350.3	358.9	365.6	370.4	373.3	374.3		
59.0000		8327.	11082.	-5495.	311.8	325.6	337.7	348.1	356.6	363.2	368.0	370.9	371.8		
59.5000		8271.	11012.	-5458.	309.7	323.5	335.5	345.9	354.3	360.9	365.6	368.5	369.4		
60.0000		8218.	10944.	-5422.	307.7	321.4	333.4	343.6	352.0	358.6	363.3	366.1	367.0		
60.5000		8097.	10637.	-5359.	306.6	31[illegible].6	331.3	341.4	349.7	356.2	360.9	363.7	364.7		
61.0000		7920.	10302.	-5266.	305.8	319.2	329.4	339.3	347.5	353.9	358.6	361.4	362.3		
61.5000		7720.	9976.	-5154.	305.0	316.9	327.8	337.3	345.3	351.7	356.3	359.0	359.9		
62.0000		7509.	9660.	-5029.	304.3	315.7	326.2	335.5	343.3	349.5	354.0	356.7	357.6		
62.5000		7294.	9356.	-4895.	303.6	314.0	324.8	333.7	341.3	347.4	351.8	354.4	355.3		
63.0000		7079.	9064.	-4758.	302.9	313.6	323.4	332.1	339.4	345.3	349.5	352.2	353.1		
63.5000		6867.	8783.	-4621.	302.2	312.5	322.0	330.5	337.6	343.3	347.5	350.0	350.9		
64.0000		6660.	8513.	-4484.	301.5	311.5	320.7	328.9	335.8	341.4	345.5	347.9	348.7		
64.5000		6459.	8254.	-4350.	300.9	310.6	319.5	327.4	334.1	339.5	343.5	345.9	346.7		
65.0000		6264.	8006.	-4219.	300.2	309.6	318.3	326.0	332.5	337.7	341.5	343.9	344.6		
65.5000		6076.	7768.	-4093.	299.5	308.7	317.1	324.6	330.9	336.0	339.7	341.9	342.7		
66.0000		5895.	7539.	-3970.	298.9	307.8	316.0	323.2	329.3	334.3	337.8	340.0	340.8		
66.5000		5721.	7320.	-3852.	298.3	306.9	314.8	321.9	327.8	332.6	336.1	338.2	338.9		
67.0000		5553.	7109.	-3738.	297.6	306.0	313.7	320.6	326.3	331.0	334.4	336.4	337.1		
67.5000		5392.	6908.	-3629.	297.0	305.2	312.7	319.3	324.9	329.4	332.7	334.7	335.4		
68.0000		5238.	6714.	-3524.	296.4	304.4	311.6	318.1	323.5	327.9	331.1	333.0	333.7		
68.5000		5090.	6529.	-3423.	295.8	303.5	310.6	316.9	322.2	326.4	329.5	331.4	332.0		
69.0000		4948.	6351.	-3326.	295.2	302.7	309.6	315.7	320.8	325.0	328.0	329.8	330.4		
69.5000		4811.	6180.	-3233.	294.6	301.9	308.6	314.5	319.6	323.6	326.5	328.3	328.9		

SMUD RAPID COOLDOWN
F. L. BOYER

DATE 04/18/78

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION LOWER HEAD

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
70.0000		4680.	6016.	-3144.	294.0	301.1	307.7	313.4	318.3	322.2	325.0	326.8	327.3		
70.5000		4555.	5859.	-3059.	293.4	300.4	306.7	312.3	317.1	320.9	323.6	325.3	325.9		
71.0000		4434.	5709.	-2977.	292.8	299.6	305.8	311.3	315.9	319.6	322.3	323.9	324.4		
71.5000		4319.	5565.	-2898.	292.2	298.9	304.9	310.2	314.7	318.3	320.9	322.5	323.0		
72.0000		4208.	5427.	-2823.	291.6	298.1	304.0	309.2	313.6	317.1	319.6	321.2	321.7		
72.5000		4102.	5294.	-2751.	291.0	297.4	303.1	308.2	312.5	315.9	318.4	319.9	320.4		
73.0000		4001.	5167.	-2682.	290.4	296.7	302.3	307.2	311.4	314.7	317.1	318.6	319.1		
73.5000		3903.	5045.	-2615.	289.9	295.9	301.4	306.3	310.3	313.6	315.9	317.3	317.8		
74.0000		3810.	4928.	-2552.	289.3	295.2	300.6	305.3	309.3	312.4	314.7	316.1	316.6		
74.5000		3720.	4816.	-2491.	288.7	294.5	299.8	304.4	308.3	311.3	313.6	314.9	315.4		
75.0000		3634.	4709.	-2432.	288.2	293.9	299.0	303.5	307.3	310.3	312.5	313.8	314.2		
75.5000		3552.	4606.	-2376.	287.6	293.2	298.2	302.6	306.3	309.2	311.4	312.6	313.1		
76.0000		3473.	4507.	-2322.	287.0	292.5	297.4	301.7	305.3	308.2	310.3	311.5	312.0		
76.5000		3399.	4413.	-2271.	286.5	291.8	296.7	300.9	304.4	307.2	309.2	310.5	310.9		
77.0000		3325.	4322.	-2221.	285.9	291.2	295.9	300.0	303.5	306.2	308.2	309.4	309.8		
77.5000		3255.	4235.	-2174.	285.4	290.5	295.2	299.2	302.6	305.3	307.2	308.4	308.8		
78.0000		3189.	4152.	-2129.	284.8	289.9	294.4	298.4	301.7	304.3	306.2	307.4	307.8		
78.5000		3125.	4072.	-2085.	284.3	289.2	293.7	297.6	300.8	303.4	305.3	306.4	306.8		
79.0000		3064.	3995.	-2044.	283.7	288.6	293.0	296.8	300.0	302.5	304.3	305.4	305.8		
79.5000		3005.	3922.	-2004.	283.2	288.0	292.3	296.0	299.1	301.6	303.4	304.5	304.8		
80.0000		2949.	3852.	-1966.	282.6	287.4	291.6	295.2	298.3	300.7	302.5	303.5	303.9		
81.0000		2733.	3433.	-1845.	282.8	286.7	290.4	293.8	296.7	299.0	300.7	301.7	302.1		
82.0000		2461.	3024.	-1682.	283.1	285.5	289.7	292.7	295.4	297.5	299.1	300.0	300.3		
83.0000		2183.	2647.	-1505.	283.5	286.4	289.2	291.4	294.2	296.1	297.5	298.4	298.7		
84.0000		1917.	2300.	-1329.	284.0	285.4	288.9	291.2	293.2	294.9	296.2	297.0	297.2		
85.0000		1667.	1982.	-1161.	284.4	286.5	288.6	290.6	292.4	293.9	295.0	295.7	295.9		
86.0000		1435.	1690.	-1005.	284.9	286.6	288.4	290.1	291.7	293.0	294.0	294.6	294.8		
87.0000		1223.	1422.	-850.	285.4	286.8	288.3	289.8	291.1	292.2	293.1	293.6	293.8		
88.0000		1028.	1177.	-727.	285.9	287.1	288.3	289.5	290.6	291.6	292.3	292.7	292.9		
89.0000		848.	952.	-605.	286.5	287.3	288.3	289.3	290.2	291.0	291.6	292.0	292.2		
90.0000		683.	746.	-493.	287.0	287.6	288.4	289.2	289.9	290.6	291.1	291.4	291.5		
91.0000		533.	558.	-391.	287.5	288.0	288.5	289.1	289.7	290.3	290.7	290.9	291.0		
92.0000		394.	385.	-297.	288.1	288.3	288.7	289.1	289.6	290.0	290.3	290.5	290.6		
93.0000		268.	226.	-210.	288.7	288.7	288.9	289.2	289.5	289.8	290.1	290.2	290.3		
94.0000		152.	81.	-131.	289.2	289.1	289.2	289.3	289.5	289.7	289.9	290.0	290.0		
95.0000		45.	-52.	-59.	289.8	289.6	289.5	289.5	289.6	289.7	289.8	289.8	289.9		
96.0000		-75.	-232.	17.	290.7	290.1	289.8	289.7	289.7	289.7	289.7	289.7	289.8		
97.0000		-199.	-401.	98.	291.5	290.8	290.3	290.0	289.8	289.8	289.7	289.7	289.7		
98.0000		-319.	-557.	177.	292.4	291.5	290.8	290.4	290.1	289.9	289.8	289.8	289.8		
99.0000		-431.	-700.	252.	293.4	292.2	291.4	290.8	290.4	290.2	290.0	289.9	289.9		

SMUD RAPID COOLDOWN

F. L. BOYER

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION LOWER HEAD

DATE 04/18/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
100.0000		-534.	-831.	322.	294.3	293.0	292.0	291.3	290.8	290.5	290.2	290.1	290.1		
101.0000		-630.	-951.	397.	295.2	293.8	292.7	291.9	291.3	290.8	290.5	290.4	290.3		
102.0000		-717.	-1061.	446.	296.1	294.6	293.4	292.4	291.7	291.2	290.9	290.7	290.6		
103.0000		-798.	-1162.	501.	297.1	295.4	294.1	293.1	292.3	291.7	291.3	291.1	291.0		
104.0000		-872.	-1255.	551.	298.0	296.3	294.8	293.7	292.8	292.2	291.7	291.5	291.4		
105.0000		-940.	-1339.	597.	299.0	297.1	295.6	294.4	293.4	292.7	292.3	292.0	291.9		
106.0000		-1002.	-1417.	639.	299.9	298.0	296.4	295.1	294.1	293.3	292.8	292.5	292.4		
107.0000		-1059.	-1489.	678.	300.9	298.8	297.2	295.8	294.7	293.9	293.4	293.1	292.9		
108.0000		-1111.	-1554.	714.	301.8	299.7	298.0	296.6	295.4	294.6	294.0	293.7	293.5		
109.0000		-1159.	-1615.	746.	302.8	300.6	298.8	297.3	296.2	295.3	294.6	294.3	294.2		
110.0000		-1203.	-1670.	776.	303.8	301.5	299.7	298.1	296.9	296.0	295.3	294.9	294.8		
111.0000		-1255.	-1750.	809.	304.8	302.5	300.5	298.9	297.7	296.7	296.0	295.6	295.5		
112.0000		-1310.	-1825.	844.	306.0	303.5	301.5	299.8	298.5	297.5	296.8	296.3	296.2		
113.0000		-1363.	-1895.	879.	307.1	304.5	302.4	300.7	299.3	298.3	297.5	297.1	297.0		
114.0000		-1413.	-1959.	912.	308.2	305.6	303.4	301.6	300.2	299.1	298.3	297.9	297.7		
115.0000		-1459.	-2017.	943.	309.3	306.7	304.4	302.6	301.1	299.9	299.2	298.7	298.5		
116.0000		-1502.	-2071.	972.	310.5	307.7	305.4	303.5	302.0	300.8	300.0	299.5	299.4		
117.0000		-1541.	-2121.	999.	311.6	308.8	306.4	304.5	302.9	301.7	300.9	300.4	300.2		
118.0000		-1578.	-2167.	1024.	312.7	309.9	307.5	305.5	303.9	302.7	301.8	301.3	301.1		
119.0000		-1611.	-2209.	1047.	313.9	311.0	308.5	306.5	304.9	303.6	302.7	302.2	302.0		
120.0000		-1642.	-2247.	1067.	315.0	312.1	309.6	307.5	305.8	304.6	303.7	303.1	302.9		
121.0000		-1670.	-2283.	1087.	316.2	313.2	310.7	308.5	306.8	305.5	304.6	304.1	303.9		
122.0000		-1696.	-2316.	1104.	317.3	314.3	311.7	309.6	307.9	306.5	305.6	305.0	304.8		
123.0000		-1720.	-2346.	1121.	318.5	315.4	312.8	310.6	308.9	307.5	306.6	306.0	305.8		
124.0000		-1742.	-2374.	1136.	319.6	316.5	313.9	311.7	309.9	308.6	307.6	307.0	306.8		
125.0000		-1763.	-2400.	1150.	320.8	317.7	315.0	312.8	311.0	309.6	308.6	308.0	307.8		
126.0000		-1782.	-2423.	1152.	321.9	318.8	316.1	313.9	312.0	310.6	309.6	309.1	308.9		
127.0000		-1799.	-2445.	1174.	323.1	319.9	317.2	314.9	313.1	311.7	310.7	310.1	309.9		
128.0000		-1815.	-2466.	1185.	324.2	321.0	318.3	316.0	314.2	312.7	311.7	311.1	310.9		
129.0000		-1830.	-2484.	1195.	325.4	322.2	319.4	317.1	315.3	313.8	312.8	312.2	312.0		
130.0000		-1844.	-2502.	1204.	326.5	323.3	320.5	318.2	316.3	314.9	313.9	313.2	313.0		
131.0000		-1856.	-2518.	1213.	327.7	324.5	321.7	319.3	317.4	316.0	314.9	314.3	314.1		
132.0000		-1869.	-2533.	1221.	328.9	325.6	322.8	320.4	318.5	317.1	316.0	315.4	315.2		
133.0000		-1879.	-2547.	1229.	330.0	326.7	323.9	321.6	319.6	318.2	317.1	316.5	316.3		
134.0000		-1889.	-2560.	1235.	331.2	327.9	325.1	322.7	320.8	319.3	318.2	317.6	317.4		
135.0000		-1899.	-2572.	1242.	332.3	329.0	326.2	323.8	321.9	320.4	319.3	318.7	318.5		
136.0000		-1908.	-2583.	1248.	333.5	330.2	327.3	324.9	323.0	321.5	320.4	319.8	319.6		
137.0000		-1916.	-2593.	1253.	334.7	331.3	328.5	326.1	324.1	322.6	321.5	320.9	320.7		
138.0000		-1924.	-2603.	1258.	335.8	332.5	329.6	327.2	325.2	323.7	322.6	322.0	321.8		
139.0000		-1931.	-2612.	1263.	337.0	333.6	330.7	328.3	326.4	324.8	323.7	323.1	322.9		

SMUD RAPID COOLDOWN

F. L. BOYER

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION LOWER HEAD DATE 04/18/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
140.0000		-1937.	-2621.	1268.	338.1	334.8	331.9	329.5	327.5	326.0	324.9	324.2	324.0		

SMUD RAPID COOLDOWN
F. L. BOYER
A-24

SMUD COOLDOWN INCIDENT-SHELL ITERATION 20 PAGE 1 DATE 04/24/78

INPUT DATA DATE 04/24/78

TOTAL NO. OF SEGMENTS = 70

BOUNDARY CONDITIONS AT THE TOP (U) END

1. A RADIAL SHEAR OF *	0.00000	POUNDS
2. A MOMENT OF	0.00000	INCH-LBS.

BOUNDARY CONDITIONS AT THE BOTTOM (V) END

1. AN AXIAL FORCE OF	1259.60000	POUNDS
2. A RADIAL SHEAR OF	0.00000	POUNDS
3. A MOMENT OF	0.00000	INCH-LBS.

* NOTE * A SEGMENTAL GROUP MAY CONSIST OF FROM ONE TO THE TOTAL NO. OF SEGMENTS.
SEGMENT ONE IS CONSIDERED AT THE TOP OF THE GEOMETRY.
ALL LOADS ABOVE, ARE ON A TOTAL LOAD BASIS.

SMUD RAPID COOLDOWN

F. L. BOYER

SMUD COOLDOWN INCIDENT-SHELL ITERATION 20 PAGE 2 DATE 04/24/78

MID-SURFACE GEOMETRY

AT TOP BOUNDARY, MEAN RADIUS = 90.1880 Z COORDINATE = 297.7910

SEGMENTAL GEOMETRY DATA BY GROUPS

SEGMENT DATA			CENTER OF CURVATURE DATA		
BOTTOM SEG. NO.	MEAN RADIUS	Z COORD.	RADIUS TO CENTER	Z COORD.	CURVATURE IDENTIFIER
10.0	90.188	255.541	0.000	0.000	0.0
13.0	89.906	250.322	0.000	0.000	0.0
44.0	89.906	85.688	0.000	0.000	0.0
55.0	88.438	73.416	0.000	0.000	0.0
70.0	.517	.013	0.000	89.949	1.0

NOTE- CURVATURE IDENTIFIER +1= POSITIVE CURVATURE
0= NO CURVATURE
-1= NEGATIVE CURVATURE

SMUD RAPID COOLDOWN
F. L. BOYER
A-26

SMUD COOLDOWN INCIDENT-SHELL ITERATION 20 PAGE 3 DATE 04/24/78

SEGMENTAL GEOMETRY BY SEGMENTS (K= SEGMENT NO.)

MEAN RADIUS

K	R(K-1)	R(K)	R(K+1)	R(K+2)	R(K+3)	R(K+4)	R(K+5)	R(K+6)	R(K+7)	R(K+8)
1	90.19	90.19	90.19	90.19	90.19	90.19	90.19	90.19	90.19	90.19
11	90.19	90.09	90.00	89.91	89.91	89.91	89.91	89.91	89.91	89.91
21	89.91	89.91	89.91	89.91	89.91	89.91	89.91	89.91	89.91	89.91
31	89.91	89.91	89.91	89.91	89.91	89.91	89.91	89.91	89.91	89.91
41	89.91	89.91	89.91	89.91	89.91	89.77	89.64	89.51	89.37	89.24
51	89.11	88.97	88.84	88.70	88.57	88.44	85.54	83.92	80.59	76.56
61	71.90	66.63	60.79	54.44	47.62	40.41	32.85	25.02	16.97	8.78
71	.52									

Z COORDINATE

K	Z(K-1)	Z(K)	Z(K+1)	Z(K+2)	Z(K+3)	Z(K+4)	Z(K+5)	Z(K+6)	Z(K+7)	Z(K+8)
1	297.79	293.57	289.34	285.12	280.89	276.67	272.44	268.22	263.99	259.77
11	255.54	253.80	252.06	250.32	245.01	239.70	234.39	229.08	223.77	218.46
21	213.15	207.84	202.53	197.21	191.90	186.59	181.28	175.97	170.66	165.35
31	160.04	154.73	149.42	144.11	138.80	133.49	128.17	122.86	117.55	112.24
41	106.93	101.62	96.31	91.00	85.69	84.57	83.46	82.34	81.23	80.11
51	78.99	77.88	76.76	75.65	74.53	73.42	65.36	57.52	49.95	42.72
61	35.98	29.51	23.64	18.34	13.64	9.59	6.22	3.56	1.63	.44
71	.01									

SMUD RAPID COOLDOWN
F. L. BOYER A-27

SMUD COOLDOWN INCIDENT-SHELL ITERATION 20 PAGE 4 DATE 04/24/78

SEGMENT THICKNESS DATA BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	TOP THICK. OF TOP SEG.	BOTTOM THICK. OF BOTTOM SEG.
1.00	10.00	12.00	12.00
11.00	13.00	12.00	8.44
14.00	44.00	8.44	8.44
45.00	55.00	8.44	5.50
56.00	70.00	5.38	5.38

SEGMENTAL THICKNESS BY SEGMENTS

THICKNESS AT TOP OF SEGMENT (HA)

K	HA(K)	HA(K+1)	HA(K+2)	HA(K+3)	HA(K+4)	HA(K+5)	HA(K+6)	HA(K+7)	HA(K+8)	HA(K+9)
1	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
11	12.00	10.81	9.63	8.44	8.44	8.44	8.44	8.44	8.44	8.44
21	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44
31	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44
41	8.44	8.44	8.44	8.44	8.44	8.17	7.91	7.64	7.37	7.10
51	6.84	6.57	6.30	6.03	5.77	5.38	5.38	5.38	5.38	5.38
61	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38

THICKNESS AT BOTTOM OF SEGMENT (HB)

K	HB(K)	HB(K+1)	HB(K+2)	HB(K+3)	HB(K+4)	HB(K+5)	HB(K+6)	HB(K+7)	HB(K+8)	HB(K+9)
1	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
11	10.81	9.63	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44
21	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44
31	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44
41	8.44	8.44	8.44	8.44	8.17	7.91	7.64	7.37	7.10	6.84
51	6.57	6.30	6.03	5.77	5.50	5.38	5.38	5.38	5.38	5.38
61	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38

SMUD T[illegible]ID COOLDOWN
F. L. BOYER

SMUD COOLDOWN INCIDENT-SHELL ITERATION 20 PAGE 5. DATE 04/24/78

MATERIAL PROPERTIES BY SEGMENTS

SEG. NO.	ALPHA	MODULUS OF TENSION	MODULUS OF SHEAR	POISSON<S RATIO
1	.7458E-05	.2762E+08	.1062E+08	.3000E+00
2	.7458E-05	.2762E+08	.1062E+08	.3000E+00
3	.7458E-05	.2762E+08	.1062E+08	.3000E+00
4	.7458E-05	.2762E+08	.1062E+08	.3000E+00
5	.7458E-05	.2762E+08	.1062E+08	.3000E+00
6	.7458E-05	.2762E+08	.1062E+08	.3000E+00
7	.7458E-05	.2762E+08	.1062E+08	.3000E+00
8	.7458E-05	.2762E+08	.1062E+08	.3000E+00
9	.7458E-05	.2762E+08	.1062E+08	.3000E+00
10	.7458E-05	.2762E+08	.1062E+08	.3000E+00
11	.7458E-05	.2762E+08	.1062E+08	.3000E+00
12	.7459E-05	.2762E+08	.1062E+08	.3000E+00
13	.7460E-05	.2761E+08	.1062E+08	.3000E+00
14	.7460E-05	.2761E+08	.1062E+08	.3000E+00
15	.7460E-05	.2761E+08	.1062E+08	.3000E+00
16	.7460E-05	.2761E+08	.1062E+08	.3000E+00
17	.7460E-05	.2761E+08	.1062E+08	.3000E+00
18	.7460E-05	.2761E+08	.1062E+08	.3000E+00
19	.7460E-05	.2761E+08	.1062E+08	.3000E+00
20	.7460E-05	.2761E+08	.1062E+08	.3000E+00
21	.7460E-05	.2761E+08	.1062E+08	.3000E+00
22	.7460E-05	.2761E+08	.1062E+08	.3000E+00
23	.7460E-05	.2761E+08	.1062E+08	.3000E+00
24	.7460E-05	.2761E+08	.1062E+08	.3000E+00
25	.7460E-05	.2761E+08	.1062E+08	.3000E+00
26	.7460E-05	.2761E+08	.1062E+08	.3000E+00
27	.7460E-05	.2761E+08	.1062E+08	.3000E+00
28	.7460E-05	.2761E+08	.1062E+08	.3000E+00
29	.7460E-05	.2761E+08	.1062E+08	.3000E+00
30	.7460E-05	.2761E+08	.1062E+08	.3000E+00
31	.7460E-05	.2761E+08	.1062E+08	.3000E+00
32	.7460E-05	.2761E+08	.1062E+08	.3000E+00
33	.7460E-05	.2761E+08	.1062E+08	.3000E+00
34	.7460E-05	.2761E+08	.1062E+08	.3000E+00
35	.7460E-05	.2761E+08	.1062E+08	.3000E+00
36	.7460E-05	.2761E+08	.1062E+08	.3000E+00
37	.7460E-05	.2761E+08	.1062E+08	.3000E+00
38	.7460E-05	.2761E+08	.1062E+08	.3000E+00
39	.7460E-05	.2761E+08	.1062E+08	.3000E+00
40	.7460E-05	.2761E+08	.1062E+08	.3000E+00
41	.7460E-05	.2761E+08	.1062E+08	.3000E+00
42	.7460E-05	.2761E+08	.1062E+08	.3000E+00

SMUD RAPID COOLDOWN
F. L. BOYER

ITERATION 20 PAGE 6 DATE 04/24/78

SMUD COOLDOWN INCIDENT-SHELL

43	.7460E-05	.2761E+08	.1062E+08	.3000E+00
44	.7460E-05	.2761E+08	.1062E+08	.3000E+00
45	.7460E-05	.2761E+08	.1062E+08	.3000E+00
46	.7460E-05	.2761E+08	.1062E+08	.3000E+00
47	.7460E-05	.2761E+08	.1062E+08	.3000E+00
48	.7460E-05	.2761E+08	.1062E+08	.3000E+00
49	.7460E-05	.2761E+08	.1062E+08	.3000E+00
50	.7460E-05	.2761E+08	.1062E+08	.3000E+00
51	.7459E-05	.2761E+08	.1062E+08	.3000E+00
52	.7459E-05	.2761E+08	.1062E+08	.3000E+00
53	.7459E-05	.2762E+08	.1062E+08	.3000E+00
54	.7459E-05	.2762E+08	.1062E+08	.3000E+00
55	.7459E-05	.2762E+08	.1062E+08	.3000E+00
56	.7459E-05	.2762E+08	.1062E+08	.3000E+00
57	.7459E-05	.2762E+08	.1062E+08	.3000E+00
58	.7459E-05	.2762E+08	.1062E+08	.3000E+00
59	.7459E-05	.2762E+08	.1062E+08	.3000E+00
60	.7459E-05	.2762E+08	.1062E+08	.3000E+00
61	.7138E-05	.2759E+08	.1061E+08	.3000E+00
62	.7138E-05	.2759E+08	.1061E+08	.3000E+00
63	.7138E-05	.2759E+08	.1061E+08	.3000E+00
64	.7138E-05	.2759E+08	.1061E+08	.3000E+00
65	.7138E-05	.2759E+08	.1061E+08	.3000E+00
66	.7138E-05	.2759E+08	.1061E+08	.3000E+00
67	.7138E-05	.2759E+08	.1061E+08	.3000E+00
68	.7138E-05	.2759E+08	.1061E+08	.3000E+00
69	.7138E-05	.2759E+08	.1061E+08	.3000E+00
70	.7138E-05	.2759E+08	.1061E+08	.3000E+00

SMUD COOLDOWN INCIDENT-SHELL ITERATION 20 PAGE 7 DATE 04/24/78

PRESSURE INPUT DATA BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	INTERNAL PRESSURE	EXTERNAL PRESSURE
1.0	70.0	1500.0	0.0

MECHANICAL LOADING ON SEGMENTAL GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	RADIAL FORCE	MOMENT	AXIAL FORCE
1.0	70.0	0.	0.	0.

STRESS CONCENTRATION FACTORS BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	INSIDE TENSION	INSIDE BENDING	OUTSIDE TENSION	OUTSIDE BENDING
1	10	1.00	1.00	1.00	1.00
11	13	1.57	1.35	1.57	1.35
14	70	1.00	1.00	1.00	1.00

SMUD RAPID COOLDOWN
F. L. BOYER
A-31

SMUD COOLDOWN INCIDENT-SHELL ITERATION 20 PAGE 8 DATE 04/24/78

TEMPERATURES PER SEGMENT USED IN PRIMARY + SECONDARY ANALYSIS

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5	SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	501.	499.	495.	491.	488.	36	505.	500.	495.	489.	484.
2	501.	498.	495.	491.	488.	37	506.	500.	495.	489.	484.
3	501.	498.	495.	491.	488.	38	505.	500.	495.	489.	484.
4	501.	498.	495.	491.	488.	39	506.	500.	495.	489.	484.
5	501.	498.	495.	491.	488.	40	506.	500.	495.	489.	484.
6	501.	498.	495.	491.	488.	41	506.	500.	495.	489.	484.
7	501.	498.	495.	491.	488.	42	506.	500.	495.	489.	484.
8	501.	499.	495.	491.	488.	43	506.	500.	495.	489.	484.
9	501.	499.	495.	491.	488.	44	506.	500.	495.	489.	484.
10	501.	499.	495.	491.	488.	45	506.	500.	495.	489.	483.
11	503.	499.	495.	491.	487.	46	507.	501.	495.	489.	483.
12	504.	499.	495.	490.	485.	47	508.	501.	495.	488.	482.
13	505.	500.	495.	489.	484.	48	508.	501.	495.	488.	481.
14	505.	500.	495.	489.	484.	49	509.	502.	495.	488.	480.
15	505.	500.	495.	489.	484.	50	510.	502.	495.	487.	480.
16	506.	500.	495.	489.	484.	51	510.	502.	495.	487.	479.
17	505.	500.	495.	489.	484.	52	511.	503.	495.	485.	478.
18	506.	500.	495.	489.	484.	53	512.	503.	495.	486.	477.
19	506.	500.	495.	489.	484.	54	512.	503.	495.	486.	477.
20	506.	500.	495.	489.	484.	55	513.	504.	495.	485.	476.
21	506.	500.	495.	489.	484.	56	513.	504.	495.	485.	476.
22	506.	500.	495.	489.	484.	57	513.	504.	495.	485.	476.
23	505.	500.	495.	489.	484.	58	513.	504.	495.	485.	476.
24	505.	500.	495.	489.	484.	59	513.	504.	495.	485.	476.
25	506.	500.	495.	489.	484.	60	513.	504.	495.	485.	476.
26	505.	500.	495.	489.	484	61	513.	504.	495.	485.	476.
27	506.	500.	495.	489.	484.	62	513.	504.	495.	485.	476.
28	505.	500.	495.	489.	484.	63	513.	504.	495.	485.	476.
29	506.	500.	495.	489.	484.	64	513.	504.	495.	485.	476.
30	506.	500.	495.	489.	484.	65	513.	504.	495.	485.	476.
31	506.	500.	495.	489.	484.	66	513.	504.	495.	485.	476.
32	506.	500.	495.	489.	484.	67	513.	504.	495.	485.	476.
33	506.	500.	495.	489.	484.	68	513.	504.	495.	485.	476.
34	506.	500.	495.	489.	484.	69	513.	504.	495.	485.	476.
35	506.	500.	495.	489.	484.	70	513.	504.	495.	485.	476.

SMUD RAPID COOLDOW

F. L. BOYER A-32

SMUD COOLDOWN INCIDENT-SHELL ITERATION 20 PAGE 9 DATE 04/24/78

PRIMARY + SECONDARY BOUNDARY AND FLEXABILITY MATRICES

BOUNDARY FORCES DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL SHEAR (O)	MOMENT (O)	RADIAL SHEAR (N)	MOMENT (N)	SUM
AXIAL FORCE (N)	0.	0.	0.	.1260E+04	0.	0.	0.	0.	.1260E+04
RADIAL SHEAR (O)	0.	0.	0.	0.	0.	0.	0.	0.	0.
MOMENT (O)	0.	0.	0.	0.	0.	0.	0.	0.	0.
RADIAL SHEAR (N)	0.	0.	0.	0.	0.	0.	0.	0.	0.
MOMENT (N)	0.	0.	0.	0.	0.	0.	0.	0.	0.

FLEXIBILITY MATRIX DUE TO A UNIT LOAD (TOTAL LOAD BASIS)

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL SHEAR (O)	MOMENT (O)	RADIAL SHEAR (N)	MOMENT (N)
AXIAL DEFL. (N)	.1085E+01	.4706E-01	0.	.1506E-06	.1241E-09	.2139E-11	.7263E-09	.6854E-09
RADIAL DEFL. (O)	-.3291E+00	-.2833E-01	0.	.1241E-09	.3543E-08	-.1325E-09	.5457E-18	-.2592E-17
ROTATION (O)	-.2811E-03	-.8443E-04	0.	.2139E-11	-.1325E-09	.1072E-10	.1091E-18	.1481E-18
RADIAL DEFL. (N)	.1824E-02	.2951E-03	0.	.7263E-09	.5457E-18	.1091E-18	.6648E-09	.5722E-11
ROTATION (N)	-.1865E-04	.2385E-06	0.	.6854E-09	-.2592E-17	.1481E-18	.5722E-11	.2422E-09

BOUNDARY DEFLECTIONS DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL SHEAR (O)	MOMENT (O)	RADIAL SHEAR (N)	MOMENT (N)	SUM
AXIAL DEFL. (N)	.1085E+01	.4706E-01	0.	.1897E-03	0.	0.	0.	0.	.1132E+01
RADIAL DEFL. (O)	-.3291E+00	-.2833E-01	0.	.1563E-06	0.	0.	0.	0.	-.3574E+00
ROTATION (O)	-.2811E-03	-.8443E-04	0.	.2694E-08	0.	0.	0.	0.	-.3655E-03
RADIAL DEFL. (N)	.1824E-02	.2951E-03	0.	.9148E-06	0.	0.	0.	0.	.2120E-02
ROTATION (N)	-.1865E-04	.2385E-06	0.	.8633E-06	0.	0.	0.	0.	-.1755E-04

SMUD RAPID COOLDOWN

F. L. BOYER

SMUD COOLDOWN INCIDENT-SHELL ITERATION 20 PAGE 10 DATE 04/24/78

FLEXIBILITY MATRIX OF ASSEMBLY AS IN PROGRAM 91060
(THIS MATRIX ONLY IS ON A PER RADIAN BASIS)

	M(O)	Q(O)	M(N)	Q(N)
ROTATION(O)	.673543E-10	.832500E-09	.930326E-18	.685644E-18
DEFLECTION(O)	.832500E-09	.222615E-07	.162864E-16	-.342867E-17
ROTATION(N)	.930326E-18	.162864E-16	.152149E-08	.359504E-10
DEFLECTION(N)	.685644E-18	-.342867E-17	.359504E-10	.417684E-08

NOTE- THE +1 SIGN CONVENTION IS USED IN THE MATRIX PRINTED HERE.
IF IT IS DESIRED TO USE THE -1 SIGN CONVENTION THEN THE
SIGNS MUST BE CHANGED ON ALL OF THE OFF-DIAGONAL ELEMENTS.

SMUD RAPID COOLDOWN
F. L BOYER
A-34

SMUD COOLDOWN INCIDENT-SHELL ITERATION 20 PAGE 11 DATE 04/24/78

PRIMARY + SECONDARY FORCES AND MOTIONS

POSITIVE DIRECTIONS (+) ARE AS FOLLOWS

TOP OF SEGMENT NO.1	BOTTOM OF REMAINING SEGMENTS
RADIAL------ TO THE LEFT	RADIAL------ TO THE RIGHT
ROTATIONAL-- CLOCKWISE	ROTATIONAL-- COUNTERCLOCKWISE
AXIAL------- UPWARD	AXIAL------- DOWNWARD

** SIGN CONVENTIONS ARE FOR A RIGHT HAND VIEW **

SEG. NO.	LOC.	RADIAL FORCE	MOMENT	AXIAL FORCE	LOC.	RADIAL MOTION	ROTATION	AXIAL MOTION
1	TOP	0.	0.	.3350E+08	TOP	-.3574E+00	-.3655E-03	0.
1	BOT.	-.4358E+06	.9734E+06	.3350E+08	BOT.	.3589E+00	.3307E-03	.1595E-01
2	BOT.	-.7390E+06	.3503E+07	.3350E+08	BOT.	.3601E+00	.2985E-03	.3187E-01
3	BOT.	-.9218E+06	.7054E+07	.3350E+08	BOT.	.3613E+00	.2712E-03	.4779E-01
4	BOT.	-.9973E+06	.1115E+08	.3350E+08	BOT.	.3623E+00	.2502E-03	.6368E-01
5	BOT.	-.9746E+06	.1515E+08	.3350E+08	BOT.	.3633E+00	.2360E-03	.7956E-01
6	BOT.	-.8594E+06	.1925E+08	.3350E+08	BOT.	.3642E+00	.2286E-03	.9544E-01
7	BOT.	-.6543E+06	.2249E+08	.3350E+08	BOT.	.3651E+00	.2269E-03	.1113E+00
8	BOT.	-.3598E+06	.2465E+08	.3350E+08	BOT.	.3660E+00	.2297E-03	.1271E+00
9	BOT.	.2985E+05	.2539E+08	.3350E+08	BOT.	.3670E+00	.2347E-03	.1430E+00
10	BOT.	.5157E+06	.2427E+08	.3350E+08	BOT.	.3680E+00	.2392E-03	.1588E+00
11	BOT.	.8750E+06	.2439E+08	.3389E+08	BOT.	.3682E+00	.2400E-03	.1653E+00
12	BOT.	.1104E+07	.2335E+08	.3429E+08	BOT.	.3683E+00	.2417E-03	.1719E+00
13	BOT.	.1199E+07	.2164E+08	.3469E+08	BOT.	.3685E+00	.2454E-03	.1786E+00
14	BOT.	.7216E+06	.1657E+08	.3469E+08	BOT.	.3699E+00	.2474E-03	.1988E+00
15	BOT.	.3635E+06	.1375E+08	.3469E+08	BOT.	.3713E+00	.2249E-03	.2191E+00
16	BOT.	.1117E+06	.1253E+08	.3469E+08	BOT.	.3724E+00	.1897E-03	.2393E+00
17	BOT.	-.5130E+05	.1241E+08	.3469E+08	BOT.	.3733E+00	.1502E-03	.2595E+00
18	BOT.	-.1466E+06	.1295E+08	.3469E+08	BOT.	.3740E+00	.1118E-03	.2797E+00
19	BOT.	-.1910E+06	.1388E+08	.3469E+08	BOT.	.3745E+00	.7735E-04	.2999E+00
20	BOT.	-.2009E+06	.1493E+08	.3469E+08	BOT.	.3748E+00	.5011E-04	.3200E+00
21	BOT.	-.1933E+06	.1593E+08	.3469E+08	BOT.	.3750E+00	.2873E-04	.3402E+00
22	BOT.	-.1659E+06	.1692E+08	.3469E+08	BOT.	.3751E+00	.1349E-04	.3604E+00
23	BOT.	-.1376E+06	.1773E+08	.3469E+08	BOT.	.3751E+00	.3676E-05	.3805E+00
24	BOT.	-.1096E+06	.1839E+08	.3469E+08	BOT.	.3751E+00	-.1615E-05	.4007E+00
25	BOT.	-.8113E+05	.1889E+08	.3469E+08	BOT.	.3750E+00	-.3321E-05	.4209E+00
26	BOT.	-.5571E+05	.1925E+08	.3469E+08	BOT.	.3750E+00	-.2340E-05	.4410E+00
27	BOT.	-.3713E+05	.1949E+08	.3469E+08	BOT.	.3750E+00	.4908E-06	.4612E+00
28	BOT.	-.8381E+04	.1959E+08	.3469E+08	BOT.	.3750E+00	.4374E-05	.4814E+00
29	BOT.	.2733E+05	.1957E+08	.3469E+08	BOT.	.3751E+00	.8529E-05	.5015E+00
30	BOT.	.4704E+05	.1940E+08	.3469E+08	BOT.	.3751E+00	.1298E-04	.5217E+00
31	BOT.	.8278E+05	.1905E+08	.3469E+08	BOT.	.3752E+00	.1404E-04	.5418E+00
32	BOT.	.1256E+06	.1851E+08	.3469E+08	BOT.	.3753E+00	.1322E-04	.5620E+00

F. L. BOYER

SMUD RAPID COOLDOWN

SMUD COOLDOWN INCIDENT-SHELL ITERATION 20 PAGE 12 DATE 04/24/78

33	BOT.	.1754E+06	.1771E+08	.3469E+08	ROT.	.3754E+00	.8224E-05	.5822E+00
34	BOT.	.2303E+06	.1664E+08	.3469E+08	ROT.	.3754E+00	-.2582E-05	.6023E+00
35	BOT.	.2854E+06	.1525E+08	.3469E+08	ROT.	.3754E+00	-.2097E-04	.6225E+00
36	BOT.	.3339E+06	.1361E+08	.3469E+08	ROT.	.3752E+00	-.4871E-04	.6426E+00
37	BOT.	.3620E+06	.1175E+08	.3469E+08	ROT.	.3749E+00	-.8729E-04	.6628E+00
38	BOT.	.3527E+06	.9827E+07	.3469E+08	ROT.	.3744E+00	-.1375E-03	.6830E+00
39	BOT.	.2827E+06	.8105E+07	.3469E+08	ROT.	.3735E+00	-.1984E-03	.7032E+00
40	BOT.	.1233E+06	.6983E+07	.3469E+08	ROT.	.3723E+00	-.2690E-03	.7234E+00
41	BOT.	-.1591E+06	.7013E+07	.3469E+08	ROT.	.3707E+00	-.3422E-03	.7436E+00
42	BOT.	-.6003E+06	.8953E+07	.3469E+08	ROT.	.3686E+00	-.4090E-03	.7638E+00
43	BOT.	-.1234E+07	.1374E+08	.3469E+08	ROT.	.3662E+00	-.4547E-03	.7841E+00
44	BOT.	-.2087E+07	.2247E+08	.3469E+08	ROT.	.3636E+00	-.4593E-03	.8045E+00
45	BOT.	-.2249E+07	.2112E+08	.3469E+08	ROT.	.3625E+00	-.4537E-03	.8087E+00
46	BOT.	-.2535E+07	.2003E+08	.3469E+08	ROT.	.3616E+00	-.4506E-03	.8129E+00
47	BOT.	-.2796E+07	.1913E+08	.3469E+08	ROT.	.3605E+00	-.4495E-03	.8172E+00
48	BOT.	-.3041E+07	.1855E+08	.3469E+08	ROT.	.3597E+00	-.4471E-03	.8215E+00
49	BOT.	-.3390E+07	.1825E+08	.3469E+08	ROT.	.3587E+00	-.4458E-03	.8257E+00
50	BOT.	-.3722E+07	.1829E+08	.3469E+08	ROT.	.3577E+00	-.4435E-03	.8300E+00
51	BOT.	-.4077E+07	.1867E+08	.3469E+08	ROT.	.3567E+00	-.4391E-03	.8343E+00
52	BOT.	-.4454E+07	.1947E+08	.3469E+08	ROT.	.3557E+00	-.4305E-03	.8386E+00
53	BOT.	-.4854E+07	.2065E+08	.3469E+08	ROT.	.3546E+00	-.4151E-03	.8430E+00
54	BOT.	-.5275E+07	.2227E+08	.3469E+08	ROT.	.3536E+00	-.3893E-03	.8473E+00
55	BOT.	-.5716E+07	.2434E+08	.3469E+08	ROT.	.3526E+00	-.3479E-03	.8517E+00
56	BOT.	-.4800E+07	.1814E+08	.3322E+08	ROT.	.3436E+00	-.9330E-04	.8836E+00
57	BOT.	-.1164E+08	.1343E+08	.3123E+08	ROT.	.3324E+00	-.3156E-04	.9149E+00
58	BOT.	-.1409E+08	.1039E+08	.2880E+08	ROT.	.3192E+00	-.1066E-03	.9450E+00
59	BOT.	-.1615E+08	.9270E+07	.2600E+08	ROT.	.3018E+00	-.2507E-03	.9733E+00
60	BOT.	-.1788E+08	.1085E+08	.2293E+08	ROT.	.2804E+00	-.3654E-03	.9992E+00
61	BOT.	-.1806E+08	.1243E+08	.1969E+08	ROT.	.2583E+00	-.3302E-03	.1022E+01
62	BOT.	-.1785E+08	.1177E+08	.1639E+08	ROT.	.2343E+00	-.2265E-03	.1042E+01
63	BOT.	-.1717E+08	.1019E+08	.1314E+08	ROT.	.2091E+00	-.1232E-03	.1062E+01
64	BOT.	-.1600E+08	.8403E+07	.1006E+08	ROT.	.1826E+00	-.4736E-04	.1079E+01
65	BOT.	-.1431E+08	.6764E+07	.7242E+07	ROT.	.1548E+00	-.2698E-05	.1095E+01
66	BOT.	-.1215E+08	.5290E+07	.4787E+07	ROT.	.1254E+00	.1747E-04	.1108E+01
67	BOT.	-.9550E+07	.3735E+07	.2776E+07	ROT.	.9590E-01	.2200E-04	.1118E+01
68	BOT.	-.6637E+07	.2639E+07	.1277E+07	ROT.	.6508E-01	.1804E-04	.1126E+01
69	BOT.	-.3477E+07	.1355E+07	.3421E+06	ROT.	.3369E-01	.9612E-05	.1130E+01
70	BOT.	0.	0.	.1260E+04	ROT.	.2120E-02	-.1755E-04	.1132E+01

(FORCE AND MOTION OUTPUT IS IN GLOBAL DIRECTIONS R AND Z)

SMUD RAPID COOLDOWN

F. L. BOYER

A-36

SMUD COOLDOWN INCIDENT-SHELL ITERATION 20 PAGE 13 DATE 04/24/78

PRIMARY + SECONDARY STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	4529.9	7342.4	-.0	4972.1	9373.1	-543.9	5349.6	11574.8	-1478.2
2	4343.1	7656.2	-.0	4977.2	9774.2	-538.2	5538.9	12069.7	-1475.2
3	4093.5	7907.1	-.0	4984.4	10131.1	-530.9	5805.5	12539.3	-1472.2
4	3902.7	8114.3	-.0	4992.8	10453.3	-522.8	6113.1	12983.3	-1469.2
5	3501.9	8296.8	-.0	5001.4	10751.2	-514.4	6424.0	13403.1	-1466.4
6	3222.1	8472.9	-.0	5009.6	11035.4	-506.3	6722.8	13801.1	-1463.6
7	2991.2	8660.1	-.0	5016.6	11315.6	-498.9	6965.5	14179.5	-1461.1
8	2935.4	8874.1	-.0	5021.6	11600.3	-492.8	7128.5	14539.7	-1458.7
9	2785.7	9128.9	-.0	5023.9	11895.3	-488.5	7182.5	14875.4	-1456.6
10	2464.1	9435.6	-.0	5022.4	12203.5	-486.5	7097.3	15186.5	-1454.7
11	3074.7	9435.0	-.0	5520.9	12547.2	-368.4	8089.6	15952.3	-1188.3
12	3349.8	9436.3	.0	6381.1	12907.2	-376.1	9333.2	16556.7	-1194.5
13	3759.5	9646.9	-.0	7354.8	13317.2	-387.2	10870.7	17351.8	-1201.3
14	4519.7	10100.4	-.0	7365.5	13738.0	-522.8	10132.6	17518.3	-1473.8
15	4931.5	10612.5	.0	7357.1	14149.8	-529.5	9707.2	17449.7	-1473.4
16	5107.4	10997.2	-.0	7353.4	14501.8	-532.2	9526.2	18170.4	-1472.5
17	5123.0	11267.4	-.0	7353.0	14793.8	-532.4	9510.7	18466.2	-1471.5
18	5037.5	11442.4	-.0	7354.5	14996.3	-531.0	9597.5	18719.5	-1470.4
19	4703.3	11542.7	-.0	7357.1	15146.4	-528.[illegible]	9734.4	18920.6	-1469.4
20	4747.4	11588.0	-.0	7360.1	15244.4	-526.2	9949.7	19073.3	-1469.6
21	4593.2	11545.6	-.0	7363.1	15301.9	-523.7	10059.1	19182.2	-1468.0
22	4453.5	11579.8	-.0	7365.9	15329.8	-521.5	10203.4	19255.0	-1467.5
23	4334.6	11551.7	-.0	7368.2	15318.0	-519.5	10326.2	19300.5	-1467.1
24	4239.5	11519.8	-.0	7370.1	15336.8	-518.0	10425.5	19326.9	-1466.9
25	4164.6	11490.1	-.0	7371.6	15327.0	-516.8	10501.9	19341.4	-1466.7
26	4111.2	11466.7	-.0	7372.6	15319.5	-515.9	10556.9	19349.8	-1466.6
27	4077.0	11453.3	-.0	7373.3	15316.0	-515.3	10592.3	19356.7	-1465.2
28	4061.1	11451.2	-.0	7373.7	15318.9	-515.0	10608.7	19364.6	-1465.5
29	4064.4	11461.8	-.0	7373.7	15329.1	-514.9	10605.3	19374.5	-1466.4
30	4089.1	11485.6	-.0	7373.3	15345.6	-515.0	10579.9	19385.4	-1466.4
31	4137.2	11522.3	-.0	7372.4	15369.7	-515.6	10528.2	19394.3	-1466.4
32	4217.8	11570.2	-.0	7371.0	15394.9	-516.3	10444.9	19396.1	-1466.4
33	4335.7	11625.9	-.0	7368.9	15417.0	-517.6	10324.3	19383.3	-1466.6
34	4494.7	11643.5	-.0	7366.0	15427.9	-519.5	10161.2	19345.8	-1466.8
35	4695.3	11733.7	-.0	7362.4	15416.8	-522.1	9953.0	19271.5	-1467.2
36	4939.2	11762.6	-.0	7357.9	15379.1	-525.3	9702.1	19146.3	-1467.8
37	5213.1	11751.4	-.0	7352.7	15270.8	-524.3	9419.1	18955.7	-1468.6
38	5495.1	11675.5	-.0	7347.3	15099.8	-533.8	9126.5	18685.1	-1469.8
39	5750.5	11505.1	-.0	7342.3	14917.2	-534.5	8803.3	18327.8	-1471.2
40	5918.1	11205.2	-.0	7338.6	14464.5	-542.7	8689.5	17879.5	-1473.0
41	5915.5	10739.1	-.0	7337.8	13969.0	-545.5	8690.2	17353.1	-1474.9
42	5535.9	10072.0	-.0	7341.9	13348.5	-545.7	8978.8	16780.6	-1476.9
43	4938.6	9178.6	-.0	7353.3	12620.4	-541.3	9697.5	16222.8	-1478.6

SMUD RAPID COOLDOWN

F. L. BOYER

A-37

SMUD COOLDOWN INCIDENT-SHELL ITERATION 20 PAGE 14 DATE 04/24/78

44	3562.8	8052.6	-.0	7375.2	11829.2	-530.2	11313.3	15777.7	-1479.6
45	3845.4	7760.6	-.0	7532.5	117[illegible]	-501.7	11337.6	15896.5	-1438.5
46	4067.9	7582.7	.0	7903.6	117[illegible].4	-503.4	11658.[illegible]	15981.8	-1440.2
47	4265.5	7396.0	-.0	8195.1	[illegible]60.6	-505.0	12047.[illegible]	16085.4	-1441.8
48	4429.9	7195.3	-.0	8509.3	11525.2	-506.3	12506.7	16211.7	-1443.4
49	4542.1	6978.7	-.0	8848.8	11594.8	-507.2	13072.9	16366.5	-1444.9
50	4583.2	6736.8	.0	9216.7	11570.1	-507.6	13767.0	16557.4	-1446.3
51	4527.2	6463.3	.0	9616.5	11552.2	-507.2	14621.9	16794.2	-1447.6
52	4361.2	6144.1	-.0	10052.5	11543.0	-506.9	15678.7	17089.9	-1448.7
53	3982.6	5782.9	.0	10524.6	11545.3	-503.9	16940.0	17461.3	-1449.6
54	3395.0	5350.9	-.0	11053.5	11563.1	-499.7	18622.5	17930.9	-1450.3
55	2509.3	4435.3	.0	11631.3	11602.3	-494.1	20662.2	18529.1	-1450.7
56	4545.0	5094.7	.0	11868.7	11242.4	-262.2	19194.6	17525.3	-1431.0
57	6265.3	5405.1	-.0	11955.7	11125.5	-337.6	17485.4	16893.0	-1443.1
58	7249.3	5528.9	.0	11865.3	10959.7	-389.7	16433.6	16645.1	-1451.3
59	7525.9	5058.1	-.0	11915.0	10462.5	-414.2	16203.3	15935.9	-1455.6
60	6457.4	3795.4	-.0	12050.2	9530.9	-409.0	17303.9	15360.7	-1454.9
61	5397.5	6738.9	.0	11964.7	13041.4	-349.0	18606.5	14334.2	-1439.4
62	5152.0	6293.9	-.0	11900.0	12430.6	-324.5	18777.6	18659.0	-1437.5
63	5355.5	6045.9	-.0	11860.5	12026.7	-327.9	18476.0	18086.6	-1439.3
64	5592.4	6033.1	-.0	11844.5	11810.1	-342.0	18090.5	17644.3	-1442.1
65	5397.5	6125.1	-.0	11845.5	11770.0	-356.9	17774.7	17483.5	-1444.7
66	6215.3	6240.7	-.0	11855.6	11781.9	-364.5	17509.6	17390.5	-1446.5
67	6345.4	6340.9	.0	11868.2	11821.5	-375.8	17460.1	17369.6	-1447.5
68	6413.9	6415.0	-.0	11877.2	11864.6	-379.9	17409.1	17382.0	-1449.0
69	6438.2	6473.8	-.0	11868.1	11911.5	-382.0	17365.7	17417.4	-1449.2
70	6383.5	10998.8	-.0	12317.7	19274.9	-383.0	18398.9	27949.5	-1448.3

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

SMUD RAPID COOLDOWN

F. L. BOYER

A-38

SMUD COOLDOWN INCIDENT-SHELL

STRESS INTENSITY PROGRAM OUT (IN KIPS)

STRESS AT BOTTOM OF SEGMENT NO. 13.

ITER	PRIMARY + SECONDARY STRESS INTENSITIES						PEAK STRESS INTENSITIES					
	L - R		R - H		H - L		L - R		R - H		H - L	
	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
20	12.1	3.8	-18.5	-9.5	6.5	5.7	23.6	9.0	-25.1	-11.4	1.5	2.4
40	37.1	-14.4	-48.0	.6	10.8	13.8	61.0	-9.2	-59.7	-4.6	-1.2	13.8
60	42.7	-20.3	-54.0	1.6	11.3	18.7	67.2	-17.0	-65.0	-3.2	-2.2	20.2
100	25.5	-7.4	-34.7	-10.8	9.4	18.3	37.1	-6.0	-37.8	-11.4	.7	17.3

STRESS OUTPUT ANALYSIS

STRESS	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
MAXIMUM	42.7	3.8	0.0	1.6	11.3	18.7	67.2	9.0	0.0	0.0	1.5	20.2
MINIMUM	0.0	-20.3	-54.0	-10.8	0.0	0.0	0.0	-17.0	-65.0	-11.4	-2.2	0.0
RANGE	42.7	24.1	54.0	12.5	11.3	16.7	67.2	26.0	65.0	11.4	3.6	20.2

SMUD RAPID COOLDOWN
F. L. BOYER
A-39

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION INSTRUMENTATION DATE 04/20/78

DIMENSIONS

INSIDE RADIUS = .3125 INCHES OUTSIDE RADIUS = 1.0000 INCHES

NO. OF NODES = 9 RADIAL INCREMENT = .0859 INCHES

MATERIAL CODE = 5 POISSON S RATIO = .3000

L = -0.0000

INITIAL CONDITIONS

NODE	RADIUS	TEMPERATURE
1	.3125	565.0
2	.3984	565.0
3	.4844	565.0
4	.5703	565.0
5	.6563	565.0
6	.7422	565.0
7	.8281	565.0
8	.9141	565.0
9	1.0000	565.0

SMUD RAPID COOLDOWN
F. L BOYER
A-40

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION INSTRUMENTATION DATE 04/20/78

TABULATION OF
BOUNDARY CONDITIONS

FLUID TEMP. CURVE APPROXIMATION		FILM COEFF. CURVE APPROXIMATION		PRESSURE CURVE APPROXIMATION	
TIME (MINUTES)	INSIDE FLUID TEMPERATURE	TIME (MINUTES)	INSIDE FILM COEFFICIENT	TIME (MINUTES)	PRESSURE (PSI)
0.0000	565.0	0.0000	150.0	0.0000	0.
5.0000	565.0	140.0000	150.0	0.0000	0.
10.0000	590.0	0.0000	0.0	0.0000	0.
15.0000	590.0	0.0000	0.0	0.0000	0.
20.0000	525.0	0.0000	0.0	0.0000	0.
40.0000	380.0	0.0000	0.0	0.0000	0.
60.0000	300.0	0.0000	0.0	0.0000	0.
80.0000	280.0	0.0000	0.0	0.0000	0.
95.0000	290.0	0.0000	0.0	0.0000	0.
110.0000	305.0	0.0000	0.0	0.0000	0.
140.0000	340.0	0.0000	0.0	0.0000	0.

TEMPERATURE CALCULATION TIMES AND PRINTOUTS

TIME INCREMENT (MINUTES)	TIME LIMIT (MINUTES)	NUMBER OF PRINTOUTS
.5000	20.000	20.
.5000	80.000	120.
1.0000	140.000	60.

SMUD RAPID COOLDOWN
F. L. BOYER A-41

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION INSTRUMENTATION DATE 04/20/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
1.0000		-0.	-0.	0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
2.0000		-0.	-0.	0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
3.0000		-0.	-0.	0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
4.0000		-0.	-0.	0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
5.0000		-0.	-0.	0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
6.0000		-149.	-261.	55.	566.4	566.1	565.9	565.7	565.6	565.5	565.5	565.5	565.5		
7.0000		-272.	-464.	121.	568.9	568.2	567.8	567.5	567.3	567.1	567.0	567.0	567.0		
8.0000		-365.	-627.	153.	571.7	571.0	570.4	570.0	569.7	569.5	569.4	569.3	569.3		
9.0000		-437.	-747.	195.	575.1	574.3	573.6	573.1	572.8	572.5	572.4	572.3	572.2		
10.0000		-492.	-839.	220.	578.9	577.9	577.2	576.7	576.3	576.0	575.8	575.7	575.7		
11.0000		-383.	-649.	174.	581.5	580.8	580.2	579.8	579.5	579.3	579.1	579.1	579.0		
12.0000		-295.	-497.	133.	583.5	583.0	582.5	582.2	582.0	581.8	581.7	581.6	581.6		
13.0000		-223.	-390.	102.	585.0	584.6	584.3	584.0	583.9	583.7	583.6	583.6	583.6		
14.0000		-172.	-291.	78.	586.2	585.9	585.6	585.4	585.3	585.2	585.1	585.1	585.1		
15.0000		-132.	-222.	60.	587.1	586.8	586.7	586.5	586.4	586.3	586.3	586.2	586.2		
16.0000		284.	506.	-123.	584.0	584.6	585.1	585.4	585.6	585.8	585.9	585.9	585.9		
17.0000		627.	1084.	-277.	579.5	579.8	580.7	581.4	581.9	582.3	582.5	582.6	582.7		
18.0000		891.	1529.	-397.	571.3	573.1	574.4	575.3	576.1	576.6	576.9	577.1	577.2		
19.0000		1094.	1873.	-498.	562.7	564.8	566.4	567.6	568.5	569.1	569.5	569.8	569.9		
20.0000		1252.	2139.	-529.	553.0	555.5	557.3	558.6	559.6	560.4	560.8	561.1	561.2		
20.5000		1231.	2092.	-551.	548.3	550.9	552.7	554.0	555.0	555.7	556.2	556.5	556.6		
21.0000		1201.	2041.	-539.	544.2	545.5	549.3	549.6	550.5	551.2	551.7	552.0	552.1		
21.5000		1175.	1996.	-527.	539.9	542.2	543.9	545.2	546.2	546.8	547.3	547.6	547.6		
22.0000		1152.	1957.	-517.	535.9	538.0	539.7	540.9	541.9	542.5	543.0	543.2	543.3		
22.5000		1132.	1924.	-508.	531.7	533.9	535.5	536.7	537.7	538.3	538.8	539.0	539.1		
23.0000		1114.	1894.	-500.	527.6	529.8	531.4	532.6	533.5	534.2	534.6	534.9	534.9		
23.5000		1099.	1869.	-493.	523.5	525.8	527.4	528.6	529.5	530.1	530.5	530.8	530.8		
24.0000		1085.	1846.	-487.	519.7	521.8	523.4	524.6	525.4	526.1	526.2	526.7	526.8		
24.5000		1074.	1827.	-482.	515.8	517.9	519.4	520.6	521.5	522.1	522.5	522.7	522.8		
25.0000		1064.	1810.	-477.	511.9	514.0	515.5	516.7	517.5	518.2	518.6	518.8	518.9		
25.5000		1056.	1796.	-473.	508.1	510.1	511.7	512.8	513.7	514.3	514.7	514.9	515.0		
26.0000		1049.	1783.	-470.	504.2	506.3	507.8	508.9	509.8	510.4	510.8	511.0	511.1		
26.5000		1042.	1773.	-467.	500.4	502.5	504.0	505.1	506.0	506.6	507.0	507.2	507.3		
27.0000		1037.	1763.	-455.	496.7	498.7	500.2	501.3	502.2	502.8	503.2	503.4	503.5		
27.5000		1032.	1756.	-463.	492.9	494.9	496.4	497.5	498.4	499.0	499.4	499.6	499.7		
28.0000		1029.	1749.	-461.	489.2	491.2	492.7	493.8	494.6	495.2	495.6	495.8	495.9		
28.5000		1024.	1743.	-459.	485.4	487.4	488.9	490.0	490.9	491.5	491.8	492.1	492.1		
29.0000		1022.	1738.	-458.	481.7	483.7	485.2	486.3	487.1	487.7	488.1	488.3	488.4		
29.5000		1019.	1734.	-457.	478.0	480.0	481.5	482.6	483.4	484.0	484.4	484.6	484.7		

F. L. BOYER

SMUD RAPID COOLDOWN

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION INSTRUMENTATION DATE 04/20/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
30.0000		1017.	1731.	-456.	474.3	476.3	477.8	478.9	479.7	480.3	480.7	480.9	481.0		
30.5000		1015.	1728.	-455.	470.6	472.6	474.1	475.2	476.0	476.6	477.0	477.2	477.3		
31.0000		1014.	1726.	-455.	466.9	468.9	470.4	471.5	472.3	472.9	473.3	473.5	473.6		
31.5000		1013.	1725.	-454.	463.2	465.2	466.7	467.8	468.6	469.2	469.6	469.8	469.9		
32.0000		1013.	1723.	-454.	459.5	461.5	463.0	464.1	464.9	465.5	465.9	466.1	466.2		
32.5000		1012.	1722.	-454.	455.9	457.9	459.3	460.4	461.2	461.8	462.2	462.5	462.5		
33.0000		1012.	1722.	-453.	452.2	454.2	455.7	456.8	457.6	458.2	458.6	458.8	458.9		
33.5000		1011.	1721.	-453.	448.5	450.5	452.0	453.1	453.9	454.5	454.9	455.1	455.2		
34.0000		1011.	1721.	-453.	444.9	446.9	448.3	449.4	450.2	450.8	451.2	451.5	451.5		
34.5000		1011.	1721.	-453.	441.2	443.2	444.7	445.8	446.6	447.2	447.6	447.8	447.9		
35.0000		1011.	1721.	-453.	437.6	439.5	441.0	442.1	442.9	443.5	443.9	444.1	444.2		
35.5000		1012.	1722.	-454.	433.9	435.9	437.4	438.5	439.3	439.9	440.3	440.5	440.6		
36.0000		1012.	1722.	-454.	430.3	432.2	433.7	434.8	435.5	436.2	436.6	436.8	436.9		
36.5000		1012.	1723.	-454.	426.6	429.6	430.1	431.2	432.0	432.6	433.0	433.2	433.3		
37.0000		1013.	1724.	-454.	422.9	424.9	426.4	427.5	428.3	428.9	429.3	429.5	429.6		
37.5000		1013.	1725.	-454.	419.3	421.3	422.8	423.9	424.7	425.3	425.7	425.9	426.0		
38.0000		1014.	1726.	-455.	415.7	417.6	419.1	420.2	421.0	421.6	422.0	422.3	422.3		
38.5000		1015.	1727.	-455.	412.0	414.0	415.5	416.6	417.4	418.0	418.4	418.6	418.7		
39.0000		1015.	1728.	-455.	408.4	410.4	411.8	412.9	413.8	414.3	414.7	415.0	415.0		
39.5000		1016.	1729.	-455.	404.7	406.7	408.2	409.3	410.1	410.7	411.1	411.3	411.4		
40.0000		1017.	1730.	-456.	401.1	403.1	404.5	405.7	406.5	407.1	407.5	407.7	407.8		
40.5000		967.	1639.	-435.	397.8	399.7	401.1	402.2	402.9	403.5	403.9	404.1	404.2		
41.0000		916.	1557.	-412.	394.8	396.5	397.9	398.4	399.6	400.1	400.5	400.7	400.8		
41.5000		871.	1476.	-392.	391.8	393.5	394.8	395.7	396.5	397.0	397.3	397.5	397.6		
42.0000		832.	1412.	-374.	389.0	390.6	391.9	392.8	393.4	393.9	394.3	394.4	394.5		
42.5000		799.	1355.	-359.	386.3	387.9	389.0	389.9	390.6	391.0	391.3	391.5	391.6		
43.0000		767.	1305.	-345.	383.7	385.2	386.3	387.2	387.8	388.2	388.5	388.7	388.8		
43.5000		743.	1261.	-334.	381.2	382.6	383.7	384.5	385.1	385.5	385.8	386.0	386.0		
44.0000		720.	1223.	-323.	378.7	380.1	381.1	381.9	382.5	382.9	383.2	383.4	383.4		
44.5000		701.	1190.	-314.	376.3	377.7	378.7	379.4	380.0	380.4	380.7	380.8	380.9		
45.0000		683.	1161.	-307.	373.9	375.3	376.3	377.0	377.6	378.0	378.2	378.4	378.4		
45.5000		667.	1136.	-300.	371.6	372.9	373.9	374.6	375.2	375.6	375.8	376.0	376.0		
46.0000		656.	1114.	-294.	369.3	370.6	371.5	372.3	372.8	373.2	373.5	373.6	373.7		
46.5000		644.	1095.	-289.	367.1	368.4	369.3	370.0	370.5	370.9	371.2	371.3	371.3		
47.0000		634.	1079.	-285.	364.9	366.1	367.1	367.8	368.3	368.6	368.9	369.0	369.1		
47.5000		626.	1064.	-281.	362.7	363.9	364.8	365.5	366.0	366.4	366.6	366.8	366.8		
48.0000		618.	1052.	-277.	360.5	361.8	362.7	363.3	363.8	364.2	364.4	364.6	364.6		
48.5000		612.	1041.	-275.	358.4	359.6	360.5	361.2	361.7	362.0	362.3	362.4	362.4		
49.0000		606.	1031.	-272.	356.3	357.5	358.4	359.0	359.5	359.9	360.1	360.2	360.3		
49.5000		602.	1023.	-270.	354.2	355.4	356.2	356.9	357.4	357.7	358.0	358.1	358.1		

SMUD RAPID COOLDOW

F. L. BOYER

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION INSTRUMENTATION

DATE 04/20/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
50.0000		597.	1016.	-258.	352.1	353.3	354.1	354.8	355.3	355.6	355.8	356.0	356.0		
50.5000		594.	1010.	-256.	350.0	351.2	352.0	352.7	353.2	353.5	353.7	353.9	353.9		
51.0000		591.	1005.	-255.	347.9	349.1	349.9	350.6	351.1	351.4	351.6	351.8	351.8		
51.5000		588.	1000.	-264.	345.9	347.0	347.9	348.5	349.0	349.3	349.6	349.7	349.7		
52.0000		585.	997.	-253.	343.8	345.0	345.8	346.5	346.9	347.3	347.5	347.6	347.7		
52.5000		584.	993.	-262.	341.8	342.9	343.9	344.4	344.9	345.2	345.4	345.6	345.6		
53.0000		582.	990.	-251.	339.7	340.9	341.7	342.3	342.8	343.2	343.4	343.5	343.5		
53.5000		581.	988.	-250.	337.7	338.8	339.7	340.3	340.8	341.1	341.3	341.5	341.5		
54.0000		579.	986.	-250.	335.6	336.8	337.6	338.3	338.7	339.1	339.3	339.4	339.5		
54.5000		578.	984.	-259.	333.5	334.7	335.6	336.2	336.7	337.0	337.3	337.4	337.4		
55.0000		579.	983.	-259.	331.6	332.7	333.6	334.2	334.7	335.0	335.2	335.3	335.4		
55.5000		577.	982.	-259.	329.6	330.7	331.5	332.2	332.6	333.0	333.2	333.3	333.4		
56.0000		576.	981.	-258.	327.5	328.7	329.5	330.1	330.6	330.9	331.2	331.3	331.3		
56.5000		575.	980.	-258.	325.5	326.6	327.5	328.1	328.6	328.9	329.1	329.3	329.3		
57.0000		575.	979.	-258.	323.5	324.6	325.5	326.1	326.6	326.9	327.1	327.2	327.3		
57.5000		575.	979.	-258.	321.5	322.6	323.4	324.1	324.5	324.9	325.1	325.2	325.3		
58.0000		573.	978.	-258.	319.5	320.6	321.4	322.1	322.5	322.9	323.1	323.2	323.3		
58.5000		573.	978.	-258.	317.4	318.6	319.4	320.0	320.5	320.8	321.1	321.2	321.2		
59.0000		573.	978.	-259.	315.4	316.5	317.4	318.0	318.5	318.8	319.1	319.2	319.2		
59.5000		573.	978.	-258.	313.4	314.6	315.4	316.0	316.5	316.8	317.0	317.2	317.2		
60.0000		573.	978.	-258.	311.4	312.5	313.4	314.0	314.5	314.8	315.0	315.2	315.2		
60.5000		527.	890.	-237.	309.9	310.8	311.6	312.1	312.6	312.9	313.1	313.2	313.2		
61.0000		478.	807.	-215.	309.3	309.2	309.9	310.5	310.9	311.1	311.3	311.4	311.5		
61.5000		435.	735.	-196.	307.0	307.8	309.5	308.9	309.3	309.5	309.7	309.8	309.8		
62.0000		397.	672.	-179.	305.8	305.5	307.1	307.5	307.9	308.1	308.3	308.3	308.4		
62.5000		365.	617.	-164.	304.6	305.3	305.9	306.3	306.6	306.8	306.9	307.0	307.0		
63.0000		335.	569.	-151.	303.6	304.2	304.7	305.1	305.4	305.5	305.7	305.8	305.8		
63.5000		312.	527.	-140.	302.6	303.2	303.6	304.0	304.2	304.4	304.5	304.6	304.6		
64.0000		290.	491.	-139.	301.7	302.2	302.7	303.0	303.2	303.4	303.5	303.6	303.6		
64.5000		271.	459.	-122.	300.9	301.3	301.7	302.0	302.2	302.4	302.5	302.6	302.6		
65.0000		255.	432.	-115.	300.0	300.5	300.8	301.1	301.3	301.5	301.6	301.6	301.7		
65.5000		240.	408.	-108.	299.2	299.7	300.0	300.3	300.5	300.6	300.7	300.8	300.8		
66.0000		229.	387.	-103.	298.5	299.9	299.2	299.5	299.7	299.8	299.9	299.9	300.0		
66.5000		217.	368.	-98.	297.8	299.2	298.5	298.7	298.9	299.0	299.1	299.2	299.2		
67.0000		209.	352.	-93.	297.1	297.5	297.8	298.0	298.2	299.3	298.4	298.4	298.4		
67.5000		199.	339.	-90.	296.4	295.8	297.1	297.3	297.5	297.6	297.7	297.7	297.7		
68.0000		192.	326.	-86.	295.8	295.1	296.4	296.6	296.8	296.9	297.0	297.0	297.0		
68.5000		185.	316.	-94.	295.1	295.5	295.8	296.0	296.1	296.2	296.3	296.4	296.4		
69.0000		181.	307.	-81.	294.5	294.9	295.2	295.4	295.5	295.6	295.7	295.7	295.7		
69.5000		176.	299.	-79.	294.0	294.3	294.6	294.7	294.9	295.	295.1	295.2	295.1		

SMUD RAPID COOLDOWN
F. L BOYER

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION INSTRUMENTATION DATE 04/20/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
70.0000		172.	292.	-77.	293.4	293.7	294.0	294.1	294.3	294.4	294.5	294.5	294.5		
70.5000		169.	286.	-75.	292.8	293.1	293.4	293.6	293.7	293.8	293.9	293.9	293.9		
71.0000		165.	281.	-74.	292.2	292.6	292.8	293.0	293.1	293.2	293.3	293.3	293.3		
71.5000		162.	276.	-73.	291.7	292.0	292.2	292.4	292.6	292.6	292.7	292.7	292.8		
72.0000		169.	272.	-72.	291.1	291.5	291.7	291.9	292.0	292.1	292.1	292.2	292.2		
72.5000		159.	269.	-71.	290.6	290.9	291.1	291.3	291.4	291.5	291.6	291.6	291.6		
73.0000		156.	266.	-70.	290.1	290.4	290.6	290.7	290.9	291.0	291.0	291.1	291.1		
73.5000		155.	263.	-69.	289.5	289.8	290.1	290.2	290.4	290.4	290.5	290.5	290.6		
74.0000		153.	261.	-69.	289.0	289.3	289.5	289.7	289.8	289.9	290.0	290.0	290.0		
74.5000		152.	259.	-69.	288.5	288.8	289.0	289.2	289.3	289.4	289.4	289.5	289.5		
75.0000		151.	257.	-68.	288.0	288.3	288.5	288.6	288.8	288.9	288.9	288.9	289.0		
75.5000		150.	255.	-67.	287.4	287.7	288.0	288.1	288.2	288.3	288.4	288.4	288.4		
76.0000		149.	254.	-67.	286.9	287.2	287.4	287.6	287.7	287.8	287.9	287.9	287.9		
76.5000		149.	253.	-67.	286.4	286.7	286.9	287.1	287.2	287.3	287.4	287.4	287.4		
77.0000		148.	252.	-66.	285.9	286.2	286.4	286.6	286.7	286.8	286.8	286.9	286.9		
77.5000		149.	251.	-66.	285.4	285.7	285.9	286.1	286.2	286.3	286.3	286.4	286.4		
78.0000		147.	250.	-66.	284.9	285.2	285.4	285.6	285.7	285.8	285.8	285.8	285.9		
78.5000		147.	250.	-66.	284.4	284.7	284.9	285.0	285.2	285.2	285.3	285.3	285.3		
79.0000		146.	249.	-66.	283.9	284.2	284.4	284.5	284.7	284.7	284.8	284.8	284.8		
79.5000		146.	249.	-66.	283.4	283.7	283.9	284.0	284.1	284.2	284.3	284.3	284.3		
80.0000		145.	248.	-65.	282.9	283.1	283.4	283.5	283.6	283.7	283.8	283.8	283.8		
81.0000		91.	150.	-41.	282.4	282.5	282.7	282.8	282.8	282.9	282.9	283.0	283.0		
82.0000		45.	75.	-21.	282.2	282.3	282.3	282.4	282.4	282.4	282.5	282.5	282.5		
83.0000		11.	17.	-5.	282.2	282.2	282.2	282.2	282.2	282.2	282.3	282.3	282.3		
84.0000		-15.	-26.	6.	282.4	282.3	282.3	282.3	282.3	282.3	282.3	282.3	282.3		
85.0000		-34.	-60.	15.	282.6	282.6	282.5	282.5	282.5	282.4	282.4	282.4	282.4		
86.0000		-49.	-85.	22.	283.0	282.9	282.9	282.8	282.8	282.7	282.7	282.7	282.7		
87.0000		-61.	-104.	27.	283.5	283.4	283.3	283.2	283.2	283.1	283.1	283.1	283.1		
88.0000		-69.	-118.	31.	284.0	283.8	283.7	283.7	283.6	283.6	283.5	283.5	283.5		
89.0000		-76.	-129.	34.	284.5	284.4	284.3	284.2	284.1	284.1	284.0	284.0	284.0		
90.0000		-81.	-137.	36.	285.1	284.9	284.8	284.7	284.7	284.6	284.6	284.6	284.6		
91.0000		-84.	-144.	38.	285.7	285.5	285.4	285.3	285.2	285.2	285.2	285.1	285.1		
92.0000		-87.	-148.	39.	286.3	286.1	286.0	285.9	285.8	285.8	285.8	285.7	285.7		
93.0000		-89.	-152.	40.	286.9	286.8	286.6	286.5	286.5	286.4	286.4	286.3	286.3		
94.0000		-91.	-155.	41.	287.5	287.4	287.3	287.2	287.1	287.0	287.0	287.0	287.0		
95.0000		-92.	-157.	41.	288.2	288.0	287.9	287.8	287.7	287.7	287.6	287.6	287.6		
96.0000		-104.	-178.	47.	289.0	288.8	288.6	288.5	288.4	288.3	288.3	288.3	288.3		
97.0000		-114.	-194.	51.	289.8	289.6	289.4	289.3	289.2	289.1	289.1	289.0	289.0		
98.0000		-121.	-206.	54.	290.6	290.4	290.2	290.1	290.0	289.9	289.9	289.8	289.8		
99.0000		-126.	-216.	57.	291.5	291.3	291.1	291.0	290.9	290.8	290.7	290.7	290.7		

SMUD RAPID COOLDOW

F. L. BOYER

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION INSTRUMENTATION DATE 04/20/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
100.0000		-131.	-223.	59.	292.4	292.2	292.0	291.9	291.8	291.7	291.6	291.6	291.6		
101.0000		-134.	-228.	60.	293.4	293.1	292.9	292.8	292.7	292.6	292.5	292.5	292.5		
102.0000		-135.	-232.	61.	294.3	294.1	293.9	293.7	293.6	293.5	293.5	293.5	293.4		
103.0000		-138.	-235.	62.	295.3	295.0	294.8	294.7	294.6	294.5	294.4	294.4	294.4		
104.0000		-139.	-237.	62.	296.3	296.0	295.8	295.6	295.5	295.5	295.4	295.4	295.4		
105.0000		-140.	-239.	63.	297.3	297.0	296.8	296.6	296.5	296.4	296.4	296.3	296.3		
106.0000		-141.	-240.	63.	298.2	298.0	297.8	297.6	297.5	297.4	297.4	297.3	297.3		
107.0000		-142.	-241.	63.	299.2	298.9	298.7	298.6	298.5	298.4	298.3	298.3	298.3		
108.0000		-142.	-242.	64.	300.2	299.9	299.7	299.6	299.5	299.4	299.3	299.3	299.3		
109.0000		-142.	-242.	64.	301.2	300.9	300.7	300.6	300.5	300.4	300.3	300.3	300.3		
110.0000		-143.	-243.	64.	302.2	301.9	301.7	301.6	301.4	301.4	301.3	301.3	301.3		
111.0000		-149.	-253.	66.	303.3	303.0	302.7	302.6	302.5	302.4	302.3	302.3	302.3		
112.0000		-153.	-260.	68.	304.3	304.0	303.8	303.6	303.5	303.4	303.4	303.3	303.3		
113.0000		-156.	-266.	70.	305.4	305.1	304.9	304.7	304.6	304.5	304.4	304.4	304.4		
114.0000		-159.	-270.	71.	306.5	306.2	306.0	305.8	305.7	305.6	305.5	305.5	305.5		
115.0000		-161.	-274.	72.	307.7	307.4	307.1	306.9	306.8	306.7	306.7	306.6	306.6		
116.0000		-162.	-276.	73.	308.9	308.5	308.3	308.1	307.9	307.8	307.8	307.7	307.7		
117.0000		-163.	-278.	73.	310.0	309.6	309.4	309.2	309.1	309.0	308.9	308.9	308.9		
118.0000		-164.	-279.	74.	311.1	310.8	310.5	310.4	310.2	310.1	310.1	310.0	310.0		
119.0000		-165.	-280.	74.	312.3	311.9	311.7	311.5	311.4	311.3	311.2	311.2	311.2		
120.0000		-165.	-281.	74.	313.4	313.1	312.8	312.7	312.5	312.4	312.4	312.3	312.3		
121.0000		-165.	-282.	74.	314.6	314.2	314.0	313.8	313.7	313.6	313.5	313.5	313.5		
122.0000		-165.	-282.	74.	315.7	315.4	315.2	315.0	314.8	314.7	314.7	314.6	314.6		
123.0000		-165.	-282.	74.	316.9	316.6	316.3	[illegible]	316.0	315.9	315.8	315.8	315.8		
124.0000		[illegible]	-283.	74.	318.1	317.7	317.5	[illegible]	317.2	317.1	317.0	317.0	317.0		
125.0000		-165.	-283.	74.	319.2	318.9	318.6	318.5	318.3	318.2	318.2	318.1	318.1		
126.0000		-165.	-283.	75.	320.4	320.1	319.8	319.6	319.5	319.4	319.3	319.3	319.3		
127.0000		-166.	-283.	75.	321.5	321.2	321.0	320.8	320.7	320.6	320.5	320.5	320.4		
128.0000		-165.	-283.	75.	322.7	322.4	322.1	322.0	321.8	321.7	321.7	321.6	321.6		
129.0000		-165.	-283.	75.	323.9	323.5	323.3	323.1	323.0	322.9	322.8	322.8	322.8		
130.0000		-166.	-283.	75.	325.0	324.7	324.5	324.3	324.2	324.1	324.0	324.0	323.9		
131.0000		-166.	-283.	75.	326.2	325.9	325.6	325.5	325.3	325.2	325.2	325.1	325.1		
132.0000		-166.	-283.	74.	327.4	327.0	326.8	326.6	326.5	326.4	326.3	326.3	326.3		
133.0000		-165.	-283.	74.	328.5	328.2	328.0	327.8	327.7	327.6	327.5	327.5	327.4		
134.0000		-166.	-283.	74.	329.7	329.4	329.1	329.0	328.8	329.7	328.7	328.6	328.6		
135.0000		-166.	-283.	74.	330.9	330.5	330.3	330.1	330.0	329.9	329.8	329.8	329.8		
136.0000		-166.	-283.	74.	332.0	331.7	331.5	331.3	331.1	331.1	331.0	331.0	330.9		
137.0000		-165.	-292.	74.	333.2	332.9	332.6	332.4	332.3	332.2	332.2	332.1	332.1		
138.0000		-166.	-282.	74.	334.4	334.0	333.8	333.6	333.5	333.4	333.3	333.3	333.3		
139.0000		-166.	-282.	74.	335.5	335.2	335.0	334.8	334.6	334.6	334.5	334.4	334.4		

SMUD RAPID COOLDOW

F. L BOYER

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION INSTRUMENTATION DATE 04/20/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
140.0000		-165.	-282.	74.	336.7	336.4	336.1	335.9	335.8	335.7	335.7	335.6	335.6		

SMUD RAPID COOLDOWN
F. L. BOYER
A-47

SMUD COOLDOWN INCIDENT-INSTRUMENTATION ITERATION 20 PAGE 1 DATE 05/04/78

INPUT DATA DATE 05/04/78

TOTAL NO. OF SEGMENTS = 39

BOUNDARY CONDITIONS AT THE TOP (0) END

1. A RADIAL SHEAR OF	0.00000	POUNDS
2. A MOMENT OF	0.00000	INCH-LBS.

BOUNDARY CONDITIONS AT THE BOTTOM (N) END

1. AN AXIAL FORCE OF	444.10000	POUNDS
2. A RADIAL SHEAR OF	0.00000	POUNDS
3. A ROTATION OF	0.00000	RADIANS

* NOTE * A SEGMENTAL GROUP MAY CONSIST OF FROM ONE TO THE TOTAL NO. OF SEGMENTS.
SEGMENT ONE IS CONSIDERED AT THE TOP OF THE GEOMETRY.
ALL LOADS ABOVE, ARE ON A TOTAL LOAD BASIS.

SMUD COOLDOWN INCIDENT-INSTRUMENTATION ITERATION 20 PAGE 2 DATE 05/04/78

MID-SURFACE GEOMETRY

AT TOP BOUNDARY, MEAN RADIUS = .6563 Z COORDINATE = 30.0000

SEGMENTAL GEOMETRY DATA BY GROUPS

SEGMENT DATA			CENTER OF CURVATURE DATA		
BOTTOM SEG. NO.	MEAN RADIUS	Z COORD..	RADIUS TO CENTER	Z COORD.	CURVATURE IDENTIFIER
10.0	.656	20.000	0.000	0.000	0.0
13.0	.656	18.500	0.000	0.000	0.0
16.0	.656	18.125	0.000	0.000	0.0
22.0	.414	17.651	0.000	0.000	0.0
23.0	.411	17.648	0.000	0.000	0.0
24.0	.411	17.500	0.000	0.000	0.0
39.0	.411	10.000	0.000	0.000	0.0

NOTE- CURVATURE IDENTIFIER +1= POSITIVE CURVATURE
0= NO CURVATURE
-1= NEGATIVE CURVATURE

SMUD COOLDOWN INCIDENT-INSTRUMENTATION ITERATION 20 PAGE 3 DATE 05/04/78

SEGMENTAL GEOMETRY BY SEGMENTS (K= SEGMENT NO.)

MEAN RADIUS

K	R(K-1)	R(K)	R(K+1)	R(K+2)	R(K+3)	R(K+4)	R(K+5)	R(K+6)	R(K+7)	R(K+8)
1	.66	.66	.66	.66	.66	.66	.66	.66	.66	.66
11	.56	.66	.66	.66	.66	.66	.66	.62	.58	.54
21	.49	.45	.41	.41	.41	.41	.41	.41	.41	.41
31	.41	.41	.41	.41	.41	.41	.41	.41	.41	.41

Z COORDINATE

K	Z(K-1)	Z(K)	Z(K+1)	Z(K+2)	Z(K+3)	Z(K+4)	Z(K+5)	Z(K+6)	Z(K+7)	Z(K+8)
1	30.00	29.00	28.00	27.00	26.00	25.00	24.00	23.00	22.00	21.00
11	20.00	19.50	19.00	18.50	18.38	18.25	18.13	18.05	17.97	17.89
21	17.81	17.73	17.65	17.65	17.50	17.00	16.50	16.00	15.50	15.00
31	14.50	14.00	13.50	13.00	12.50	12.00	11.50	11.00	10.50	10.00

SMUD RAPID COOLDOWN
F. L. BOYER A-50

SMUD COOLDOWN INCIDENT-INSTRUMENTATION ITERATION 20 PAGE 4 DATE 05/04/78

SEGMENT THICKNESS DATA BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	TOP THICK. OF TOP SEG.	BOTTOM THICK. OF BOTTOM SEG.
1.00	16.00	.69	.69
17.00	22.00	.69	.20
23.00	23.00	.20	.21
24.00	39.00	.21	.21

SEGMENTAL THICKNESS BY SEGMENTS

THICKNESS AT TOP OF SEGMENT (HA)

K	HA(K)	HA(K+1)	HA(K+2)	HA(K+3)	HA(K+4)	HA(K+5)	HA(K+6)	HA(K+7)	HA(K+8)	HA(X+9)
1	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69
11	.69	.69	.69	.69	.69	.69	.69	.61	.53	.45
21	.36	.28	.20	.21	.21	.21	.21	.21	.21	.21
31	.21	.21	.21	.21	.21	.21	.21	.21	.21	

THICKNESS AT BOTTOM OF SEGMENT (HB)

K	HB(K)	HB(K+1)	HB(K+2)	HB(K+3)	HB(K+4)	HB(K+5)	HB(K+6)	HB(K+7)	HB(K+8)	HB(K+9)
1	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69
11	.69	.69	.69	.69	.69	.69	.61	.53	.45	.36
21	.28	.20	.21	.21	.21	.21	.21	.21	.21	.21
31	.21	.21	.21	.21	.21	.21	.21	.21	.21	

SMUD RAPID COOLDOW
F. L. BOYER
A-51

SMUD COOLDOWN INCIDENT-INSTRUMENTATION ITERATION 20 PAGE 5 DATE 05/04/78

MATERIAL PROPERTIES BY SEGMENTS

SEG. NO.	ALPHA	MODULUS OF TENSION	MODULUS OF SHEAR	POISSON<S RATIO
1	.7856E-05	.2922E+08	.1124E+08	.3000E+00
2	.7856E-05	.2922E+08	.1124E+08	.3000E+00
3	.7856E-05	.2922E+08	.1124E+08	.3000E+00
4	.7856E-05	.2922E+08	.1124E+08	.3000E+00
5	.7856E-05	.2922E+08	.1124E+08	.3000E+00
6	.7856E-05	.2922E+08	.1124E+08	.3000E+00
7	.7856E-05	.2922E+08	.1124E+08	.3000E+00
8	.7856E-05	.2922E+08	.1124E+08	.3000E+00
9	.7856E-05	.2922E+08	.1124E+08	.3000E+00
10	.7856E-05	.2922E+08	.1124E+08	.3000E+00
11	.7856E-05	.2922E+08	.1124E+08	.3000E+00
12	.7856E-05	.2922E+08	.1124E+08	.3000E+00
13	.7856E-05	.2922E+08	.1124E+08	.3000E+00
14	.7856E-05	.2922E+08	.1124E+08	.3000E+00
15	.7856E-05	.2922E+08	.1124E+08	.3000E+00
16	.7856E-05	.2922E+08	.1124E+08	.3000E+00
17	.7857E-05	.2922E+08	.1124E+08	.3000E+00
18	.7858E-05	.2922E+08	.1124E+08	.3000E+00
19	.7859E-05	.2921E+08	.1124E+08	.3000E+00
20	.7860E-05	.2921E+08	.1123E+08	.3000E+00
21	.7861E-05	.2921E+08	.1123E+08	.3000E+00
22	.7863E-05	.2920E+08	.1123E+08	.3000E+00
23	.7863E-05	.2920E+08	.1123E+08	.3000E+00
24	.7863E-05	.2920E+08	.1123E+08	.3000E+00
25	.7863E-05	.2920E+08	.1123E+08	.3000E+00
26	.7863E-05	.2920E+08	.1123E+08	.3000E+00
27	.7863E-05	.2920E+08	.1123E+08	.3000E+00
28	.7863E-05	.2920E+08	.1123E+08	.3000E+00
29	.7863E-05	.2920E+08	.1123E+08	.3000E+00
30	.7863E-05	.2920E+08	.1123E+08	.3000E+00
31	.7863E-05	.2920E+08	.1123E+08	.3000E+00
32	.7863E-05	.2920E+08	.1123E+08	.3000E+00
33	.7863E-05	.2920E+08	.1123E+08	.3000E+00
34	.7863E-05	.2920E+08	.1123E+08	.3000E+00
35	.7863E-05	.2920E+08	.1123E+08	.3000E+00
36	.7863E-05	.2920E+08	.1123E+08	.3000E+00
37	.7863E-05	.2920E+08	.1123E+08	.3000E+00
38	.7863E-05	.2920E+08	.1123E+08	.3000E+00
39	.7863E-05	.2920E+08	.1123E+08	.3000E+00

SMUD RAPID COOLDOWN
F. L. BOYER

SMUD COOLDOWN INCIDENT-INSTRUMENTATION ITERATION 20 PAGE 6 DATE 05/04/78

PRESSURE INPUT DATA BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	INTERNAL PRESSURE	EXTERNAL PRESSURE
1.0	16.0	1500.0	1500.0
17.0	39.0	1500.0	0.0

MECHANICAL LOADING ON SEGMENTAL GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	RADIAL FORCE	MOMENT	AXIAL FORCE
1.0	16.0	0.	0.	0.
17.0	17.0	.234E+04	0.	-.785E+03
18.0	18.0	.216E+04	0.	-.785E+03
19.0	19.0	.194E+04	0.	-.785E+03
20.0	20.0	.150E+04	0.	-.785E+03
21.0	21.0	.128E+04	0.	-.785E+03
22.0	22.0	.106E+04	0.	-.785E+03
23.0	39.0	0.	0.	0.

STRESS CONCENTRATION FACTORS BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	INSIDE TENSION	INSIDE BENDING	OUTSIDE TENSION	OUTSIDE BENDING
1	15	1.00	1.00	1.00	1.00
16	16	4.00	4.00	2.00	2.00
17	21	2.00	2.00	1.00	1.00

SMUD RAPID COOLDOWN
F. L BOYER

SMUD COOLDOWN INCIDENT-INSTRUMENTATION ITERATION 20 PAGE 7 DATE 05/04/78

22	22	2.00	2.00	4.00	4.00
23	39	1.00	1.00	1.00	1.00

SMUD RAPID COOLDOWN
F. L. BOYER

SMUD COOLDOWN INCIDENT-INSTRUMENTATION ITERATION 20 PAGE 8 DATE 05/04/78

TEMPERATURES PER SEGMENT USED IN PRIMARY + SECONDARY ANALYSIS

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5	SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	483.	483.	483.	483.	483.	20	490.	488.	487.	486.	484.
2	483.	483.	483.	483.	483.	21	491.	490.	488.	486.	485.
3	483.	483.	483.	483.	483.	22	493.	491.	489.	487.	485.
4	483.	483.	483.	483.	483.	23	493.	491.	489.	487.	485.
5	483.	483.	483.	483.	483.	24	493.	491.	489.	487.	485.
6	483.	483.	483.	483.	483.	25	493.	491.	489.	487.	485.
7	483.	483.	483.	483.	483.	26	493.	491.	489.	487.	485.
8	483.	483.	483.	483.	483.	27	493.	491.	489.	487.	485.
9	483.	483.	483.	483.	483.	28	493.	491.	489.	487.	485.
10	483.	483.	483.	483.	483.	29	493.	491.	489.	487.	485.
11	483.	483.	483.	483.	483.	30	493.	491.	489.	487.	485.
12	483.	483.	483.	483.	483.	31	493.	491.	489.	487.	485.
13	483.	483.	483.	483.	483.	32	493.	491.	489.	487.	485.
14	483.	483.	483.	483.	483.	33	493.	491.	489.	487.	485.
15	483.	483.	483.	483.	483.	34	493.	491.	489.	487.	485.
16	483.	483.	483.	483.	483.	35	493.	491.	489.	487.	485.
17	485.	484.	484.	484.	483.	36	493.	491.	489.	487.	485.
18	486.	486.	485.	484.	484.	37	493.	491.	489.	487.	485.
19	488.	487.	486.	485.	484.	38	493.	491.	489.	487.	485.
						39	493.	491.	489.	487.	485.

SMUD RAPID COOLDOWN
F. L. BOYER A-55

SMUD COOLDOWN INCIDENT-INSTRUMENTATION ITERATION 20 PAGE 9 DATE 05/04/78

PRIMARY + SECONDARY BOUNDARY AND FLEXABILITY MATRICES

BOUNDARY FORCES DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL SHEAR (O)	MOMENT (O)	RADIAL SHEAR (N)	ROTATION (N)	SUM
AXIAL FORCE (N)	0.	0.	0.	.4441E+03	0.	0.	0.	0.	.4441E+03
RADIAL SHEAR (O)	0.	0.	0.	0.	0.	0.	0.	0.	0.
MOMENT (O)	0.	0.	0.	0.	0.	0.	0.	0.	0.
RADIAL SHEAR (N)	0.	0.	0.	0.	0.	0.	0.	0.	0.
MOMENT (N)	.2432E+02	-.4380E-01	.1030E-11	-.3971E+01	0.	0.	0.	0.	.2030E+02

FLEXIBILITY MATRIX DUE TO A UNIT LOAD (TOTAL LOAD BASIS)

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL SHEAR (O)	MOMENT (O)	RADIAL SHEAR (N)	MOMENT (N)
AXIAL DEFL. (N)	.7631E-01	.2605E-03	-.7545E-03	.6485E-06	.6865E-09	.8006E-08	-.4539E-08	.3061E-07
RADIAL DEFL. (O)	-.2491E-02	.2368E-04	-.3235E-05	.6865E-09	.2622E-07	-.2782E-07	-.8031E-33	-.5200E-32
ROTATION (O)	.4971E-07	.7234E-06	-.3773E-04	.8006E-08	-.2782E-07	.1324E-06	.2601E-32	.1668E-31
RADIAL DEFL. (N)	.1569E-02	.3151E-04	-.5595E-18	-.4539E-08	-.8031E-33	.2601E-32	.1122E-06	.3631E-06
ROTATION (N)	-.8323E-04	.1499E-06	-.3524E-17	.3061E-07	-.5200E-32	.1668E-31	.3631E-06	.3423E-05

BOUNDARY DEFLECTIONS DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL SHEAR (O)	MOMENT (O)	RADIAL SHEAR (N)	ROTATION (N)	SUM
AXIAL DEFL. (N)	.7631E-01	.2605E-03	-.7545E-03	.2879E-03	0.	0.	0.	0.	.7610E-01
RADIAL DEFL. (O)	-.2491E-02	.2368E-04	-.3235E-05	.3049E-06	0.	0.	0.	0.	-.2470E-02
ROTATION (O)	.4971E-07	.7238E-06	-.3773E-04	.3556E-05	0.	0.	0.	0.	-.3340E-04
RADIAL DEFL. (N)	.1578E-02	.3149E-04	-.1857E-18	-.3458E-05	0.	0.	0.	0.	.1606E-02
ROTATION (N)	-.4337E-18	.8470E-21	-.2465E-31	.1084E-18	0.	0.	0.	0.	-.4337E-18

F. L. BOYER

SMUD RAPID COOLDOWN

SMUD COOLDOWN INCIDENT-INSTRUMENTATION ITERATION 20 PAGE 10 DATE 05/04/78

FLEXIBILITY MATRIX OF ASSEMBLY AS IN PROGRAM 91060
(THIS MATRIX ONLY IS ON A PER RADIAN BASIS)

	M(O)	Q(O)	M(N)	Q(N)
ROTATION(O)	.832130E-06	.174799E-06	.104776E-30	.163440E-31
DEFLECTION(O)	.174799E-06	.164715E-06	.326757E-31	.504587E-32
ROTATION(N)	.104776E-30	.326757E-31	.215083E-04	.228164E-05
DEFLECTION(N)	.163440E-31	.504587E-32	.228164E-05	.704873E-06

NOTE- THE +1 SIGN CONVENTION IS USED IN THE MATRIX PRINTED HERE.
IF IT IS DESIRED TO USE THE -1 SIGN CONVENTION THEN THE
SIGNS MUST BE CHANGED ON ALL OF THE OFF-DIAGONAL ELEMENTS.

SMUD RAPID COOLDOWN
F. L. BOYER

SMUD COOLDOWN INCIDENT-INSTRUMENTATION ITERATION 20 PAGE 11 DATE 05/04/78

PRIMARY + SECONDARY FORCES AND MOTIONS

POSITIVE DIRECTIONS (+) ARE AS FOLLOWS

TOP OF SEGMENT NO.1	BOTTOM OF REMAINING SEGMENTS
RADIAL------ TO THE LEFT	RADIAL------ TO THE RIGHT
ROTATIONAL-- CLOCKWISE	ROTATIONAL-- COUNTERCLOCKWISE
AXIAL------- UPWARD	AXIAL------- DOWNWARD

** SIGN CONVENTIONS ARE FOR A RIGHT HAND VIEW **

SEG. NO.	LOC.	RADIAL FORCE	MOMENT	AXIAL FORCE	LOC.	RADIAL MOTION	ROTATION	AXIAL MOTION
1	TOP	0.	0.	-.4171E+04	TOP	-.2470E-02	-.3340E-04	0.
1	BOT.	-.6517E+02	.2542E+03	-.4171E+04	BOT.	.2479E-02	-.2086E-05	.3773E-02
2	BOT.	.1539E+02	.2555E+03	-.4171E+04	BOT.	.2476E-02	-.1117E-07	.7548E-02
3	BOT.	-.2[illegible]52E+01	.2514E+03	-.4171E+04	BOT.	.2477E-02	.3409E-07	.1132E-01
4	BOT.	.[illegible]436E+00	.2523E+03	-.4171E+04	BOT.	.2477E-02	-.7870E-08	.1510E-01
5	BOT.	-.4956E-01	.2522E+03	-.4171E+04	BOT.	.2477E-02	.1249E-08	.1887E-01
6	BOT.	-.2073E-01	.2522E+03	-.4171E+04	BOT.	.2477E-02	.4257E-09	.2265E-01
7	BOT.	.1932E+00	.2521E+03	-.4171E+04	BOT.	.2477E-02	-.3241E-08	.2642E-01
8	BOT.	-.1226E+01	.2525E+03	-.4171E+04	BOT.	.2477E-02	.9719E-08	.3020E-01
9	BOT.	.5335E+01	.2513E+03	-.4171E+04	BOT.	.2477E-02	.6442E-07	.3398E-01
10	BOT.	-.1790E+02	.2435E+03	-.4171E+04	BOT.	.2476E-02	-.1653E-05	.3775E-01
11	BOT.	-.2097E+03	.3002E+03	-.4171E+04	BOT.	.2474E-02	.1448E-05	.3964E-01
12	BOT.	-.5978E+03	.5401E+03	-.4171E+04	BOT.	.2472E-02	.2710E-04	.4153E-01
13	BOT.	.1271E+03	.8120E+03	-.4171E+04	BOT.	.2495E-02	.9065E-04	.4342E-01
14	BOT.	.9593E+03	.7479E+03	-.4171E+04	BOT.	.2511E-02	.1052E-03	.4349E-01
15	BOT.	.2264E+04	.5501E+03	-.4171E+04	BOT.	.2532E-02	.1116E-03	.4436E-01
16	BOT.	.4201E+04	.1493E+03	-.4171E+04	BOT.	.2561E-02	.1025E-03	.4483E-01
17	BOT.	.2604E+04	.2319E+01	-.3398E+04	BOT.	.2427E-02	.9091E-04	.4512E-01
18	BOT.	.1407E+04	-.7020E+02	-.2626E+04	BOT.	.228[illegible]E-02	.7008E-04	.4542E-01
19	BOT.	.5064E+03	-.9087E+02	-.1853E+04	BOT.	.2147E-02	.3810E-04	.4572E-01
20	BOT.	.1106E+02	-.7527E+02	-.1081E+04	BOT.	.2030E-02	-.6989E-05	.4601E-01
21	BOT.	-.4087E+03	-.4911E+02	-.3080E+03	BOT.	.1845E-02	-.6766E-04	.4630E-01
22	BOT.	-.8413E+03	-.1462E+02	.4650E+03	BOT.	.1684E-02	-.1420E-03	.4659E-01
23	BOT.	-.[illegible]0E+03	-.1522E+02	.4441E+03	BOT.	.1671E-02	-.1456E-03	.4660E-01
24	BOT.	-.146[illegible]E+03	.5057E+02	.4441E+03	BOT.	.1633E-02	-.1567E-03	.4717E-01
25	BOT.	.4538E+02	.2273E+02	.4441E+03	BOT.	.1602E-02	.8165E-05	.4910E-01
26	BOT.	-.7695E+01	.1949E+02	.4441E+03	BOT.	.1607E-02	.1232E-08	.5103E-01
27	BOT.	.1086E+01	.2044E+02	.4441E+03	BOT.	.1606E-02	-.8703E-07	.5296E-01
28	BOT.	-.1396E+00	.2029E+02	.4441E+03	BOT.	.1606E-02	.1772E-07	.5489E-01
29	BOT.	.1690E-01	.2030E+02	.4441E+03	BOT.	.1606E-02	-.2687E-08	.5681E-01
30	BOT.	-.1962E-02	.2030E+02	.4441E+03	BOT.	.1606E-02	.3594E-09	.5874E-01
31	BOT.	.2202E-03	.2030E+02	.4441E+03	BOT.	.1606E-02	-.4468E-10	.6067E-01
32	BOT.	-.2403E-04	.2030E+02	.4441E+03	BOT.	.1606E-02	.5288E-11	.6260E-01

F. L. BOYER

SMUD RAPID COOLDOWN

SMUD COOLDOWN INCIDENT-INSTRUMENTATION ITERATION 20 PAGE 12 DATE 05/04/78

33	BOT.	.2558E-05	.2030E+02	.4441E+03	BOT.	.1606E-02	-.6028E-12	.6453E-01
34	BOT.	-.2655E-06	.2030E+02	.4441E+03	BOT.	.1606E-02	.6671E-13	.6646E-01
35	BOT.	.2722E-07	.2030E+02	.4441E+03	BOT.	.1606E-02	-.7174E-14	.6839E-01
36	BOT.	-.2342E-08	.2030E+02	.4441E+03	BOT.	.1606E-02	.8049E-15	.7032E-01
37	BOT.	.4461E-09	.2030E+02	.4441E+03	BOT.	.1606E-02	-.8023E-16	.7225E-01
38	BOT.	.3893E-09	.2030E+02	.4441E+03	BOT.	.1606E-02	.9411E-16	.7417E-01
39	BOT.	0.	.2030E+02	.4441E+03	BOT.	.1606E-02	-.4337E-18	.7610E-01

(FORCE AND MOTION OUTPUT IS IN GLOBAL DIRECTIONS R AND Z)

SMUD RAPID COOLDOW
F. L. BOYER

SMUD COOLDOWN INCIDENT-INSTRUMENTATION ITERATION 20 PAGE 13 DATE 05/04/78

PRIMARY + SECONDARY STRESSES

SEG. NO.	OUTSIDE			MIDPLANE			INSIDE		
	LONG	HOOP	RAD.	LONG	HOOP	RAD.	LONG	HOOP	RAD.
1	-1475.6	-1432.3	-1526.8	-1514.1	-1426.6	-1604.7	-1429.5	-1169.7	-1526.8
2	-1490.1	-1497.3	-1515.1	-1475.0	-1513.8	-1537.1	-1443.0	-1517.9	-1515.1
3	-1462.3	-1489.2	-1517.1	-1486.5	-1517.4	-1549.4	-1484.6	-1523.1	-1517.1
4	-1463.6	-1490.1	-1516.8	-1484.4	-1515.2	-1547.5	-1474.5	-1516.6	-1516.8
5	-1467.5	-1490.0	-1516.8	-1484.7	-1515.7	-1547.8	-1476.3	-1514.1	-1516.8
6	-1467.7	-1490.0	-1516.8	-1484.6	-1515.6	-1547.7	-1476.0	-1517.8	-1516.8
7	-1467.5	-1489.9	-1516.8	-1484.7	-1515.6	-1547.7	-1476.3	-1517.9	-1516.8
8	-1469.3	-1490.4	-1516.9	-1484.5	-1516.0	-1547.9	-1475.2	-1518.3	-1516.9
9	-1467.0	-1487.9	-1516.7	-1484.8	-1512.3	-1546.9	-1476.7	-1510.8	-1515.7
10	-1439.1	-1496.9	-1517.6	-1488.8	-1541.8	-1552.5	-1523.0	-1601.4	-1517.6
11	-1391.0	-1570.0	-1521.1	-1468.5	-1603.2	-1575.5	-1306.4	-1613.2	-1521.1
12	-2230.4	-1645.1	-1515.8	-1364.6	-1505.2	-1548.8	-361.4	-933.2	-1515.8
13	-2993.6	-1300.3	-1462.5	-1209.8	-429.6	-1227.2	880.4	1934.8	-1462.5
14	-2597.8	-867.0	-1385.8	-1093.1	202.3	-745.9	391.4	2657.2	-1385.8
15	-1947.1	-219.9	-1344.5	-1160.7	1177.3	-478.2	-451.0	4051.6	-1344.5
16	-705.1	725.9	-1298.8	-1332.8	2315.9	-173.4	-2118.9	5625.7	-1294.8
17	-1399.4	2421.7	.0	-2586.2	3148.0	293.8	-3907.2	4723.5	-705.8
18	-96[illegible]	2923.9	.0	-2468.1	4145.4	523.5	-4131.2	6477.3	-611.7
19	[illegible]	3383.6	-.0	-2307.1	5059.2	671.5	-4239.4	7974.9	-575.1
20	-45[illegible]	3753.1	.0	-2030.3	5822.4	717.8	-4047.8	9114.2	-595.3
21	49[illegible]	3948.6	.0	-1610.9	6314.5	641.1	-3546.2	9705.0	-668.6
22	28[illegible]	3987.6	.0	-577.1	6537.5	453.5	-1723.9	9819.0	-777.6
23	23[illegible]	[illegible]355.0	-.0	1697.9	7143.1	326.4	960.7	10732.5	-375.4
24	-211[illegible]	[illegible]92.2	-.0	1304.0	4642.5	370.4	4462.8	8755.8	-1184.7
25	-52[illegible]	[illegible].7	-.0	1110.6	1992.5	114.6	2547.2	4355.8	-1311.0
26	[illegible]	[illegible].2	.0	1047.2	2174.7	-8.4	2170.2	4579.1	-1348.7
27	-401.9	[illegible].6	-.0	1066.9	2181.2	6.4	2337.0	4633.7	-1343.2
28	-379.4	[illegible].6	.0	1063.5	2178.0	4.7	2307.0	4620.2	-1343.9
29	-381.8	427.0	-.0	1064.0	2179.6	4.9	2311.4	4622.4	-1343.9
30	-381.3	427.1	-.0	1063.9	2179.5	4.9	2310.8	4622.1	-1343.9
31	-381.4	427.1	-.0	1063.9	2179.5	4.9	2310.9	4622.1	-1343.9
32	-381.4	427.1	.0	1063.9	2178.5	4.9	2310.9	4622.1	-1343.9
33	-381.4	427.1	-.0	1063.9	2178.5	4.9	2310.9	4622.1	-1343.9
34	-381.4	427.1	.0	1063.9	2178.5	4.9	2310.9	4622.1	-1343.9
35	-381.4	427.1	-.0	1063.9	2178.5	4.9	2310.9	4622.1	-1343.9
36	-381.4	427.1	.0	1063.9	2178.5	4.9	2310.9	4622.1	-1343.9
37	-381.4	427.1	-.0	1063.9	2178.5	4.9	2310.9	4622.1	-1343.9
38	-381.4	427.1	.0	1063.9	2178.5	4.9	2310.9	4622.1	-1343.9
39	-381.4	427.1	-.0	1063.9	2178.5	4.9	2310.9	4622.1	-1343.9

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

SMUD RAPID COOLDOWN

F. L. BOYER

SMUD COOLDOWN INCIDENT-INSTRUMENTATION

STRESS INTENSITY PROGRAM OUT (IN KIPS)

STRESS AT BOTTOM OF SEGMENT NO. 22.

ITEM	PRIMARY + SECONDARY STRESS INTENSITIES						PEAK STRESS INTENSITIES					
	L - R		R - H		H - L		L - R		R - H		H - L	
	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
20	-.9	.3	-10.5	-4.0	11.5	3.7	-2.1	1.8	-10.9	-5.5	13.0	3.7
40	-14.2	11.0	-30.5	-19.8	44.7	8.8	-28.3	44.6	-27.3	-31.9	55.7	-12.7

STRESS OUTPUT ANALYSIS

STRESS	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
MAXIMUM	0.0	11.0	0.0	0.0	44.7	8.8	0.0	44.6	0.0	0.0	55.7	3.7
MINIMUM	-14.2	0.0	-30.5	-19.8	0.0	0.0	-28.3	0.0	-27.3	-31.9	0.0	-12.7
RANGE	14.2	11.0	30.6	19.8	44.7	8.8	28.3	44.6	27.3	31.9	55.7	16.4

SMUD RAPID COOLDOWN
F. L. BOYER

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION UPPER HEAD DATE 04/20/78

DIMENSIONS

INSIDE RADIUS = 87.2500 INCHES OUTSIDE RADIUS = 93.8750 INCHES
NO. OF NODES = 9 RADIAL INCREMENT = .8281 INCHES
MATERIAL CODE = 12 POISSON S RATIO = .3000
L = -0.0000

INITIAL CONDITIONS

NODE	RADIUS	TEMPERATURE
1	87.2500	565.0
2	88.0781	565.0
3	88.9063	565.0
4	89.7344	565.0
5	90.5625	565.0
6	91.3906	565.0
7	92.2188	565.0
8	93.0469	565.0
9	93.8750	565.0

SMUD RAPID COOLDOWN
E. D. McKIM

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION UPPER HEAD DATE 04/20/78

TABULATION OF
BOUNDARY CONDITIONS

FLUID TEMP. CURVE APPROXIMATION		FILM COEFF. CURVE APPROXIMATION		PRESSURE CURVE APPROXIMATION	
TIME (MINUTES)	INSIDE FLUID TEMPERATURE	TIME (MINUTES)	INSIDE FILM COEFFICIENT	TIME (MINUTES)	PRESSURE (PSI)
0.0000	565.0	0.0000	500.0	0.0000	0.
5.0000	565.0	140.0000	500.0	0.0000	0.
10.0000	590.0	0.0000	0.0	0.0000	0.
15.0000	590.0	0.0000	0.0	0.0000	0.
20.0000	525.0	0.0000	0.0	0.0000	0.
40.0000	380.0	0.0000	0.0	0.0000	0.
60.0000	300.0	0.0000	0.0	0.0000	0.
80.0000	280.0	0.0000	0.0	0.0000	0.
95.0000	290.0	0.0000	0.0	0.0000	0.
110.0000	305.0	0.0000	0.0	0.0000	0.
140.0000	340.0	0.0000	0.0	0.0000	0.

TEMPERATURE CALCULATION TIMES AND PRINTOUTS

TIME INCREMENT (MINUTES)	TIME LIMIT (MINUTES)	NUMBER OF PRINTOUTS
.5000	20.000	20.
.5000	80.000	120.
1.0000	140.000	60.

SMUD RAPID COOLDOWN
A. D. McKIM

A-63

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION UPPER HEAD   DATE 04/20/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
1.0000		-0.	-0.	0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
2.0000		-0.	-0.	0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
3.0000		-0.	-0.	0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
4.0000		-0.	-0.	0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
5.0000		-0.	-0.	0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
6.0000		-211.	-[illegible]71.	83.	567.9	565.9	565.2	565.0	565.0	565.0	565.0	565.0	565.0		
7.0000		-621.	-1706.	259.	571.7	567.9	566.1	565.4	565.1	565.0	565.0	565.0	565.0		
8.0000		-1126.	-2637.	524.	575.8	570.5	567.6	566.1	565.5	565.2	565.1	565.0	565.0		
9.0000		-1683.	-3546.	831.	579.9	573.4	569.4	567.2	566.0	565.5	565.2	565.1	565.1		
10.0000		-2266.	-4428.	1173.	584.2	576.5	571.6	568.6	566.8	565.9	565.4	565.2	565.2		
11.0000		-2650.	-4512.	1453.	585.6	578.9	573.7	570.1	567.8	566.5	565.8	565.4	565.3		
12.0000		-2837.	-4401.	1643.	586.2	580.2	575.3	571.5	568.9	567.3	566.3	565.8	565.6		
13.0000		-2923.	-4265.	1766.	586.6	581.2	576.5	572.8	570.0	568.1	566.9	566.3	566.1		
14.0000		-2945.	-4122.	1837.	586.9	581.9	577.4	573.8	570.9	568.9	567.6	566.8	566.6		
15.0000		-2929.	-3979.	1858.	587.1	582.4	578.2	574.6	571.8	569.7	568.3	567.4	567.2		
16.0000		-2337.	-1836.	1655.	579.7	580.6	578.3	575.3	572.6	570.5	569.0	568.1	567.8		
17.0000		-1212.	734.	1155.	569.9	575.7	576.5	575.1	573.0	571.1	569.7	568.8	568.5		
18.0000		173.	3290.	459.	559.6	569.3	573.2	573.8	572.8	571.5	570.3	569.5	569.2		
19.0000		1703.	5785.	-381.	548.8	562.1	568.9	571.6	572.0	571.4	570.6	570.0	569.8		
20.0000		3309.	8206.	-1320.	537.8	554.3	563.7	568.6	570.5	570.9	570.7	570.3	570.2		
20.5000		4049.	9016.	-1796.	533.6	550.4	561.0	566.8	569.5	570.5	570.6	570.4	570.3		
21.0000		4704.	9660.	-2225.	530.0	547.0	558.3	565.0	568.4	569.9	570.4	570.4	570.4		
21.5000		5309.	10265.	-2643.	526.5	543.8	555.6	563.1	567.2	569.3	570.1	570.3	570.4		
22.0000		5874.	10846.	-3044.	523.1	540.7	553.1	561.2	566.0	568.5	569.7	570.2	570.3		
22.5000		6409.	11410.	-3?28.	519.7	537.7	550.6	559.3	564.6	567.7	569.2	569.9	570.1		
23.0000		6919.	11958.	-3795.	516.4	534.8	548.2	557.3	563.3	566.8	568.7	569.6	569.8		
23.5000		7406.	12493.	-4146.	513.0	531.9	545.7	555.4	561.8	565.8	568.1	569.2	569.5		
24.0000		7875.	13017.	-4494.	509.7	529.0	543.3	553.5	560.4	564.8	567.4	568.7	569.1		
24.5000		8326.	13529.	-4807.	506.3	526.1	540.9	551.6	558.9	563.7	566.6	568.1	568.6		
25.0000		8763.	14030.	-5119.	503.0	523.2	538.5	549.6	557.4	562.6	565.8	567.5	568.0		
25.5000		9186.	14521.	-5419.	499.7	520.4	536.1	547.7	555.9	561.4	564.9	566.7	567.3		
26.0000		9596.	15003.	-5709.	496.3	517.5	533.7	545.7	554.3	560.2	563.9	566.0	566.6		
26.5000		9994.	15475.	-5999.	493.0	514.6	531.3	543.7	552.7	558.9	562.9	565.1	565.8		
27.0000		10382.	15937.	-6261.	489.7	511.7	528.8	541.7	551.1	557.6	561.8	564.2	564.9		
27.5000		10760.	16391.	-6524.	486.3	508.8	526.4	539.7	549.4	556.3	560.7	563.2	564.0		
28.0000		11129.	16836.	-6790.	483.0	505.9	523.9	537.6	547.7	554.9	559.6	562.2	563.1		
28.5000		11488.	17272.	-7030.	479.7	503.0	521.4	535.5	546.0	553.4	558.3	561.1	562.0		
29.0000		11839.	17700.	-7272.	476.3	500.1	518.9	533.4	544.2	551.9	557.1	560.0	560.9		
29.5000		12183.	18120.	-7509.	473.0	497.2	516.4	531.2	542.4	550.4	555.7	558.8	559.8		

SMUD RAPID COOLDOWN
... D. McKIM

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION UPPER HEAD DATE 04/20/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
30.0000		12519.	18531.	-7740.	469.6	494.2	513.8	529.1	540.5	548.8	554.4	557.6	558.6		
30.5000		12847.	18935.	-7966.	466.2	491.3	511.3	526.9	538.7	547.2	553.0	556.3	557.3		
31.0000		13169.	19331.	-8186.	462.9	488.3	508.7	524.7	536.8	545.6	551.5	554.9	556.1		
31.5000		13483.	19719.	-8402.	459.5	485.4	506.1	522.4	534.8	543.9	550.0	553.6	554.7		
32.0000		13792.	20100.	-8613.	456.1	482.4	503.5	520.1	532.9	542.2	548.5	552.1	553.3		
32.5000		14093.	20473.	-8819.	452.7	479.4	500.9	517.8	530.9	540.4	546.9	550.7	551.9		
33.0000		14389.	20839.	-9021.	449.4	475.4	498.2	515.5	528.8	538.6	545.3	549.1	550.4		
33.5000		14679.	21198.	-9219.	446.0	473.3	495.5	513.2	526.8	536.8	543.6	547.6	548.9		
34.0000		14963.	21551.	-9412.	442.6	470.3	492.9	510.8	524.7	534.9	541.9	546.0	547.3		
34.5000		15241.	21896.	-9602.	439.2	467.3	490.2	508.4	522.5	533.0	540.2	544.3	545.7		
35.0000		15514.	22235.	-9788.	435.8	464.2	487.4	506.0	520.4	531.1	538.4	542.7	544.1		
35.5000		15781.	22567.	-9970.	432.4	461.1	484.7	503.5	518.2	529.1	536.6	540.9	542.4		
36.0000		16043.	22893.	-10149.	429.0	458.1	481.9	501.1	516.0	527.1	534.7	539.2	540.6		
35.5000		16300.	23212.	-10323.	425.6	455.0	479.2	498.6	513.7	525.0	532.8	537.4	538.9		
37.0000		16552.	23525.	-10495.	422.1	451.9	476.4	496.1	511.5	523.0	530.9	535.6	537.1		
37.5000		16799.	23832.	-10663.	418.7	448.8	473.6	493.5	509.2	520.9	528.9	533.7	535.2		
38.0000		17041.	24133.	-10828.	415.3	445.7	470.7	491.0	506.9	518.7	527.0	531.8	533.4		
38.5000		17279.	24428.	-10999.	411.9	442.5	467.9	488.4	504.5	516.6	524.9	529.8	531.4		
39.0000		17510.	24717.	-11147.	408.4	439.4	465.0	485.8	502.1	514.4	522.9	527.9	529.5		
39.5000		17738.	25000.	-11302.	405.0	436.2	462.2	483.2	499.7	512.1	520.8	525.8	527.5		
40.0000		17961.	25278.	-11454.	401.6	433.1	459.3	480.5	497.3	509.9	518.6	523.8	525.5		
40.5000		18134.	25337.	-11586.	398.9	430.1	456.4	477.9	494.8	507.6	516.5	521.7	523.4		
41.0000		18252.	25309.	-11693.	396.6	427.3	453.6	475.2	492.4	505.3	514.3	519.6	521.4		
41.5000		18335.	25265.	-11790.	394.3	424.8	450.9	472.6	489.9	503.0	512.1	517.5	519.2		
42.0000		18394.	25214.	-11850.	392.1	422.3	448.3	470.0	487.4	500.6	509.9	515.3	517.1		
42.5000		18432.	25160.	-11906.	390.0	419.9	445.8	467.5	485.0	498.3	507.6	513.1	514.9		
43.0000		18456.	25103.	-11949.	387.9	417.6	443.4	465.0	482.5	495.9	505.3	510.9	512.7		
43.5000		18467.	25045.	-11981.	385.7	415.3	441.0	462.6	480.1	493.5	503.0	508.6	510.5		
44.0000		18469.	24986.	-12003.	383.6	413.0	438.6	460.2	477.7	491.2	500.7	506.4	508.2		
44.5000		18462.	24926.	-12017.	381.5	410.8	436.3	457.8	475.3	488.8	498.4	504.1	506.0		
45.0000		18449.	24867.	-12024.	379.5	408.6	434.0	455.5	473.0	486.5	496.1	501.8	503.7		
45.5000		18430.	24808.	-12025.	377.4	406.4	431.7	453.1	470.6	484.2	493.8	499.5	501.4		
46.0000		18407.	24749.	-12021.	375.3	404.2	429.4	450.8	468.3	481.8	491.4	497.2	499.1		
46.5000		18380.	24691.	-12012.	373.2	402.1	427.2	448.5	466.0	479.5	489.1	494.9	496.8		
47.0000		18351.	24633.	-12001.	371.2	399.9	425.0	446.2	463.6	477.2	486.8	492.6	494.5		
47.5000		18319.	24576.	-11986.	369.1	397.8	422.7	444.0	461.3	474.9	484.5	490.2	[illegible]		
48.0000		18285.	24519.	-11969.	367.1	395.6	420.5	441.7	459.0	472.5	482.2	487.9	489.8		
48.5000		18250.	24462.	-11950.	365.0	393.5	418.3	439.4	456.8	470.2	479.8	485.6	487.5		
49.0000		18214.	24407.	-11930.	363.0	391.4	416.1	437.2	454.5	467.9	477.5	483.3	485.2		
49.5000		18178.	24351.	-11908.	360.9	389.2	413.9	435.0	452.2	465.6	475.2	480.9	482.8		

SMUD RAPID COOLDOWN

E. D. McKIM

A-65

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION UPPER HEAD DATE 04/20/78

TIME	EQUIV RAD	LIN. TR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
50.0000		18140.	24297.	-11886.	358.9	387.1	411.8	432.7	449.9	463.3	472.9	478.6	480.5		
50.5000		18102.	24243.	-11853.	356.8	385.0	409.6	430.5	447.7	461.0	470.6	476.3	478.2		
51.0000		18064.	24190.	-11839.	354.8	382.9	407.4	428.3	445.4	458.7	468.3	474.0	475.9		
51.5000		18026.	24137.	-11815.	352.8	380.8	405.3	426.1	443.1	456.5	466.0	471.7	473.6		
52.0000		17988.	24085.	-11791.	350.7	378.7	403.1	423.9	440.9	454.2	463.7	469.4	471.2		
52.5000		17950.	24033.	-11766.	348.7	376.6	400.9	421.6	438.6	451.9	461.4	467.0	468.9		
53.0000		17912.	23982.	-11741.	346.6	374.5	398.8	419.4	436.4	449.6	459.1	464.7	466.6		
53.5000		17874.	23932.	-11717.	344.6	372.4	396.6	417.2	434.2	447.4	456.8	462.4	464.3		
54.0000		17835.	23883.	-11692.	342.6	370.3	394.5	415.0	431.9	445.1	454.5	460.1	462.0		
54.5000		17799.	23834.	-11657.	340.5	368.2	392.3	412.8	429.7	442.8	452.2	457.8	459.7		
55.0000		17762.	23785.	-11643.	338.5	366.1	390.2	410.7	427.5	440.6	449.9	455.6	457.4		
55.5000		17725.	23737.	-11619.	336.5	364.0	388.0	408.5	425.2	438.3	447.7	453.3	455.1		
56.0000		17689.	23690.	-11595.	334.4	361.9	385.9	406.3	423.0	436.1	445.4	451.0	452.8		
56.5000		17653.	23643.	-11571.	332.4	359.8	383.8	404.1	420.8	433.8	443.1	448.7	450.5		
57.0000		17617.	23597.	-11547.	330.4	357.7	381.6	401.9	418.6	431.6	440.9	446.4	448.3		
57.5000		17582.	23552.	-11523.	328.3	355.7	379.5	399.7	416.4	429.3	438.6	444.1	446.0		
58.0000		17547.	23507.	-11500.	326.3	353.6	377.4	397.6	414.2	427.1	436.3	441.9	443.7		
58.5000		17512.	23462.	-11477.	324.3	351.5	375.2	395.4	412.0	424.9	434.1	439.6	441.4		
59.0000		17479.	23418.	-11454.	322.2	349.4	373.1	393.2	409.7	422.6	431.8	437.3	439.2		
59.5000		17444.	23375.	-11432.	320.2	347.3	371.0	391.1	407.5	420.4	429.6	435.1	436.9		
60.0000		17411.	23332.	-11409.	318.2	345.2	368.8	388.9	405.3	418.2	427.3	432.8	434.6		
60.5000		17335.	23089.	-11371.	316.9	343.3	366.7	386.7	403.1	415.9	425.1	430.6	432.4		
61.0000		17211.	22774.	-11312.	315.9	341.6	364.7	384.6	401.0	413.7	422.8	428.3	430.1		
61.5000		17059.	22449.	-11238.	315.0	340.1	362.9	382.5	398.8	411.5	420.6	426.1	427.9		
62.0000		16889.	22124.	-11151.	314.1	338.8	361.1	380.5	396.7	409.3	418.4	423.8	425.6		
62.5000		16705.	21801.	-11053.	313.3	337.5	359.4	378.6	394.6	407.1	416.1	421.6	423.4		
63.0000		16512.	21481.	-10946.	312.5	336.2	357.8	376.7	392.5	405.0	413.9	419.3	421.1		
63.5000		16311.	21165.	-10832.	311.7	335.0	356.2	374.9	390.5	402.9	411.8	417.1	418.9		
64.0000		16105.	20854.	-10711.	311.0	333.8	354.7	373.1	388.5	400.8	409.6	414.9	416.7		
64.5000		15896.	20548.	-10586.	310.2	332.7	353.2	371.3	386.6	398.7	407.4	412.7	414.5		
65.0000		15686.	20247.	-10457.	309.5	331.6	351.8	369.6	384.7	396.7	405.3	410.5	412.3		
65.5000		15474.	19951.	-10325.	308.7	330.5	350.4	368.0	382.8	394.7	403.2	408.4	410.1		
66.0000		15262.	19660.	-10192.	309.0	328.4	349.0	366.4	381.0	392.7	401.1	406.3	408.0		
66.5000		15051.	19374.	-10057.	307.3	329.4	347.7	364.8	379.2	390.7	399.1	404.1	405.8		
67.0000		14842.	19094.	-9922.	306.6	327.4	346.4	363.2	377.4	388.8	397.1	402.1	403.7		
67.5000		14634.	18818.	-9787.	305.9	326.4	345.1	361.7	375.7	386.9	395.1	400.0	401.7		
68.0000		14429.	18548.	-9652.	305.2	325.4	343.8	360.2	374.0	385.1	393.1	398.0	399.6		
68.5000		14225.	18282.	-9518.	304.5	324.4	342.6	358.7	372.3	383.2	391.1	396.0	397.6		
69.0000		14024.	18022.	-9385.	303.8	323.4	341.3	357.2	370.7	381.4	389.2	394.0	395.6		
69.5000		13825.	17766.	-9254.	303.2	322.5	340.1	355.8	369.0	379.6	387.3	392.0	393.6		

SMUD R[illegible] COOLDOW
D. McKIM

A-66

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION UPPER HEAD DATE 04/20/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
70.0000		13630.	17515.	-9124.	302.5	321.5	338.9	354.3	367.4	377.9	385.5	390.1	391.6		
70.5000		13438.	17269.	-8995.	301.8	320.6	337.7	352.9	365.8	376.1	383.6	388.2	389.7		
71.0000		13249.	17027.	-8859.	301.1	319.7	336.6	351.5	364.2	374.4	381.8	386.3	387.8		
71.5000		13063.	16791.	-8744.	300.5	319.7	335.4	350.2	362.7	372.7	380.0	384.4	385.9		
72.0000		12880.	16558.	-8621.	299.8	317.8	334.3	348.8	361.2	371.0	378.2	382.6	384.1		
72.5000		12700.	16330.	-8500.	299.2	316.9	333.2	347.5	359.7	369.4	376.5	380.8	382.2		
73.0000		12523.	16106.	-8381.	298.5	316.0	332.0	346.2	358.2	367.8	374.8	379.0	380.4		
73.5000		12350.	15887.	-8264.	297.9	315.2	330.9	344.9	356.7	366.2	373.1	377.2	378.6		
74.0000		12179.	15672.	-8150.	297.2	314.3	329.9	343.6	355.3	364.6	371.4	375.5	376.9		
74.5000		12012.	15461.	-8037.	296.6	313.4	328.8	342.4	353.9	363.0	369.7	373.8	375.2		
75.0000		11849.	15254.	-7926.	295.9	312.6	327.7	341.1	352.4	361.5	368.1	372.1	373.5		
75.5000		11687.	15050.	-7817.	295.3	311.7	326.7	339.9	351.1	360.0	366.5	370.4	371.8		
76.0000		11529.	14851.	-7710.	294.7	310.9	325.6	338.6	349.7	358.5	364.9	368.8	370.1		
76.5000		11374.	14656.	-7606.	294.0	310.0	324.6	337.4	348.3	357.0	363.3	367.2	368.5		
77.0000		11222.	14464.	-7503.	293.4	309.2	323.6	336.3	347.0	355.6	361.8	365.6	366.8		
77.5000		11072.	14277.	-7402.	292.8	308.4	322.6	335.1	345.7	354.1	360.3	364.0	365.3		
78.0000		10926.	14092.	-7303.	292.1	307.5	321.6	333.9	344.4	352.7	358.8	362.4	363.7		
78.5000		10782.	13912.	-7206.	291.5	306.7	320.6	332.8	343.1	351.3	357.3	360.9	362.1		
79.0000		10642.	13735.	-7110.	290.9	305.9	319.6	331.6	341.8	349.9	355.8	359.4	360.6		
79.5000		10504.	13561.	-7017.	290.3	305.1	318.6	330.5	340.5	348.5	354.4	357.9	359.1		
80.0000		10368.	13390.	-6925.	289.7	304.3	317.6	329.4	339.3	347.2	352.9	356.4	357.6		
81.0000		10029.	12793.	-6717.	289.4	303.1	315.8	327.2	336.8	344.5	350.1	353.5	354.7		
82.0000		9631.	12159.	-6479.	289.5	302.2	314.3	325.2	334.5	342.0	347.4	350.7	351.8		
83.0000		9212.	11541.	-6223.	289.6	301.6	313.0	323.4	332.3	339.5	344.7	347.9	349.0		
84.0000		8785.	10943.	-5956.	289.8	301.1	311.8	321.7	330.2	337.1	342.2	345.3	346.3		
85.0000		8361.	10367.	-5694.	290.1	300.6	310.8	320.2	328.3	334.9	339.8	342.7	343.7		
86.0000		7942.	9812.	-5412.	290.3	300.3	309.9	318.7	326.5	332.8	337.4	340.3	341.2		
87.0000		7534.	9279.	-5143.	290.6	300.0	309.1	317.4	324.8	330.8	335.2	337.9	338.8		
88.0000		7137.	8766.	-4890.	290.9	299.7	308.3	316.2	323.2	328.9	333.1	335.7	336.5		
89.0000		6752.	8274.	-4623.	291.3	299.5	307.6	315.1	321.7	327.1	331.1	333.5	334.4		
90.0000		6381.	7801.	-4374.	291.6	299.4	307.0	314.0	320.3	325.4	329.2	331.5	332.3		
91.0000		6023.	7347.	-4133.	292.0	299.2	306.4	313.1	318.9	323.8	327.4	329.6	330.3		
92.0000		5678.	6911.	-3901.	292.3	299.2	305.9	312.1	317.7	322.3	325.7	327.7	328.4		
93.0000		5346.	6492.	-3677.	292.7	299.1	305.4	311.3	316.5	320.8	324.0	326.0	326.7		
94.0000		5027.	6090.	-3452.	293.1	299.1	305.0	310.5	315.4	319.5	322.5	324.4	325.0		
95.0000		4721.	5704.	-3255.	293.5	299.1	304.6	309.8	314.4	318.2	321.1	322.8	323.4		
96.0000		4412.	5280.	-3050.	294.1	299.2	304.3	309.1	313.5	317.0	319.7	321.4	321.9		
97.0000		4100.	4861.	-2845.	294.8	299.4	304.0	308.5	312.6	315.9	318.5	320.0	320.5		
98.0000		3794.	4458.	-2644.	295.5	299.6	303.9	308.0	311.8	314.9	317.3	318.7	319.2		
99.0000		3495.	4070.	-2446.	296.2	299.9	303.8	307.6	311.1	314.0	316.2	317.5	318.0		

SMUD RAPID COOLDOWN
L. D. McKIM

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION UPPER HEAD DATE 04/20/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
100.0000		3206.	3697.	-2253.	297.0	300.2	303.8	307.2	310.4	313.1	315.2	316.4	316.8		
101.0000		2925.	3339.	-2066.	297.7	300.6	303.8	306.9	309.8	312.3	314.2	315.4	315.8		
102.0000		2656.	2996.	-1885.	298.5	301.0	303.8	306.7	309.3	311.6	313.3	314.4	314.8		
103.0000		2396.	2667.	-1710.	299.3	301.4	303.9	306.5	308.9	311.0	312.5	313.5	313.9		
104.0000		2145.	2350.	-1542.	300.0	301.9	304.1	306.3	308.5	310.4	311.8	312.7	313.0		
105.0000		1905.	2047.	-1390.	300.8	302.4	304.2	306.2	308.2	309.9	311.2	312.0	312.3		
106.0000		1675.	1756.	-1224.	301.6	302.9	304.4	306.2	307.9	309.4	310.6	311.3	311.6		
107.0000		1454.	1477.	-1074.	302.4	303.4	304.7	306.2	307.7	309.0	310.1	310.7	311.0		
108.0000		1241.	1209.	-930.	303.3	303.9	305.0	306.2	307.5	308.7	309.6	310.2	310.4		
109.0000		1037.	952.	-793.	304.1	304.5	305.3	306.3	307.4	308.4	309.2	309.7	309.9		
110.0000		841.	705.	-660.	304.9	305.0	305.6	306.4	307.3	308.2	308.9	309.3	309.5		
111.0000		645.	442.	-530.	305.9	305.7	306.0	306.6	307.3	308.0	308.6	309.0	309.[illegible]		
112.0000		451.	144.	-402.	306.8	306.3	306.4	306.8	307.3	307.9	308.4	308.7	308.[illegible]		
113.0000		261.	-65.	-276.	307.8	307.1	306.8	307.0	307.4	307.8	308.2	308.4	308.5		
114.0000		75.	-304.	-153.	308.8	307.8	307.3	307.3	307.5	307.8	308.0	308.2	308.3		
115.0000		-103.	-534.	-33.	309.8	308.6	307.9	307.6	307.6	307.8	308.0	308.1	308.2		
116.0000		-275.	-754.	92.	310.8	309.3	308.4	308.0	307.8	307.9	307.9	308.0	308.0		
117.0000		-442.	-965.	194.	311.9	310.1	309.0	308.4	308.1	308.0	308.0	308.0	308.0		
118.0000		-602.	-1168.	302.	312.9	310.9	309.6	308.8	308.4	308.1	308.0	308.0	308.0		
119.0000		-755.	-1362.	405.	313.9	311.8	310.3	309.3	308.7	308.3	308.1	308.0	308.0		
120.0000		-903.	-1549.	505.	315.0	312.6	310.9	309.8	309.0	308.5	308.3	308.1	308.1		
121.0000		-1045.	-1728.	600.	316.0	313.5	311.6	310.3	309.4	308.8	308.5	308.3	308.2		
122.0000		-1181.	-1899.	692.	317.1	314.3	312.3	310.8	309.8	309.1	308.7	308.5	308.4		
123.0000		-1311.	-2064.	790.	318.1	315.2	313.0	311.4	310.3	309.5	309.0	308.7	308.6		
124.0000		-1437.	-2222.	855.	319.2	316.1	313.8	312.0	310.7	309.9	309.3	309.0	308.9		
125.0000		-1557.	-2374.	946.	320.2	317.0	314.5	312.6	311.2	310.3	309.6	309.3	309.1		
126.0000		-1672.	-2519.	1024.	321.3	317.9	315.3	313.3	311.8	310.7	310.0	309.6	309.5		
127.0000		-1783.	-2659.	1097.	322.4	318.9	316.1	313.9	312.3	311.2	310.4	310.0	309.8		
128.0000		-1889.	-2792.	1171.	323.5	319.8	316.9	314.6	312.9	311.7	310.8	310.4	310.2		
129.0000		-1991.	-2921.	1239.	324.5	320.7	317.7	315.3	313.5	312.2	311.3	310.8	310.6		
130.0000		-2088.	-3044.	1305.	325.6	321.7	318.5	316.1	314.2	312.8	311.8	311.3	311.1		
131.0000		-2182.	-3162.	1369.	326.7	322.7	319.4	316.8	314.8	313.3	312.3	311.8	311.6		
132.0000		-2272.	-3275.	1429.	327.8	323.6	320.2	317.5	315.5	313.9	312.9	312.3	312.1		
133.0000		-2358.	-3384.	1488.	328.9	324.6	321.1	318.3	316.2	314.6	313.5	312.8	312.6		
134.0000		-2441.	-3489.	1544.	330.0	325.6	322.0	319.1	316.9	315.2	314.1	313.4	313.2		
135.0000		-2520.	-3589.	1597.	331.1	326.6	322.9	319.9	317.6	315.9	314.7	314.0	313.7		
136.0000		-2595.	-3685.	1649.	332.2	327.6	323.8	320.7	318.3	316.6	315.3	314.6	314.4		
137.0000		-2670.	-3777.	1698.	333.3	328.6	324.7	321.6	319.1	317.3	316.0	315.2	315.0		
138.0000		-2740.	-3866.	1746.	334.4	329.6	325.6	322.4	319.9	318.0	316.7	315.9	315.6		
139.0000		-2807.	-3951.	1791.	335.5	330.6	326.6	323.3	320.7	318.7	317.4	316.6	316.3		

A. D. McKIM
SMUD RAPID COOLDOWN

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION UPPER HEAD DATE 04/20/78

TIME	EQUIV LIN. RAD STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
140.0000	-2872.	-4032.	1835.	336.6	331.6	327.5	324.2	321.5	319.5	318.1	317.3	317.0		

SMUD RAPID COOLDOWN
A. D. McKIM

A-69

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION CLOSURE FLANGE DATE 05/12/78

DIMENSIONS

INSIDE RADIUS =	76.1875 INCHES	OUTSIDE RADIUS =	100.0000 INCHES
NO. OF NODES =	9	RADIAL INCREMENT =	2.9766 INCHES
MATERIAL CODE =	12	POISSON S RATIO =	.3000
L =	0.0000		

INITIAL CONDITIONS

NODE	RADIUS	TEMPERATURE
1	76.1875	565.0
2	79.1641	565.0
3	8[illegible]406	565.0
4	8[illegible].1172	565.0
5	88.0938	565.0
6	91.0703	565.0
7	94.0469	565.0
8	97.0234	565.0
9	100.0000	565.0

SMUD RAPID COOLDOWN
M. D. McKIM

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION CLOSURE FLANGE   DATE 05/12/78

TABULATION OF
BOUNDARY CONDITIONS

FLUID TEMP. CURVE APPROXIMATION		FILM COEFF. CURVE APPROXIMATION		PRESSURE CURVE APPROXIMATION	
TIME (MINUTES)	INSIDE FLUID TEMPERATURE	TIME (MINUTES)	INSIDE FILM COEFFICIENT	TIME (MINUTES)	PRESSURE (PSI)
0.0000	565.0	0.0000	500.0	0.0000	0.
5.0000	565.0	140.0000	500.0	0.0000	0.
10.0000	590.0	0.0000	0.0	0.0000	0.
15.0000	590.0	0.0000	0.0	0.0000	0.
20.0000	525.0	0.0000	0.0	0.0000	0.
40.0000	380.0	0.0000	0.0	0.0000	0.
60.0000	300.0	0.0000	0.0	0.0000	0.
80.0000	280.0	0.0000	0.0	0.0000	0.
95.0000	290.0	0.0000	0.0	0.0000	0.
1[illegible]0.0000	305.0	0.0000	0.0	0.0000	0.
140.0000	340.0	0.0000	0.0	0.0000	0.

TEMPERATURE CALCULATION TIMES AND PRINTOUTS

TIME INCREMENT (MINUTES)	TIME LIMIT (MINUTES)	NUMBER OF PRINTOUTS
.5000	20.000	20.
.5000	80.000	120.
1.0000	140.000	60.

SMUD RAPID COOLDOWN
A. D. McKIM

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION CLOSURE FLANGE DATE 05/12/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
1.0000		-0.	-0.	-0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
2.0000		-0.	-0.	-0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
3.0000		-0.	-0.	-0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
4.0000		-0.	-0.	-0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
5.0000		-0.	-0.	-0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
6.0000		-76.	-531.	23.	566.9	565.1	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
7.0000		-240.	-1535.	74.	570.5	565.4	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
8.0000		-456.	-2673.	143.	574.6	565.9	565.1	565.0	565.0	565.0	565.0	565.0	565.0		
9.0000		-708.	-3849.	228.	578.8	566.7	565.2	565.0	565.0	565.0	565.0	565.0	565.0		
10.0000		-990.	-5035.	325.	583.2	567.8	565.3	565.0	565.0	565.0	565.0	565.0	565.0		
11.0000		-1225.	-5694.	411.	585.7	569.0	565.6	565.1	565.0	565.0	565.0	565.0	565.0		
12.0000		-1394.	-5879.	479.	586.6	570.1	565.8	565.1	565.0	565.0	565.0	565.0	565.0		
13.0000		-1535.	-5927.	539.	587.0	571.1	566.2	565.2	565.0	565.0	565.0	565.0	565.0		
14.0000		-1654.	-5933.	594.	587.2	572.0	566.5	565.3	565.0	565.0	565.0	565.0	565.0		
15.0000		-1767.	-5926.	645.	587.3	572.8	566.9	565.4	565.1	565.0	565.0	565.0	565.0		
16.0000		-1674.	-4539.	634.	582.6	573.4	567.3	565.5	565.1	565.0	565.0	565.0	565.9		
17.0000		-1339.	-1915.	546.	573.4	573.3	567.7	565.6	565.1	565.0	565.0	565.0	565.0		
18.0000		-864.	1067.	408.	562.9	572.4	567.9	565.8	565.2	565.0	565.0	565.0	565.0		
19.0000		-285.	4151.	230.	551.7	570.7	568.0	565.9	565.2	565.0	565.0	565.0	565.0		
20.0000		378.	7263.	17.	540.4	569.5	568.0	566.0	565.2	565.0	565.0	565.0	565.0		
20.5000		712.	8630.	-94.	535.4	567.1	567.9	566.1	565.3	565.1	565.0	565.0	565.0		
21.0000		1029.	9763.	-202.	531.2	565.7	567.8	566.1	565.3	565.1	565.0	565.0	565.0		
21.5000		1339.	10773.	-309.	527.4	564.2	567.6	566.[illegible]	565.3	565.1	565.0	565.0	565.0		
22.0000		1645.	11715.	-418.	523.8	562.7	567.3	566.2	565.3	565.1	565.0	565.0	565.0		
22.5000		1954.	12621.	-527.	520.3	561.2	567.0	566.2	565.4	565.1	565.0	565.0	565.0		
23.0000		2266.	13507.	-639.	517.0	559.6	566.7	566.2	565.4	565.1	565.0	565.0	565.0		
23.5000		2580.	14382.	-754.	513.6	558.0	566.3	566.1	565.4	565.1	565.0	565.0	565.0		
24.0000		2899.	15250.	-870.	510.3	556.4	565.9	566.1	565.4	565.1	565.0	565.0	565.0		
24.5000		3222.	16114.	-990.	506.9	554.7	565.5	566.1	565.5	565.1	565.0	565.0	565.0		
25.0000		3549.	16974.	-1111.	503.6	553.1	565.0	566.0	565.5	565.1	565.0	565.0	565.0		
25.5000		3879.	17832.	-1236.	500.3	551.4	564.5	565.9	565.5	565.2	565.0	565.0	565.0		
26.0000		4215.	18688.	-1363.	496.9	549.7	564.0	565.8	565.5	565.2	565.0	565.0	565.0		
26.5000		4554.	19543.	-1492.	493.6	547.9	563.4	565.7	565.5	565.2	565.0	565.0	565.0		
27.0000		4897.	20396.	-1624.	490.2	546.2	562.8	565.6	565.5	565.2	565.0	565.0	565.0		
27.5000		5244.	21247.	-1758.	486.9	544.4	562.2	565.5	565.5	565.2	565.1	565.0	565.0		
28.0000		5595.	22096.	-1895.	483.6	542.7	561.5	565.3	565.4	565.2	565.1	565.0	565.0		
28.5000		5950.	22944.	-2034.	480.2	540.9	560.8	565.1	565.4	565.2	565.1	565.0	565.0		
29.0000		6309.	23791.	-2176.	476.9	539.0	560.1	564.9	565.4	565.2	565.1	565.0	565.0		
29.5000		6670.	24636.	-2320.	473.5	537.2	559.4	564.7	565.4	565.2	565.1	565.0	565.0		

SMUD RAPID COOLDOV

A. D. McKIM

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION CLOSURE FLANGE DATE 05/12/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
30.0000		7036.	25480.	-2467.	470.2	533.3	558.6	564.5	565.3	565.2	565.1	565.0	565.0		
30.5000		7405.	26322.	-2616.	466.8	533.5	557.8	564.3	565.3	565.2	565.1	565.0	565.0		
31.0000		7779.	27163.	-2767.	463.4	531.6	557.0	564.0	565.2	565.2	565.1	565.0	565.0		
31.5000		8154.	28002.	-2921.	460.1	529.7	556.2	563.8	565.2	565.2	565.1	565.0	565.0		
32.0000		8533.	28840.	-3077.	456.7	527.7	555.3	563.5	565.1	565.2	565.1	565.0	565.0		
32.5000		8916.	29676.	-3236.	453.3	525.8	554.5	563.2	565.0	565.2	565.1	565.0	565.0		
33.0000		9301.	30511.	-3396.	450.0	523.8	553.6	562.9	564.9	565.2	565.1	565.0	565.0		
33.5000		9690.	31344.	-3559.	446.6	521.8	552.6	562.5	564.9	565.1	565.1	565.0	565.0		
34.0000		10082.	32176.	-3725.	443.2	519.9	551.7	562.2	564.8	565.1	565.1	565.0	565.0		
34.5000		10477.	33007.	-3892.	439.8	517.9	550.7	561.8	564.7	565.1	565.1	565.0	565.0		
35.0000		10874.	33836.	-4062.	436.5	515.8	549.8	561.5	564.6	565.1	565.1	565.0	565.0		
35.5000		11274.	34664.	-4234.	433.1	513.8	548.8	561.1	564.4	565.1	565.1	565.0	565.0		
36.0000		11679.	35490.	-4408.	429.7	511.8	547.8	560.7	564.3	565.0	565.1	565.0	565.0		
36.5000		12083.	36315.	-4584.	426.3	509.7	546.7	560.2	564.2	565.0	565.1	565.0	565.0		
37.0000		12492.	37138.	-4762.	422.9	507.6	545.7	559.8	564.0	565.0	565.1	565.0	565.0		
37.5000		12903.	37960.	-4943.	419.5	505.5	544.6	559.4	563.9	564.9	565.1	565.0	565.0		
38.0000		13316.	38781.	-5125.	416.1	503.4	543.5	558.9	563.7	564.9	565.1	565.0	565.0		
38.5000		13732.	39600.	-5310.	412.7	501.3	542.4	558.4	563.6	564.8	565.0	565.0	565.0		
39.0000		14150.	40418.	-5497.	409.3	499.2	541.3	557.9	563.4	564.8	565.0	565.0	565.0		
39.5000		14571.	41235.	-5685.	405.9	497.0	540.2	557.4	563.2	564.7	565.0	565.0	565.0		
40.0000		14994.	42050.	-5876.	402.5	494.9	539.0	556.9	563.0	564.7	565.0	565.0	565.0		
40.5000		15404.	42753.	-6064.	399.5	492.7	537.8	556.4	562.8	564.6	565.0	565.0	565.0		
41.0000		15795.	43319.	-6248.	397.0	490.6	536.6	555.8	562.6	564.5	565.0	565.0	565.0		
41.5000		16175.	43815.	-6429.	394.7	488.5	535.5	555.3	562.4	564.5	565.0	565.0	565.0		
42.0000		16546.	44275.	-6609.	392.6	486.4	534.2	554.7	562.2	564.4	564.9	565.0	565.0		
42.5000		16911.	44714.	-6787.	390.5	484.4	533.0	554.1	561.9	564.3	564.9	565.0	565.0		
43.0000		17272.	45143.	-6965.	388.4	482.4	531.8	553.5	561.7	564.2	564.9	565.0	565.0		
43.5000		17624.	45565.	-7142.	386.4	480.4	530.6	552.9	561.4	564.2	564.9	565.0	565.0		
44.0000		17981.	45983.	-7319.	384.4	478.5	529.3	552.3	561.2	564.1	564.8	565.0	565.0		
44.5000		18330.	46399.	-7495.	382.4	476.6	528.1	551.7	560.9	564.0	564.8	565.0	565.0		
45.0000		18677.	46813.	-7671.	380.4	474.7	526.9	551.0	560.6	563.9	564.8	565.0	565.0		
45.5000		19020.	47225.	-7847.	378.4	472.8	525.6	550.4	560.3	563.8	564.8	565.0	565.0		
46.0000		19361.	47636.	-8023.	376.4	471.0	524.4	549.7	560.0	563.6	564.7	565.0	565.0		
46.5000		19700.	48046.	-8199.	374.5	469.2	523.1	549.1	559.7	563.5	564.7	565.0	565.0		
47.0000		20037.	48455.	-8374.	372.5	467.4	521.9	548.4	559.4	563.4	564.6	565.0	565.0		
47.5000		20371.	48863.	-8550.	370.5	465.6	520.7	547.7	559.1	563.3	564.6	564.9	565.0		
48.0000		20704.	49270.	-8726.	368.5	463.8	519.4	547.0	558.8	563.2	564.6	564.9	565.0		
48.5000		21035.	49676.	-8901.	366.6	462.1	518.2	546.3	558.5	563.0	564.5	564.9	565.0		
49.0000		21364.	50081.	-9077.	364.6	460.3	517.0	545.6	558.1	562.9	564.5	564.9	565.0		
49.5000		21691.	50485.	-9253.	362.7	458.6	515.7	544.9	557.8	562.7	564.4	564.9	565.0		

SMUD RAPID COOLDOW
D. McKIN

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION CLOSURE FLANGE DATE 05/12/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
50.0000		22017.	50888.	-9429.	360.7	456.9	514.5	544.2	557.4	562.6	564.4	564.9	565.0		
50.5000		22341.	51291.	-9605.	358.7	455.2	513.3	543.4	557.1	562.4	564.3	564.8	565.0		
51.0000		22664.	51692.	-9781.	356.8	453.5	512.0	542.7	556.7	562.3	564.2	564.8	564.9		
51.5000		22986.	52093.	-9957.	354.8	451.8	510.8	542.0	556.3	562.1	564.2	564.8	564.9		
52.0000		23306.	52494.	-10134.	352.9	450.1	509.6	541.2	555.9	562.0	564.1	564.8	564.9		
52.5000		23625.	52893.	-10310.	350.9	448.5	508.3	540.5	555.6	561.8	564.0	564.8	564.9		
53.0000		23943.	53292.	-10487.	349.0	446.8	507.1	539.7	555.2	561.6	564.0	564.7	564.9		
53.5000		24260.	53690.	-10664.	347.0	445.1	505.9	539.0	554.8	561.4	563.9	564.7	564.9		
54.0000		24575.	54087.	-10841.	345.1	443.5	504.7	538.2	554.4	561.2	563.8	564.7	564.9		
54.5000		24890.	54483.	-11018.	343.1	441.9	503.5	537.4	553.9	561.0	563.7	564.6	564.8		
55.0000		25204.	54879.	-11195.	341.2	440.2	502.2	536.7	553.5	560.8	563.7	564.6	564.8		
55.5000		25516.	55274.	-11373.	339.3	438.6	501.0	535.9	553.1	560.6	563.6	564.6	564.8		
56.0000		25828.	55669.	-11550.	337.3	437.0	499.8	535.1	552.7	560.4	563.5	564.5	564.8		
56.5000		26139.	56063.	-11728.	335.4	435.3	498.6	534.3	552.2	560.2	563.4	564.5	564.8		
57.0000		26449.	56456.	-11906.	333.4	433.7	497.4	533.5	551.8	560.0	563.3	564.5	564.7		
57.5000		26759.	56849.	-12084.	331.5	432.1	496.2	532.8	551.4	559.8	563.2	564.4	564.7		
58.0000		27067.	57240.	-12262.	329.5	430.5	495.0	532.0	550.9	559.6	563.1	564.4	564.7		
58.5000		27375.	57631.	-12440.	327.6	428.9	493.8	531.2	550.5	559.3	563.0	564.3	564.7		
59.0000		27682.	58022.	-12618.	325.6	427.3	492.5	530.4	550.0	559.1	562.9	564.3	564.6		
59.5000		27988.	58412.	-12797.	323.7	425.7	491.3	529.6	549.5	558.9	562.8	564.2	564.6		
60.0000		28293.	58801.	-12975.	321.8	424.1	490.1	528.8	549.1	558.6	562.7	564.2	564.6		
60.5000		28583.	59085.	-13150.	320.2	422.5	488.9	528.0	548.6	558.4	562.6	564.1	564.5		
61.0000		28853.	59242.	-13318.	319.1	420.9	487.7	527.2	548.1	558.1	562.5	564.1	564.5		
61.5000		29110.	59336.	-13482.	318.3	419.4	486.5	526.3	547.6	557.9	562.3	564.0	564.5		
62.0000		29356.	59397.	-13644.	[illegible]	417.9	485.3	525.5	547.1	557.6	562.2	564.0	564.4		
62.5000		29594.	59441.	-13802.	316.7	416.5	484.1	524.7	546.7	557.4	562.1	563.9	564.4		
63.0000		29826.	59476.	-13958.	316.0	415.1	482.9	523.9	546.2	557.1	562.0	563.9	564.3		
63.5000		30050.	59506.	-14112.	315.4	413.7	481.8	523.1	545.7	556.8	561.8	563.8	564.3		
64.0000		30270.	59534.	-14263.	314.7	412.4	480.6	522.3	545.2	556.6	561.7	563.7	564.2		
64.5000		30483.	59560.	-14413.	314.1	411.2	479.4	521.4	544.7	556.3	561.6	563.7	564.2		
65.0000		30692.	59585.	-14561.	313.5	409.9	478.3	520.6	544.1	556.0	561.4	563.6	564.1		
65.5000		30896.	59609.	-14707.	312.9	408.7	477.2	519.8	543.6	555.7	561.3	563.5	564.1		
66.0000		31096.	59633.	-14851.	312.2	407.6	476.0	519.0	543.1	555.4	561.1	563.4	564.0		
66.5000		31291.	59656.	-14994.	311.6	406.4	474.9	518.1	542.6	555.1	561.0	563.4	564.0		
67.0000		31482.	59679.	-15135.	311.0	405.3	473.8	517.3	542.1	554.8	560.8	563.3	563.9		
67.5000		31670.	59702.	-15275.	310.4	404.2	472.7	516.5	541.5	554.5	560.7	563.2	563.9		
68.0000		31853.	59724.	-15413.	309.9	403.1	471.7	515.7	541.0	554.2	560.5	563.1	563.8		
68.5000		32033.	59747.	-15549.	309.3	402.1	470.6	514.9	540.5	553.9	560.3	563.0	563.7		
69.0000		32209.	59769.	-15684.	308.7	401.1	469.5	514.1	540.0	553.6	560.2	562.9	563.7		
69.5000		32382.	59791.	-15818.	308.1	400.1	468.5	513.2	539.4	553.3	560.0	562.8	563.6		

SMUD RAPID COOLDOWN

A. D. McKIM

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION CLOSURE FLANGE

DATE 05/12/78

TIME	EQUIV RAD	LIN. STN.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
70.0000		32552.	59812.	-15950.	307.5	399.1	467.5	512.4	538.9	553.0	559.8	562.8	563.5		
70.5000		32719.	59834.	-16081.	306.9	398.1	466.5	511.5	538.3	552.7	559.7	562.7	563.5		
71.0000		32882.	59856.	-16211.	306.4	397.1	465.5	510.8	537.8	552.3	559.5	562.6	563.4		
71.5000		33043.	59877.	-16339.	305.8	396.2	464.5	510.0	537.3	552.0	559.3	562.5	563.3		
72.0000		33201.	59899.	-16466.	305.2	395.3	463.5	509.2	536.7	551.7	559.1	562.4	563.2		
72.5000		33356.	59920.	-16591.	304.7	394.3	462.5	508.4	536.2	551.4	558.9	562.2	563.2		
73.0000		33509.	59941.	-16716.	304.1	393.4	461.6	507.6	535.6	551.0	558.7	562.1	563.1		
73.5000		33659.	59962.	-16839.	303.5	392.6	460.6	506.9	535.1	550.7	558.6	562.0	563.0		
74.0000		33806.	59984.	-16961.	303.0	391.7	459.7	506.1	534.5	550.3	558.4	561.9	562.9		
74.5000		33951.	60005.	-17081.	302.4	390.8	458.7	505.3	534.0	550.0	558.2	561.8	562.8		
75.0000		34094.	60026.	-17201.	301.9	390.0	457.8	504.5	533.4	549.7	558.0	561.7	562.7		
75.5000		34234.	60047.	-17319.	301.3	389.1	456.9	503.7	532.9	549.3	557.8	561.6	562.6		
76.0000		34372.	60068.	-17436.	300.8	388.3	456.0	503.0	532.3	549.0	557.6	561.4	562.5		
76.5000		34508.	60090.	-17552.	300.2	387.5	455.1	502.2	531.8	548.6	557.3	561.3	562.4		
77.0000		34642.	60111.	-17666.	299.7	386.6	454.3	501.5	531.2	548.2	557.1	561.2	562.3		
77.5000		34774.	60132.	-17780.	299.1	385.8	453.4	500.7	530.7	547.9	556.9	561.1	562.2		
78.0000		34904.	60153.	-17892.	298.6	385.0	452.5	499.9	530.1	547.5	556.7	560.9	562.1		
78.5000		35032.	60174.	-18004.	298.0	384.3	451.7	499.2	529.5	547.2	556.5	560.8	562.0		
79.0000		35158.	60195.	-18114.	297.5	383.5	450.8	498.5	529.0	546.8	556.3	560.6	561.9		
79.5000		35282.	60217.	-18223.	296.9	382.7	450.0	497.7	528.4	546.4	556.0	560.5	561.8		
80.0000		35404.	60238.	-18331.	296.4	381.9	449.1	497.0	527.9	546.1	555.8	560.4	561.7		
81.0000		35616.	60091.	-18535.	296.0	380.5	447.5	495.5	526.8	545.3	555.4	560.1	561.4		
82.0000		35790.	59787.	-18725.	296.1	379.1	445.9	494.1	525.7	544.6	554.9	559.8	561.2		
83.0000		35941.	59444.	-18905.	296.4	377.8	444.3	492.7	524.6	543.8	554.4	559.4	560.9		
84.0000		36073.	59091.	-19075.	296.8	376.7	442.8	491.3	523.5	543.1	553.9	559.1	560.6		
85.0000		36188.	58736.	-19237.	297.2	375.7	441.3	489.9	522.4	542.3	553.4	558.8	560.4		
86.0000		36288.	58381.	-19391.	297.6	374.7	439.9	488.5	521.3	541.5	552.9	558.4	560.1		
87.0000		36375.	58027.	-19537.	298.0	373.8	438.5	487.1	520.2	540.8	552.4	558.1	559.8		
88.0000		36448.	57673.	-19675.	298.5	373.0	437.2	485.8	519.1	540.0	551.9	557.7	[illegible]		
89.0000		36510.	57321.	-19806.	298.9	372.3	435.9	484.5	518.1	539.2	551.3	557.4	[illegible]		
90.0000		36560.	56969.	-19931.	299.4	371.6	434.7	483.2	517.0	538.4	550.8	557.0	558.8		
91.0000		36600.	56619.	-20049.	299.8	371.0	433.5	482.0	[illegible]	537.6	550.2	556.6	558.5		
92.0000		36630.	56270.	-20160.	300.3	370.4	432.4	480.8	[illegible]	536.8	549.7	556.2	558.1		
93.0000		36650.	55922.	-20265.	300.8	369.9	431.3	479.6	513.8	536.1	549.1	555.8	557.8		
94.0000		36662.	55575.	-20363.	301.2	369.4	430.2	478.4	512.8	535.3	548.6	555.4	557.4		
95.0000		36665.	55230.	-20456.	301.7	368.9	429.2	477.2	511.8	534.5	548.0	554.9	557.0		
96.0000		36655.	54848.	-20541.	302.4	368.5	428.2	476.1	510.8	533.7	547.4	554.5	556.6		
97.0000		36631.	54436.	-20619.	303.1	368.1	427.3	475.0	509.8	532.9	546.8	554.0	556.2		
98.0000		36596.	54017.	-20689.	303.9	367.8	426.4	473.9	508.8	532.1	546.2	553.6	555.8		
99.0000		36552.	53599.	-20753.	304.7	367.5	425.5	472.9	507.8	531.3	545.6	553.1	555.4		

SMUD RAPID COOLDOWN

A. D. McKIM

A-75

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION CLOSURE FLANGE DATE 05/12/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
100.0000		36500.	53181.	-20811.	305.5	367.3	424.7	471.8	506.8	530.5	545.0	552.7	555.0		
101.0000		36439.	52764.	-20853.	305.3	367.1	423.9	470.4	505.8	529.7	544.4	552.2	554.6		
102.0000		36370.	52349.	-20909.	307.1	366.9	423.1	469.8	504.9	528.9	543.8	551.7	554.1		
103.0000		36295.	51935.	-20949.	307.9	366.8	422.4	468.9	504.0	528.1	543.2	551.2	553.7		
104.0000		36212.	51523.	-20984.	308.8	365.7	421.7	467.9	503.0	527.3	542.6	550.7	553.2		
105.0000		36123.	51113.	-21014.	309.6	366.7	421.1	467.0	502.1	526.6	542.0	550.2	552.8		
106.0000		36027.	50704.	-21038.	310.4	366.6	420.4	466.1	501.2	525.8	541.3	549.7	552.3		
107.0000		35926.	50297.	-21057.	311.3	365.6	419.8	465.3	500.3	525.0	540.7	549.2	551.8		
108.0000		35819.	49891.	-21071.	312.1	366.6	419.3	464.4	499.5	524.2	540.1	548.7	551.3		
109.0000		35707.	49487.	-21080.	313.0	366.6	418.7	463.6	498.6	523.5	539.4	548.1	550.8		
110.0000		35589.	49084.	-21085.	313.9	366.7	418.2	462.8	497.7	522.7	538.8	547.6	550.3		
111.0000		35464.	48664.	-21084.	314.9	366.8	417.7	462.0	496.9	521.9	538.2	547.0	549.8		
112.0000		35331.	48229.	-21077.	315.7	366.9	.17.3	461.3	496.1	521.2	537.5	546.5	549.3		
113.0000		35192.	47793.	-21066.	316.7	367.0	416.8	460.5	495.3	520.4	536.9	545.9	548.8		
114.0000		35048.	47357.	-21049.	317.7	367.2	416.4	459.8	494.5	519.7	536.2	545.4	548.3		
115.0000		34898.	46922.	-21029.	318.8	367.3	416.0	459.1	493.7	518.9	535.6	544.8	547.7		
116.0000		34743.	46489.	-21003.	319.8	367.5	415.6	458.4	492.9	518.2	534.9	544.3	547.2		
117.0000		34584.	46057.	-20974.	320.8	367.8	415.3	457.8	492.1	517.5	534.3	543.7	546.7		
118.0000		34420.	45627.	-20940.	321.8	368.0	415.0	457.2	491.4	516.7	533.6	543.1	546.1		
119.0000		34252.	45198.	-20902.	322.8	368.3	414.7	456.5	490.7	516.0	533.0	542.5	545.6		
120.0000		34081.	44771.	-20860.	323.9	368.5	414.4	455.9	489.9	515.3	532.3	541.9	545.0		
121.0000		33905.	44346.	-20815.	324.9	368.8	414.1	455.3	489.2	514.6	531.7	541.4	544.4		
122.0000		33726.	43922.	-20765.	325.9	369.1	413.9	454.8	488.5	513.9	531.0	540.8	543.9		
123.0000		33543.	43500.	-20712.	327.0	369.5	413.7	454.2	487.8	513.2	530.4	540.2	543.3		
124.0000		33358.	43079.	-20656.	328.0	369.8	413.5	453.7	487.1	512.5	529.7	539.6	542.7		
125.0000		33169.	42660.	-20596.	329.0	370.2	413.3	453.2	486.5	511.8	529.1	539.0	542.1		
126.0000		32977.	42242.	-20533.	330.1	370.5	413.1	452.7	485.8	511.1	528.4	538.4	541.6		
127.0000		32782.	41826.	-20466.	331.1	370.9	413.0	452.2	485.2	510.4	527.8	537.8	541.0		
128.0000		32585.	41411.	-20397.	332.2	371.3	412.9	451.7	484.6	509.8	527.1	537.2	540.4		
129.0000		32385.	40998.	-20324.	333.2	371.7	412.8	451.3	483.9	509.1	526.5	536.5	539.8		
130.0000		32183.	40587.	-20249.	334.3	372.1	412.7	450.8	483.3	508.4	525.9	535.9	539.2		
131.0000		31978.	40176.	-20171.	335.3	372.5	412.6	450.4	482.7	507.8	525.2	535.3	538.6		
132.0000		31771.	39768.	-20090.	336.4	372.9	412.5	450.0	482.1	507.1	524.6	534.7	538.0		
133.0000		31561.	39361.	-20006.	337.4	373.4	412.4	449.6	481.6	506.5	523.9	534.1	537.4		
134.0000		31350.	38955.	-19920.	338.5	373.8	412.4	449.2	481.0	505.9	523.3	533.5	536.8		
135.0000		31137.	38550.	-19831.	339.5	374.3	412.4	448.9	480.4	505.2	522.7	532.9	536.2		
136.0000		30922.	38148.	-19740.	340.6	374.8	412.4	448.5	479.9	504.6	522.0	532.2	535.6		
137.0000		30705.	37746.	-19646.	341.7	375.2	412.4	448.2	479.4	504.0	521.4	531.6	535.0		
138.0000		30487.	37346.	-19550.	342.7	375.7	412.4	447.9	478.8	503.4	520.8	531.0	534.3		
139.0000		30267.	36947.	-19455.	343.8	376.2	412.4	447.5	478.3	502.8	520.1	530.4	533.7		

SMUD RAPID COOLDOWN

D. McKIM

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION CLOSURE FLANGE

DATE 05/12/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
140.0000		30045.	36550.	-19352.	344.8	376.7	412.4	447.2	477.8	502.2	519.5	529.8	533.1	[illegible]	[illegible]

SMUD RAPID COOLDOWN

A. D. McKIM

A-77

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION NOZZLE CFN   DATE 04/25/78

DIMENSIONS

INSIDE RADIUS = 6.3125 INCHES   OUTSIDE RADIUS = 7.8125 INCHES
NO. OF NODES = 9   RADIAL INCREMENT = .1875 INCHES
MATERIAL CODE = 12   POISSON S RATIO = .3000
L = 0.0000

INITIAL CONDITIONS

NODE	RADIUS	TEMPERATURE
1	6.3125	565.0
2	6.5000	565.0
3	6.6875	565.0
4	6.8750	565.0
5	7.0625	565.0
6	7.2500	565.0
7	7.4375	565.0
8	7.6250	565.0
9	7.8125	565.0

SMUD RAPID COOLDOWN
A. D. McKIM

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION NOZZLE CFN DATE 04/25/78

TABULATION OF
BOUNDARY CONDITIONS

FLUID TEMP. CURVE APPROXIMATION TIME (MINUTES)	INSIDE FLUID TEMPERATURE	FILM COEFF. CURVE APPROXIMATION TIME (MINUTES)	INSIDE FILM COEFFICIENT	PRESSURE CURVE APPROXIMATION TIME (MINUTES)	PRESSURE (PSI)
0.0000	565.0	0.0000	900.0	0.0000	0.
5.0000	565.0	140.0000	900.0	0.0000	0.
10.0000	590.0	0.0000	0.0	0.0000	0.
15.0000	590.0	0.0000	0.0	0.0000	0.
20.0000	525.0	0.0000	0.0	0.0000	0.
40.0000	380.0	0.0000	0.0	0.0000	0.
60.0000	300.0	0.0000	0.0	0.0000	0.
80.0000	280.0	0.0000	0.0	0.0000	0.
95.0000	290.0	0.0000	0.0	0.0000	0.
110.0000	305.0	0.0000	0.0	0.0000	0.
140.0000	340.0	0.0000	0.0	0.0000	0.

TEMPERATURE CALCULATION TIMES AND PRINTOUTS

TIME INCREMENT (MINUTES)	TIME LIMIT (MINUTES)	NUMBER OF PRINTOUTS
.5000	20.000	20.
.5000	80.000	120.
1.0000	140.000	60.

SMUD RAPID COOLDOWN
E. D. McKIM

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION NOZZLE CFN DATE 04/25/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
1.0000		-0.	-0.	0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
2.0000		-0.	-0.	0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
3.0000		-0.	-0.	0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
4.0000		-0.	-0.	0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
5.0000		-0.	-0.	0.	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0	565.0		
6.0000		-425.	-642.	254.	568.7	567.8	567.2	566.6	566.3	566.0	565.8	565.7	565.6		
7.0000		-714.	-1022.	439.	573.0	571.8	570.7	569.9	569.2	568.7	568.3	566.1	568.1		
8.0000		-877.	-1238.	543.	577.6	576.1	574.9	573.8	573.0	572.4	571.9	571.7	571.6		
9.0000		-970.	-1361.	603.	582.4	580.8	579.4	578.3	577.3	576.6	576.1	575.9	575.8		
10.0000		-1024.	-1431.	637.	587.3	585.6	584.1	582.9	582.0	581.2	580.7	580.4	580.3		
11.0000		-624.	-829.	403.	588.6	587.7	586.8	586.1	585.5	585.0	584.7	584.4	584.4		
12.0000		-357.	-471.	229.	589.2	588.7	588.2	587.8	587.4	587.2	587.0	586.8	585.8		
13.0000		-203.	-267.	130.	589.5	589.2	589.0	588.7	588.5	588.4	588.3	588.2	588.2		
14.0000		-113.	-152.	74.	589.7	589.6	589.4	589.3	589.2	589.1	589.0	589.0	589.0		
15.0000		-53.	-86.	42.	589.9	589.8	589.7	589.6	589.5	589.5	589.4	589.4	589.4		
16.0000		1072.	1623.	-636.	580.4	582.5	584.2	585.5	586.5	587.2	587.7	588.0	588.0		
17.0000		1842.	2538.	-1131.	569.1	572.4	575.1	577.3	579.0	580.3	581.2	581.8	581.9		
18.0000		2277.	3211.	-1411.	557.1	561.0	564.3	567.0	569.1	570.8	571.9	572.6	572.8		
19.0000		2517.	3529.	-1566.	544.7	548.9	552.5	555.5	557.8	559.7	561.0	561.7	562.0		
20.0000		2651.	3702.	-1651.	532.0	535.4	540.1	543.3	545.8	547.7	549.1	549.9	550.1		
20.5000		2444.	3347.	-1542.	527.5	531.4	534.7	537.5	539.9	541.7	543.0	543.8	544.1		
21.0000		2230.	3055.	-1403.	523.3	526.9	530.0	532.6	534.7	536.4	537.5	538.2	538.5		
21.5000		2062.	2834.	-1296.	519.3	522.6	525.5	527.9	529.9	531.4	532.5	533.1	533.3		
22.0000		1936.	2667.	-1215.	515.4	518.5	521.2	523.5	525.3	526.8	527.8	528.4	528.6		
22.5000		1841.	2541.	-1154.	511.6	514.6	517.1	519.3	521.0	522.4	523.3	523.9	524.1		
23.0000		1769.	2446.	-1107.	507.8	510.7	513.1	515.2	516.9	518.2	519.1	519.6	519.8		
23.5000		1714.	2374.	-1072.	504.0	505.9	509.2	511.2	512.9	514.1	515.0	515.5	515.7		
24.0000		1673.	2320.	-1046.	500.3	503.1	505.4	507.4	508.9	510.2	511.0	511.5	511.7		
24.5000		1642.	2278.	-1026.	496.6	499.3	501.6	503.5	505.1	506.3	507.1	507.6	507.8		
25.0000		1618.	2247.	-1011.	492.9	495.6	497.9	499.8	501.3	502.5	503.3	503.8	504.0		
25.5000		1599.	2223.	-999.	489.3	491.9	494.1	496.0	497.5	498.7	499.5	500.0	500.2		
26.0000		1585.	2204.	-990.	485.6	488.2	490.4	492.3	493.8	495.0	495.8	496.2	496.4		
26.5000		1574.	2189.	-983.	482.0	484.6	486.8	488.6	490.1	491.2	492.0	492.5	492.7		
27.0000		1566.	2178.	-977.	478.3	480.9	483.1	484.9	486.4	487.5	488.3	488.8	489.0		
27.5000		1559.	2169.	-973.	474.7	477.2	479.4	481.3	482.7	483.9	484.7	485.1	485.3		
28.0000		1554.	2162.	-970.	471.0	473.6	475.8	477.6	479.1	480.2	481.0	481.4	481.6		
28.5000		1549.	2156.	-967.	467.4	470.0	472.1	473.9	475.4	476.5	477.3	477.8	477.9		
29.0000		1545.	2150.	-964.	463.8	466.3	468.5	470.3	471.7	472.9	473.7	474.1	474.3		
29.5000		1542.	2146.	-962.	460.1	462.7	464.8	466.6	468.1	469.2	470.0	470.5	470.6		

SMUD RAPID COOLDOWN

J. D. McKIM

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION NOZZLE CFN DATE 04/25/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
30.0000		1539.	2142.	-961.	456.5	459.0	461.2	463.0	464.4	465.6	466.3	466.8	467.0		
30.5000		1537.	2139.	-959.	452.9	455.4	457.6	459.4	460.8	461.9	462.7	463.2	463.3		
31.0000		1535.	2136.	-958.	449.2	451.8	453.9	455.7	457.2	458.3	459.0	459.5	459.7		
31.5000		1533.	2133.	-956.	445.6	448.1	450.3	452.1	453.5	454.6	455.4	455.9	456.0		
32.0000		1531.	2131.	-955.	442.0	444.5	446.6	448.4	449.9	451.0	451.8	452.2	452.4		
32.5000		1529.	2128.	-954.	438.4	440.9	443.0	444.8	446.2	447.3	448.1	448.6	448.7		
33.0000		1527.	2126.	-953.	434.7	437.2	439.4	441.2	442.6	443.7	444.5	444.9	445.1		
33.5000		1526.	2124.	-952.	431.1	433.6	435.7	437.5	438.9	440.1	440.8	441.3	441.4		
34.0000		1524.	2121.	-951.	427.5	430.0	432.1	433.9	435.3	436.4	437.2	437.6	437.8		
34.5000		1522.	2119.	-950.	423.8	426.3	428.5	430.2	431.7	432.8	433.5	434.0	434.2		
35.0000		1521.	2117.	-949.	420.2	422.7	424.8	426.6	428.0	429.1	429.9	430.4	430.5		
35.5000		1519.	2115.	-949.	416.6	419.1	421.2	423.0	424.4	425.5	426.3	426.7	426.9		
36.0000		1518.	2113.	-947.	413.0	415.4	417.6	419.3	420.8	421.8	422.6	423.1	423.2		
36.5000		1515.	2111.	-946.	409.3	411.8	413.9	415.7	417.1	418.2	419.0	419.4	419.6		
37.0000		1515.	2108.	-945.	405.7	408.2	410.3	412.1	413.5	414.6	415.3	415.8	415.9		
37.5000		1513.	2106.	-944.	402.1	404.5	406.7	408.4	409.8	410.9	411.7	412.2	412.3		
38.0000		1512.	2104.	-943.	398.4	400.9	403.0	404.8	406.2	407.3	408.1	408.5	408.7		
38.5000		1510.	2102.	-942.	394.8	397.3	399.4	401.1	402.6	403.6	404.4	404.9	405.0		
39.0000		1509.	2100.	-941.	391.2	393.6	395.8	397.5	398.9	400.0	400.8	401.2	401.4		
39.5000		1507.	2098.	-940.	387.6	390.0	392.1	393.9	395.3	396.4	397.1	397.6	397.7		
40.0000		1505.	2096.	-939.	383.9	385.4	388.5	390.2	391.6	392.7	393.5	393.9	394.1		
40.5000		1364.	1861.	-860.	381.4	383.5	385.4	386.9	388.2	389.2	389.9	390.4	390.5		
41.0000		1224.	1676.	-771.	379.1	381.0	382.7	384.1	385.2	386.1	386.8	387.1	387.3		
41.5000		1120.	1538.	-704.	376.8	378.6	380.1	381.4	382.5	383.3	383.9	384.2	384.3		
42.0000		1043.	1436.	-654.	374.6	376.3	377.7	378.9	379.9	380.7	381.2	381.5	381.6		
42.5000		985.	1360.	-618.	372.5	374.1	375.5	376.6	377.5	378.2	378.7	379.0	379.1		
43.0000		943.	1304.	-590.	370.4	371.9	373.2	374.3	375.2	375.9	376.4	376.7	376.8		
43.5000		911.	1262.	-570.	368.3	369.8	371.1	372.1	373.0	373.6	374.1	374.4	374.5		
44.0000		888.	1231.	-555.	366.3	367.7	369.0	370.0	370.8	371.5	371.9	372.2	372.3		
44.5000		870.	1208.	-544.	364.3	365.7	366.9	367.9	368.7	369.3	369.8	370.0	370.1		
45.0000		859.	1191.	-536.	362.2	363.6	364.8	365.4	366.6	367.2	367.7	367.9	368.0		
45.5000		849.	1178.	-529.	360.2	361.6	362.8	363.7	364.5	365.1	365.6	365.8	365.9		
46.0000		841.	1169.	-525.	358.2	359.6	360.7	361.7	362.5	363.1	363.5	363.8	363.9		
46.5000		835.	1161.	-521.	356.2	357.5	358.7	359.7	360.4	361.0	361.5	361.7	361.9		
47.0000		831.	1156.	-518.	354.2	355.5	356.7	357.6	358.4	359.0	359.4	359.7	359.8		
47.5000		824.	1152.	-516.	352.2	353.5	354.7	355.6	356.4	357.0	357.4	357.7	357.7		
48.0000		825.	1148.	-515.	350.1	351.5	352.6	353.6	354.4	355.0	355.4	355.6	355.7		
48.5000		823.	1145.	-514.	348.1	349.5	350.6	351.6	352.4	352.9	353.4	353.6	353.7		
49.0000		821.	1143.	-512.	346.1	347.5	348.6	349.6	350.3	350.9	351.4	351.6	351.7		
49.5000		820.	1141.	-512.	344.1	345.5	346.6	347.6	348.3	348.9	349.3	349.6	349.7		

SMUD RAPID COOLDOWN
... D. McKIM

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION NOZZLE CFN DATE 04/25/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
50.0000		819.	1140.	-511.	342.1	343.5	344.6	345.6	346.3	346.9	347.3	347.6	347.7		
50.5000		818.	1138.	-510.	340.1	341.5	342.6	343.6	344.3	344.9	345.3	345.6	345.6		
51.0000		817.	1137.	-510.	338.1	339.5	340.6	341.5	342.3	342.9	343.3	343.6	343.6		
51.5000		[illegible]	1136.	-509.	336.1	337.5	338.6	339.5	340.3	340.9	341.3	341.5	341.6		
52.0000		[illegible]	1135.	-509.	334.1	335.5	336.6	337.5	338.3	338.9	339.3	339.5	339.5		
52.5000		815.	1134.	-508.	332.1	333.5	334.6	335.5	336.3	336.9	337.3	337.5	337.6		
53.0000		814.	1133.	-508.	330.1	331.5	332.6	333.5	334.3	334.9	335.3	335.5	335.6		
53.5000		813.	1132.	-507.	328.1	329.4	330.6	331.5	332.3	332.9	333.3	333.5	333.6		
54.0000		813.	1131.	-507.	326.1	327.4	328.6	329.5	330.3	330.9	331.3	331.5	331.6		
54.5000		812.	1131.	-507.	324.1	325.4	326.6	327.5	328.3	328.9	329.3	329.5	329.6		
55.0000		811.	1130.	-506.	322.1	323.4	324.6	325.5	326.3	326.9	327.3	327.5	327.6		
55.5000		811.	1129.	-505.	320.1	321.4	322.6	323.5	324.3	324.8	325.3	325.5	325.6		
56.0000		810.	1128.	-505.	318.1	319.4	320.6	321.5	322.3	322.8	323.3	323.5	323.6		
56.5000		809.	1127.	-505.	316.1	317.4	318.6	319.5	320.3	320.8	321.2	321.5	321.6		
57.0000		809.	1126.	-505.	314.1	315.4	316.6	317.5	318.2	318.8	319.2	319.5	319.6		
57.5000		808.	1125.	-504.	312.1	313.4	314.6	315.5	316.2	316.8	317.2	317.5	317.6		
58.0000		809.	1124.	-504.	310.1	311.4	312.5	313.5	314.2	314.8	315.2	315.5	315.5		
58.5000		807.	1123.	-503.	308.1	309.4	310.5	311.5	312.2	312.8	313.2	313.5	313.5		
59.0000		805.	1122.	-503.	306.1	307.4	308.5	309.5	310.2	310.8	311.2	311.5	311.5		
59.5000		806.	1121.	-503.	304.1	305.4	306.5	307.5	308.2	308.9	309.2	309.5	309.5		
60.0000		805.	1121.	-502.	302.1	303.4	304.5	305.5	306.2	306.8	307.2	307.4	307.5		
60.5000		674.	906.	-429.	301.1	302.1	303.0	303.8	304.4	304.9	305.3	305.5	305.6		
61.0000		548.	738.	-348.	300.3	301.1	301.9	302.5	303.0	303.4	303.7	303.9	304.0		
61.5000		454.	614.	-288.	299.6	300.3	300.9	301.4	301.9	302.2	302.4	302.6	302.6		
62.0000		386.	524.	-244.	299.0	299.5	300.1	300.5	300.9	301.2	301.4	301.5	301.5		
62.5000		335.	458.	-212.	298.3	298.9	299.3	299.7	300.0	300.3	300.4	300.5	300.6		
63.0000		297.	410.	-189.	297.8	298.2	298.6	299.0	299.3	[illegible]	299.6	299.7	299.8		
63.5000		273.	374.	-171.	297.2	297.6	298.0	298.3	298.6	298.8	298.9	299.0	299.0		
64.0000		253.	348.	-159.	296.6	297.0	297.4	297.7	297.9	298.1	298.2	298.3	298.3		
64.5000		239.	330.	-150.	296.1	296.5	296.8	297.1	297.3	297.5	297.6	297.7	297.7		
65.0000		228.	316.	-143.	295.6	296.0	296.3	296.5	296.7	296.9	297.0	297.1	297.1		
65.5000		221.	306.	-138.	295.1	295.4	295.7	296.0	296.2	296.4	296.5	296.5	296.6		
66.0000		215.	298.	-134.	294.6	294.9	295.2	295.5	295.7	295.8	295.9	296.0	296.0		
66.5000		211.	293.	-132.	294.0	294.4	294.7	294.9	295.1	295.3	295.4	295.4	295.5		
67.0000		209.	289.	-130.	293.5	293.9	294.2	294.4	294.6	294.8	294.9	294.9	294.9		
67.5000		205.	286.	-128.	293.0	293.4	293.7	293.9	294.1	294.2	294.3	294.4	294.4		
68.0000		204.	284.	-127.	292.5	292.9	293.1	293.4	293.6	293.7	293.8	293.9	293.9		
68.5000		203.	282.	-127.	292.0	292.4	292.6	292.9	293.1	293.2	293.3	293.4	293.4		
69.0000		202.	281.	-126.	291.5	291.9	292.1	292.4	292.6	292.7	292.8	292.9	292.9		
69.5000		201.	280.	-126.	291.0	291.4	291.6	291.9	292.1	292.2	292.3	292.4	292.4		

SMUD RAPID COOLDOWN
... D. McKIM

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION NOZZLE CFN DATE 04/25/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
70.0000		201.	279.	-125.	290.5	290.9	291.1	291.4	291.6	291.7	291.8	291.9	291.9		
70.5000		200.	279.	-125.	290.0	290.4	290.6	290.9	291.0	291.2	291.3	291.4	291.4		
71.0000		200.	278.	-125.	289.5	289.8	290.1	290.4	290.5	290.7	290.8	290.9	290.9		
71.5000		200.	278.	-125.	289.0	289.3	289.6	289.9	290.0	[illegible]	290.3	290.3	290.4		
72.0000		200.	278.	-125.	288.5	288.8	289.1	289.4	289.5	[illegible]	289.8	289.8	289.9		
72.5000		199.	278.	-124.	288.0	288.3	288.6	288.9	289.0	289.2	289.3	289.3	289.4		
73.0000		199.	278.	-124.	287.5	287.8	288.1	288.4	288.5	288.7	288.8	288.8	288.9		
73.5000		199.	277.	-124.	287.0	287.3	287.6	287.9	288.0	288.2	288.3	288.3	288.4		
74.0000		199.	277.	-124.	286.5	286.8	287.1	287.4	287.5	287.7	287.8	287.8	287.9		
74.5000		199.	277.	-124.	286.0	286.3	286.6	286.9	287.0	287.2	287.3	287.3	287.4		
75.0000		199.	277.	-124.	285.5	285.8	286.1	286.4	286.5	286.7	286.8	286.8	286.9		
75.5000		199.	277.	-124.	285.0	285.3	285.6	285.9	286.0	286.2	286.3	286.3	286.4		
76.0000		199.	277.	-124.	284.5	284.8	285.1	285.4	285.5	285.7	285.8	285.8	285.9		
76.5000		199.	277.	-124.	284.0	284.3	284.6	284.9	285.0	285.2	285.3	285.3	285.4		
77.0000		199.	277.	-124.	283.5	283.8	284.1	284.4	284.5	284.7	284.8	284.8	284.9		
77.5000		199.	277.	-124.	283.0	283.3	283.6	283.9	284.0	284.2	284.3	284.3	284.4		
78.0000		199.	277.	-124.	282.5	282.8	283.1	283.4	283.5	283.7	283.8	283.8	283.9		
78.5000		199.	277.	-124.	282.0	282.3	282.6	282.9	283.0	283.2	283.3	283.3	283.4		
79.0000		199.	277.	-124.	281.5	281.8	282.1	282.4	282.5	282.7	282.8	282.8	282.9		
79.5000		199.	276.	-124.	281.0	281.3	281.6	281.8	282.0	282.2	282.3	282.3	282.4		
80.0000		199.	276.	-124.	280.5	280.8	281.1	281.3	281.5	281.7	281.8	281.8	281.9		
81.0000		55.	62.	-38.	280.8	280.8	280.4	280.9	281.0	281.0	281.1	281.1	281.1		
82.0000		-33.	-53.	19.	281.2	281.2	281.1	281.1	281.0	281.0	281.0	281.0	281.0		
83.0000		-79.	-114.	49.	281.8	281.7	281.5	281.4	281.4	281.3	281.3	281.3	281.2		
84.0000		-104.	-147.	64.	282.4	282.2	282.1	282.0	281.9	281.8	281.7	281.7	281.7		
85.0000		-117.	-164.	73.	283.0	282.8	282.7	282.5	282.4	282.3	282.3	282.3	282.2		
86.0000		-124.	-174.	77.	283.7	283.5	283.3	283.2	283.1	283.0	282.9	282.9	282.8		
87.0000		-128.	-179.	80.	284.3	284.1	284.2	283.8	283.7	283.6	283.5	283.5	283.5		
88.0000		-130.	-181.	81.	285.0	284.8	284.6	284.5	284.3	284.2	284.2	284.1	284.1		
89.0000		-131.	-183.	82.	285.7	285.5	285.3	285.1	285.0	284.9	284.8	284.8	284.8		
90.0000		-132.	-184.	82.	286.3	286.1	285.9	285.8	285.7	285.6	285.5	285.5	285.5		
91.0000		-132.	-184.	82.	287.0	286.8	286.6	286.5	286.3	286.2	286.2	286.1	286.1		
92.0000		-132.	-184.	83.	287.7	287.5	287.3	287.1	287.0	286.9	286.8	286.8	286.8		
93.0000		-132.	-184.	83.	288.3	288.1	287.9	287.8	287.7	287.6	287.5	287.5	287.4		
94.0000		-133.	-185.	83.	289.0	288.8	288.6	288.4	288.3	288.2	288.2	288.1	288.1		
95.0000		-133.	-185.	83.	289.7	289.5	289.3	289.1	289.0	288.9	288.8	288.8	288.8		
96.0000		-162.	-228.	100.	290.6	290.3	290.1	289.9	289.8	289.6	289.6	289.5	289.5		
97.0000		-179.	-251.	111.	291.5	291.3	291.0	290.8	290.6	290.5	290.4	290.4	290.3		
98.0000		-189.	-263.	117.	292.5	292.2	292.0	291.7	291.6	291.4	291.3	291.3	291.3		
99.0000		-194.	-270.	121.	293.5	293.2	292.9	292.7	292.5	292.4	292.3	292.2	292.2		

SMUD RAPID COOLDOWN
[illegible] D. McKIM

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION NOZZLE CFN

DATE 04/25/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
100.0000		-196.	-274.	122.	294.5	294.2	293.9	293.7	293.5	293.4	293.3	293.2	293.2		
101.0000		-198.	-276.	123.	295.5	295.2	294.9	294.7	294.5	294.4	294.3	294.2	294.2		
102.0000		-199.	-277.	124.	296.5	296.2	295.9	295.7	295.5	295.3	295.2	295.2	295.2		
103.0000		-199.	-277.	124.	297.5	297.2	296.9	296.7	296.5	296.3	296.2	296.2	296.2		
104.0000		-199.	-278.	124.	298.5	298.2	297.9	297.7	297.5	297.3	297.2	297.2	297.2		
105.0000		-200.	-278.	125.	299.5	299.2	298.9	298.7	298.5	298.3	298.2	298.2	298.2		
106.0000		-200.	-278.	125.	300.5	300.2	299.9	299.7	299.5	299.3	299.2	299.2	299.2		
107.0000		-200.	-278.	125.	301.5	301.2	300.9	300.7	300.5	300.3	300.2	300.2	300.2		
108.0000		-200.	-279.	125.	302.5	302.2	301.9	301.7	301.5	301.3	301.2	301.2	301.2		
109.0000		-200.	-279.	125.	303.5	303.2	302.9	302.7	302.5	302.3	302.2	302.2	302.2		
110.0000		-200.	-279.	125.	304.5	304.2	303.9	303.7	303.5	303.3	303.2	303.2	303.2		
111.0000		-215.	-301.	134.	305.6	305.3	305.0	304.7	304.5	304.4	304.3	304.2	304.2		
112.0000		-224.	-312.	139.	306.8	306.4	306.1	305.8	305.6	305.5	305.4	305.3	305.3		
113.0000		-228.	-319.	142.	307.9	307.6	307.2	307.0	306.8	306.6	306.5	306.4	306.4		
114.0000		-231.	-322.	144.	309.1	308.7	308.4	308.1	307.9	307.7	307.6	307.6	307.5		
115.0000		-233.	-324.	145.	310.3	309.9	309.6	309.3	309.1	308.9	308.8	308.7	308.7		
116.0000		-233.	-325.	146.	311.4	311.0	310.7	310.4	310.2	310.1	309.9	309.9	309.8		
117.0000		-234.	-326.	146.	312.6	312.2	311.9	311.6	311.4	311.2	311.1	311.0	311.0		
118.0000		-234.	-326.	146.	313.8	313.4	313.0	312.8	312.6	312.4	312.3	312.2	312.2		
119.0000		-234.	-326.	146.	314.9	314.5	314.2	313.9	313.7	313.5	313.4	313.4	313.3		
120.0000		-235.	-327.	146.	316.1	315.7	315.4	315.1	314.9	314.7	314.6	314.5	314.5		
121.0000		-235.	-327.	146.	317.2	315.9	316.5	316.3	316.0	315.9	315.8	315.7	315.7		
122.0000		-235.	-327.	146.	318.4	318.0	317.7	317.4	317.2	317.0	316.9	316.9	316.8		
123.0000		-235.	-327.	147.	319.6	319.2	318.9	318.6	318.4	318.2	318.1	318.0	318.0		
124.0000		-235.	-327.	147.	320.7	320.4	320.0	319.8	319.5	319.4	319.3	319.2	319.2		
125.0000		-235.	-328.	147.	321.9	321.5	321.2	320.9	320.7	320.5	320.4	320.4	320.3		
126.0000		-235.	-328.	147.	323.1	322.7	322.4	322.1	321.9	321.7	321.6	321.5	321.5		
127.0000		-235.	-328.	147.	324.2	323.9	323.5	323.3	323.0	322.9	322.8	322.7	322.7		
128.0000		-236.	-328.	147.	325.4	325.0	324.7	324.4	324.2	324.0	323.9	323.8	323.8		
129.0000		-235.	-328.	147.	326.6	326.2	325.9	325.6	325.4	325.2	325.1	325.0	325.0		
130.0000		-236.	-328.	147.	327.7	327.4	327.0	326.8	326.5	326.4	326.3	326.2	326.2		
131.0000		-235.	-328.	147.	328.9	328.5	328.2	327.9	327.7	327.5	327.4	327.3	327.3		
132.0000		-235.	-329.	147.	330.1	329.7	329.4	329.1	328.9	328.7	328.6	328.5	328.5		
133.0000		-235.	-329.	147.	331.2	330.9	330.5	330.3	330.0	329.9	329.7	329.7	329.7		
134.0000		-236.	-329.	147.	332.[illegible]	332.0	331.7	331.4	331.2	331.0	330.9	330.8	330.8		
135.0000		-236.	-329.	147.	333.6	333.2	332.9	332.6	332.4	332.2	332.1	332.0	332.0		
136.0000		-236.	-329.	147.	334.7	334.4	334.0	333.8	333.5	333.4	333.2	333.2	333.2		
137.0000		-236.	-329.	148.	335.9	335.5	335.2	334.9	334.7	334.5	334.4	334.3	334.3		
138.0000		-237.	-329.	148.	337.1	336.7	336.4	336.1	335.9	335.7	335.6	335.5	335.5		
139.0000		-237.	-330.	148.	338.2	337.9	337.5	337.3	337.0	336.9	336.7	336.7	336.6		

SMUD RAPID COOLDOWN
A. D. McKIM

A-84

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION NOZZLE CFN DATE 04/25/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
140.0000		-237.	-330.	148.	339.4	339.0	338.7	338.4	338.2	338.0	337.9	337.8	337.8		

SMUD RAPID COOLDOWN

J. D. McKIN

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION OUTLET NOZZLE DATE 04/27/78

DIMENSIONS

INSIDE RADIUS = 18.3125 INCHES OUTSIDE RADIUS = 30.0000 INCHES
NO. OF NODES = 9 RADIAL INCREMENT = 1.4609 INCHES
MATERIAL CODE = 5 POISSON S RATIO = .3000
L = 0.0000

INITIAL CONDITIONS

NODE	RADIUS	TEMPERATURE
1	18.3125	565.0
2	19.7734	565.0
3	21.2344	565.0
4	22.6953	565.0
5	24.1563	565.0
6	25.6172	555.0
7	27.0701	565.0
8	28.5291	565.0
9	30.0000	565.0

SMUD RAPID COOLDOWN
I. D. McKIM

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION OUTLET NOZZLE DATE 04/27/78

TABULATION OF BOUNDARY CONDITIONS

FLUID TEMP. CURVE APPROXIMATION TIME (MINUTES)	INSIDE FLUID TEMPERATURE	FILM COEFF. CURVE APPROXIMATION TIME (MINUTES)	INSIDE FILM COEFFICIENT	PRESSURE CURVE APPROXIMATION TIME (MINUTES)	PRESSURE (PSI)
0.0000	565.0	0.0000	1000.0	0.0000	0.
5.0000	565.0	140.0000	1000.0	0.0000	0.
10.0000	590.0	0.0000	0.0	0.0000	0.
15.0000	590.0	0.0000	0.0	0.0000	0.
20.0000	525.0	0.0000	0.0	0.0000	0.
40.0000	380.0	0.0000	0.0	0.0000	0.
60.0000	300.0	0.0000	0.0	0.0000	0.
80.0000	280.0	0.0000	0.0	0.0000	0.
95.0000	290.0	0.0000	0.0	0.0000	0.
110.0000	305.0	0.0000	0.0	0.0000	0.
140.0000	340.0	0.0000	0.0	0.0000	0.

TEMPERATURE CALCULATION TIMES AND PRINTOUTS

TIME INCREMENT (MINUTES)	TIME LIMIT (MINUTES)	NUMBER OF PRINTOUTS
.5000	20.000	20.
.5000	80.000	120.
1.0000	140.000	60.

SMUD RAPID COOLDOWN

E. D. McKIM

A-87

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION OUTLET NOZZLE DATE 04/27/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
50.0000		29971.	56748.	-13926.	347.3	427.1	482.4	518.6	540.2	552.7	559.2	562.2	563.0		
50.5000		30314.	57129.	-14143.	345.3	425.3	480.9	517.2	539.5	552.1	558.9	562.0	562.9		
51.0000		30654.	57509.	-14359.	343.3	423.6	479.4	516.1	538.7	551.6	558.5	561.8	562.7		
51.5000		30991.	57887.	-14572.	341.3	421.8	478.0	515.0	537.9	551.1	558.2	561.6	562.5		
52.0000		31324.	58264.	-14794.	339.3	420.0	476.5	513.8	537.1	550.6	557.9	561.3	562.3		
52.5000		31655.	58641.	-14995.	337.3	418.3	475.0	512.7	536.2	550.1	557.5	561.1	562.1		
53.0000		31983.	59017.	-15204.	335.3	416.6	473.6	511.6	535.4	549.5	557.2	560.9	562.0		
53.5000		32308.	59393.	-15412.	333.4	414.8	472.1	510.4	534.6	549.0	556.8	560.6	561.7		
54.0000		32630.	59767.	-15618.	331.4	413.1	470.7	509.3	533.8	548.4	556.5	560.4	561.5		
54.5000		32950.	60141.	-15822.	329.4	411.4	469.2	508.2	533.0	547.9	555.1	560.1	561.3		
55.0000		33269.	60514.	-16025.	327.4	409.6	467.8	507.1	532.2	547.3	555.8	559.9	561.1		
55.5000		33583.	60886.	-16227.	325.4	407.9	466.4	505.9	531.4	546.7	555.4	559.6	560.9		
56.0000		33876.	61257.	-16427.	323.4	406.2	464.9	504.8	530.5	546.2	555.0	559.4	560.6		
56.5000		34205.	61627.	-16625.	321.4	404.5	463.5	503.7	529.7	545.6	554.6	559.1	560.4		
57.0000		34515.	61996.	-16822.	319.5	402.8	462.1	502.6	528.9	545.0	554.2	558.8	560.1		
57.5000		34821.	62365.	-17018.	317.5	401.1	460.7	501.5	528.0	544.4	553.8	558.5	559.9		
58.0000		35125.	62733.	-17212.	315.5	399.4	459.3	500.3	527.2	543.8	553.4	558.2	559.6		
58.5000		35427.	63100.	-17405.	313.5	397.7	457.9	499.2	526.4	543.2	553.0	557.9	559.4		
59.0000		35728.	63466.	-17596.	311.5	396.0	456.5	498.1	525.5	542.6	552.6	557.6	559.1		
59.5000		36025.	63831.	-17786.	309.5	394.3	455.1	497.0	524.7	542.0	552.1	557.3	558.8		
60.0000		36322.	64195.	-17975.	307.6	392.6	453.7	495.9	523.9	541.4	551.7	556.9	558.5		
60.5000		36575.	64234.	-18151.	306.5	391.0	452.3	494.8	523.0	540.8	551.3	556.6	558.2		
61.0000		36796.	64200.	-18317.	305.9	389.4	450.9	493.7	522.2	540.2	550.8	556.3	557.9		
61.5000		37003.	64127.	-18478.	305.3	387.9	449.5	492.5	521.3	539.6	550.4	555.9	557.6		
62.0000		37195.	64054.	-18632.	304.7	386.6	448.1	491.4	520.5	539.0	549.9	555.6	557.3		
62.5000		37379.	63992.	-18782.	304.2	385.2	446.8	490.3	519.6	538.3	549.5	555.2	557.0		
63.0000		37551.	63911.	-18927.	303.6	384.0	445.5	489.2	518.8	537.7	549.0	554.9	556.6		
63.5000		37714.	63841.	-19057.	303.1	382.8	444.3	488.1	517.9	537.1	548.5	554.5	556.3		
64.0000		37869.	63772.	-19203.	302.5	381.6	442.9	487.0	517.1	536.4	548.0	554.1	556.0		
64.5000		38015.	63705.	-19336.	302.0	380.5	441.7	486.0	516.2	535.8	547.6	553.7	555.6		
65.0000		38155.	63638.	-19464.	301.4	379.4	440.5	484.9	515.3	535.1	547.1	553.3	555.3		
65.5000		38287.	63572.	-19598.	300.9	378.4	439.3	483.8	514.5	534.5	546.6	553.0	554.9		
66.0000		38413.	63507.	-19709.	300.3	377.4	438.2	482.8	513.6	533.8	546.1	552.6	554.5		
66.5000		38534.	63443.	-19827.	299.8	376.4	437.0	481.7	512.8	533.2	545.6	552.2	554.2		
67.0000		38649.	63380.	-19941.	299.3	375.4	435.9	480.7	511.9	532.5	545.1	551.7	553.8		
67.5000		38757.	63317.	-20051.	298.7	374.5	434.8	479.7	511.1	531.9	544.6	551.3	553.4		
68.0000		38861.	63255.	-20159.	298.2	373.5	433.7	478.7	510.3	531.2	544.1	550.9	553.0		
68.5000		38961.	63195.	-20253.	297.7	372.6	432.7	477.7	509.4	530.5	543.5	550.5	552.6		
69.0000		39055.	63135.	-20364.	297.1	371.7	431.6	476.7	508.6	529.9	543.0	550.0	552.2		
69.5000		391[illegible]6.	63075.	-20463.	296.6	370.9	430.6	475.7	507.7	529.2	542.5	549.6	551.8		

SMUD RAPID COOLDOW[N]
R. D. McKIM
A-88

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION OUTLET NOZZLE DATE 04/27/78

TIME	EQUIV RAD	LIN. IN.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE1
70.0000		39232.	63017.	-20558.	296.1	370.0	429.6	474.7	506.9	528.5	542.0	549.2	551.4		
70.5000		39314.	62959.	-20651.	295.5	369.2	428.6	473.8	506.1	527.9	541.4	548.7	551.0		
71.0000		39393.	62901.	-20740.	295.0	368.4	427.7	472.8	505.3	527.2	540.9	548.3	550.6		
71.5000		39468.	62845.	-20827.	294.5	367.5	426.7	471.9	504.4	526.5	540.4	547.8	550.1		
72.0000		39540.	62788.	-20912.	294.0	366.7	425.8	471.0	503.6	525.8	539.8	547.4	549.7		
72.5000		39608.	62733.	-20994.	293.4	365.9	424.8	470.0	502.8	525.2	539.3	546.9	549.3		
73.0000		39673.	62678.	-21073.	292.9	365.2	423.9	469.1	502.0	524.5	538.7	546.4	548.3		
73.5000		39735.	62624.	-21150.	292.4	364.4	423.0	468.2	501.2	523.8	538.1	545.9	548.4		
74.0000		39794.	62570.	-21224.	291.9	363.6	422.1	467.3	500.4	523.1	537.6	545.5	547.9		
74.5000		39851.	62517.	-21296.	291.4	362.9	421.3	466.5	499.6	522.5	537.0	545.0	547.5		
75.0000		39904.	62464.	-21366.	290.8	362.1	420.4	465.6	498.8	521.8	536.5	544.5	547.0		
75.5000		39956.	62412.	-21433.	290.3	361.4	419.5	464.7	498.0	521.1	535.9	544.0	546.5		
76.0000		40004.	62361.	-21498.	289.8	360.7	418.7	463.9	497.2	520.4	535.3	543.5	546.1		
76.5000		40050.	62310.	-21561.	289.3	359.9	417.8	463.0	496.4	519.8	534.8	543.0	545.6		
77.0000		40094.	62259.	-21622.	288.8	359.2	417.0	462.2	495.7	519.1	534.2	542.5	545.1		
77.5000		40136.	62209.	-21681.	288.2	358.5	416.2	461.3	494.9	518.4	533.6	542.0	544.6		
78.0000		40176.	62159.	-21738.	287.7	357.8	415.4	460.5	494.1	517.7	533.0	541.5	544.1		
78.5000		40213.	62110.	-21793.	287.2	357.1	414.6	459.7	493.4	517.1	532.4	540.9	543.6		
79.0000		40249.	62061.	-21845.	286.7	356.4	413.8	458.9	492.6	516.4	531.9	540.4	543.1		
79.5000		40283.	62013.	-21897.	286.2	355.7	413.0	458.1	491.8	515.7	531.3	539.9	542.6		
80.0000		40314.	61965.	-21946.	285.7	355.1	412.2	457.3	491.1	515.0	530.7	539.4	542.1		
81.0000		40309.	61465.	-22022.	285.9	353.8	410.7	455.7	489.6	513.7	529.5	538.3	541.1		
82.0000		40261.	60890.	-22079.	286.5	352.8	409.2	454.1	488.1	512.4	528.3	537.2	540.1		
83.0000		40185.	60320.	-22122.	287.0	351.9	407.8	452.6	486.6	511.0	527.1	536.1	539.[illegible]		
84.0000		40086.	59756.	-22151.	287.6	351.1	406.4	451.1	485.2	509.7	525.9	535.0	537.[illegible]		
85.0000		39968.	59198.	-22167.	288.2	350.5	405.2	449.6	483.8	508.4	524.7	533.9	536.9		
86.0000		39834.	58645.	-22173.	288.7	349.9	404.0	448.2	482.3	507.1	523.5	532.8	535.8		
87.0000		39684.	58097.	-22168.	289.3	349.4	402.8	446.8	480.9	505.7	522.3	531.7	534.7		
88.0000		39521.	57555.	-22154.	289.9	349.0	401.8	445.5	479.6	504.4	521.1	530.5	533.6		
89.0000		39345.	57017.	-22130.	290.5	348.6	400.8	444.2	478.2	503.1	519.9	529.4	532.4		
90.0000		39161.	56484.	-22097.	291.1	348.3	399.8	443.0	476.9	501.8	518.7	528.2	531.3		
91.0000		38966.	55956.	-22057.	291.7	348.0	398.9	441.7	475.6	500.6	517.4	527.1	530.2		
92.000		38763.	55432.	-22008.	292.3	347.8	398.1	440.6	474.3	499.3	516.2	525.9	529.0		
93.0000		38551.	54912.	-21952.	292.9	347.6	397.3	439.4	473.0	498.0	515.0	524.7	527.9		
94.0000		38333.	54397.	-21889.	293.5	347.4	396.5	438.3	471.8	496.8	513.8	523.6	526.7		
95.0000		38108.	53886.	-21820.	294.1	347.2	395.8	437.2	470.5	495.5	512.6	522.4	525.6		
96.0000		37864.	53296.	-21740.	295.0	347.1	395.1	436.2	469.3	494.3	511.4	521.2	524.4		
97.0000		37609.	52697.	-21653.	295.9	347.0	394.4	435.2	468.2	493.0	510.2	520.0	523.2		
98.0000		37343.	52102.	-21558.	296.8	347.0	393.8	434.2	467.0	491.8	508.9	518.8	522.0		
99.0000		37069.	51512.	-21457.	297.8	347.1	393.2	433.3	465.9	490.6	507.7	517.7	520.9		

SMUD RAPID COOLDOW

D. McKIM

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION OUTLET NOZZLE **** 91232 REV 4 12-15-74 04/27/78 14.02.50 PAGE 18
**** FULL CERTIFICATION **** **** FULL CERTIFICATION **** **** FULL CERTIFICATION **** J10CC16

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION OUTLET NOZZLE DATE 04/27/78

TIME	EQUIV RAD	LIN. STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
100.0000		36789.	50927.	-21349.	298.7	347.2	392.7	432.3	464.8	489.4	506.5	516.5	519.7		
101.0000		36503.	50346.	-21236.	299.6	347.3	392.2	431.5	463.7	488.3	505.3	515.3	518.5		
102.0000		36212.	49769.	-21117.	300.6	347.4	391.7	430.6	462.6	487.1	504.2	514.1	517.3		
103.0000		35916.	49197.	-20994.	301.5	347.6	391.2	429.8	461.5	485.9	503.0	512.9	516.1		
104.0000		35615.	48629.	-20865.	302.4	347.7	390.9	429.0	460.5	484.8	501.8	511.7	514.9		
105.0000		35311.	48065.	-20733.	303.4	347.9	390.5	428.2	459.5	483.7	500.6	510.5	513.8		
106.0000		35004.	47505.	-20596.	304.3	348.2	390.1	427.4	458.5	482.6	499.5	509.4	512.5		
107.0000		34693.	46949.	-20455.	305.3	348.4	389.8	426.7	457.5	481.5	498.3	508.2	511.4		
108.0000		34380.	46396.	-20311.	306.2	348.7	389.5	426.0	456.6	480.4	497.1	507.0	510.2		
109.0000		34064.	45848.	-20153.	307.2	348.9	389.2	425.3	455.6	479.3	496.0	505.8	509.0		
110.0000		33747.	45304.	-20012.	308.1	349.2	388.9	424.7	454.7	478.2	494.9	504.7	507.9		
111.0000		33421.	44722.	-19857.	309.2	349.5	388.7	424.0	453.8	477.2	493.7	503.5	505.7		
112.0000		33090.	44136.	-19697.	310.3	349.8	388.5	423.4	452.9	476.1	492.6	502.3	505.5		
113.0000		32756.	43555.	-19535.	311.4	350.2	388.3	422.8	452.1	475.1	491.5	501.2	504.4		
114.0000		32419.	42978.	-19369.	312.5	350.6	388.1	422.2	451.2	474.1	490.4	500.0	503.2		
115.0000		32077.	42405.	-19201.	313.6	351.0	387.9	421.7	450.4	473.1	489.3	498.9	502.0		
116.0000		31738.	41835.	-19030.	314.7	351.4	387.8	421.1	449.6	472.1	488.2	497.8	500.9		
117.0000		31395.	41269.	-18857.	315.9	351.9	387.7	420.6	448.8	471.1	487.1	496.6	499.7		
118.0000		31050.	40707.	-18692.	317.0	352.3	387.6	420.1	448.0	470.2	486.1	495.5	498.6		
119.0000		30705.	40149.	-18505.	318.1	352.8	387.5	419.7	447.3	469.2	485.0	494.4	497.5		
120.0000		30358.	39595.	-18326.	319.2	353.3	387.5	419.2	446.5	468.3	484.0	493.3	496.4		
121.0000		30012.	39044.	-18145.	320.3	353.7	387.5	418.7	445.8	467.4	482.9	492.2	495.2		
122.0000		29664.	38496.	-17963.	321.4	354.2	387.4	418.3	445.1	466.5	[illegible]	491.1	494.1		
123.0000		29316.	37952.	-17780.	322.6	354.8	387.4	417.9	444.4	465.6	[illegible]	490.0	493.0		
124.0000		28969.	37412.	-17596.	323.7	355.3	387.4	417.5	443.7	464.7	479.9	488.9	491.9		
125.0000		28621.	36875.	-17410.	324.8	355.8	387.4	417.1	443.0	463.8	478.9	487.9	490.8		
126.0000		28273.	36341.	-17224.	325.9	356.3	387.5	416.8	442.3	462.9	477.9	486.8	489.8		
127.0000		27925.	35811.	-17036.	327.0	356.9	387.5	416.4	441.7	462.1	476.9	485.8	488.7		
128.0000		27578.	35284.	-16848.	328.2	357.4	387.6	416.1	441.1	461.2	475.9	484.7	487.6		
129.0000		27231.	34760.	-16650.	329.3	358.0	387.7	415.8	440.4	460.4	475.0	483.7	486.6		
130.0000		26885.	34240.	-16471.	330.4	358.6	387.7	415.5	439.8	459.6	474.0	482.7	485.5		
131.0000		26539.	33722.	-16291.	331.5	359.1	387.8	415.2	439.2	458.8	473.1	481.7	484.5		
132.0000		26194.	33208.	-16091.	332.7	359.7	387.9	414.9	438.7	458.0	472.1	480.6	483.5		
133.0000		25850.	32697.	-15901.	333.8	360.3	388.1	414.6	438.1	457.2	471.2	479.7	482.4		
134.0000		25507.	32190.	-15710.	334.9	360.9	388.2	414.4	437.5	456.5	470.3	478.7	481.4		
135.0000		25164.	31685.	-15520.	336.0	361.5	388.3	414.1	437.0	455.7	469.4	477.7	480.4		
136.0000		24823.	31183.	-15329.	337.2	362.1	388.5	413.9	436.5	455.0	468.5	476.7	479.4		
137.0000		24482.	30685.	-15139.	338.3	362.7	388.6	413.6	436.0	454.2	467.7	475.8	478.5		
138.0000		24143.	30189.	-14948.	339.4	363.3	388.8	413.4	435.5	453.5	466.8	474.8	477.5		
139.0000		23804.	29696.	-14758.	340.5	363.9	388.9	413.2	435.0	452.8	465.9	473.9	476.5		

SMUD RAPID COOLDO

L. D. McKIM

A-90

SMUD REACTOR TRIP TEMPERATURE DISTRIBUTION OUTLET NOZZLE DATE 04/27/78

TIME	EQUIV LIN. RAD STR.	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE10	NODE11
140.0000	23467.	29207.	-14568.	341.7	364.5	389.1	413.0	434.5	452.1	465.1	473.0	475.6		

SMUD RAPID COOLDOWN
L. D. McKIM

CONTRACT NO. 595-7072 620-0011	DOCUMENT COMMENT FORM	RELEASED BY [signature] TASK ENGINEER 11/8/78 DATE	
SUPPLIER B&W	PREPARED BY: [signature] NAME 11/8/78 DATE	REL. DATE 11-17-78	PAGE 1 OF 1
PO. NO.			

PART/TGS	B&W DOC. NO.	DOCUMENT TITLE	CUSTOMER/ SUPPLIER DOC. NO.	STATUS	RRL NUMBER
59-01-001		SMUD COOLDOWN INCIDENT, JUSTIFICATION OF PRESSURIZER FOR SACRAMENTO MUNICIPAL UTILITY DISTRICT (RANCHO SECO), B&W CONTRACT 620-0011-59	620-0011-59	APPROVED	N/A

33 0276 00

DISTRIBUTION:

J.M. BURNETT (W/ 1 ATTACH)
R.R. SCHAEFER (W/1 ATTACH) - MTV
J.J. KELLY (W/6 ATTACH)
J.T. JANIS (W/0 ATTACH)

SMUD COOLDOWN INCIDENT

JUSTIFICATION OF PRESSURIZER

FOR

SACRAMENTO MUNICIPAL UTILITY DISTRICT
RANCHO SECO

B&W CONTRACT NO: 620-0011-59

PREPARED BY: John N. Stackhouse / Associate Engr. / 6-5-78

CHECKED BY: David M. Loftus / Associate Eng. / 6-6-78

APPROVED BY: R.P. Schaefer / Senior Engr. / 6-7-78

Mt. Vernon Engineering
The Babcock & Wilcox Company
Mt. Vernon, Indiana

B & W DOCUMENT NUMBER
33 0276 00

TABLE OF CONTENTS

PAGE NO.

Introduction.. 1

Discussion.. 1

Results... 2

Conclusion.. 3

References.. 4

Transient Description... A-1 Thru A-6

Pressurizer Spray Nozzle Justification .... B-1 Thur B-5

APPENDIX

Spray Nozzle, 91213 Output.................................... Y-1 Thru Y-13

INTRODUCTION:

The purpose of this discussion is to provide an assessment of the affect that the accelerated cooldown, experienced at SMUD, had upon the Pressurizer and to determine what analytical work should be done, if any, to justify the structural integrity of the Pressurizer and to show that the Pressurizer is still in accordance with Section III of the ASME Boiler and Pressure Vessel Code.

This rapid cooldown transient is being analyzed since it was not defined in the Reactor Coolant System Functional Specification, CS(F)-3-92/NSS-11, and was therefore not analyzed in the Pressurizer Stress Report, 620-0011-59.

DISCUSSION:

In order to determine what thermal/pressure transient the Pressurizer was subjected to, it is necessary to look at the sequence of events and descriptive curves contained in reference D-1.

From reference D-1, it can be seen that the reactor coolant pressure transient consists of a ΔP of approximately 900 psi due to a pressure drop from 2400 psi to 1500 psi in approximately 15 minutes. The reactor coolant thermal transient describes an accelerated temperature drop from 590°F to 280°F in approximately 1 hour. However, this thermal transient is not applicable when considering the bulk fluid temperature of the Pressurizer. The bulk fluid temperature may be determined from standard steam tables using the pressure transient for the accelerated cooldown since the Pressurizer is considered to remain at saturation. Thus, at saturation a temperature of ≈660°F exists for a pressure of 2400 psi while a temperature of ≈600°F corresponds to a pressure of 1500 psi

Therefore, it is concluded that the Pressurizer was not subjected to the accelerated thermal cooldown transient shown for the reactor coolant.

Comparison of the thermal/pressure transient experienced by the bulk fluid of the Pressurizer with the thermal/pressure transients described in the Functional Specification, reference B-5, reveals that a more severe condition is depicted by Transient 9, "Rapid Depressurization".

Transient 9 describes a thermal/pressure transient that consists of a pressure drop from 2200 psi to 800 psi and a temperature drop from 650°F to 520°F with both conditions occurring simultaneously over a 15 minute period.

DISCUSSION: (Continued)

Note that, with the exception of the Pressurizer Spray Nozzle, none of the cumulative usage factors of the components of the pressurizer are increased by analyzing an additional cycle of "Rapid Depressurization". However, for the Pressurizer Spray Nozzle a new cumulative usage factor has been calculated for the SMUD accelerated cooldown transient.

RESULTS:

The following is a tabulation of the original and new cumulative usage factors for the affected pressurizer components:

LOCATION	ORIGINAL C.U.F.	NEW C.U.F.
Pressurizer Spray Nozzle	.330	.345

CONCLUSION:

It has been concluded that the Pressurizer still meets all of the requirements of the ASME Boiler and Pressure Vessel Code, Section III; and that the accelerated cooldown of the system does not reduce any of the number of cycles originally designed for and defined in the Functional Specification, Ref. B-5.

REFERENCES:

A. Drawings

1. B&W Drawing #135483E7 - Pressurizer List of Material
2. B&W Drawing #135493E5 - 4" Spray Nozzle Details

B. Codes, Specifications, and Reports

1. USAS B31.7 - 1969.
2. ASME Boiler and Pressure Vessel Code, Section III, 1965 Edition thru Summer 1967 Addenda.
3. "Design Analysis of 4" SCH 120 Spray Nozzle, Report No. 9, prepared by R.C. Bodell, dated December 1971.
4. "Pressurizer Stress Report for SMUD, Rancho Seco #1, B&W contract #620-0011-59, SMUD Order #3075, dated August 1974.
5. B&W Reactor Coolant System Functional CS(F)3-92/NSS-11.

C. Computer Programs

1. B&W Program #91213 - Slab Temperature Distribution.

D. General

1. Letter from J.M. Burnett to Distribution, subject - SMUD Cooldown Incident, 620-0011-50/59, dated 4-4-78.

2. Letter from J.M. Burnett to Distribution, subject - SMUD Cooldown Incident, 620-0011-50/59, dated 4-7-78.

3. Letter from R.W. Moore to J.M. Burnett, subject - Pressurizer Spray Following Rapid SMUD Cooldown of 3-20-78, 620-0011-50/59, dated 5-23-78.

4. Letter from J. M. Burnett to Distribution, subject - SMUD Cooldown Incident, 620-0011-50/59, dated 4/20/78.

- A -

TRANSIENT DESCRIPTION

The following pages of this section contain a description of the sequence of events of the SMUD Cooldown Incident. Also contained herein is a time-temperature and time-pressure plot of the reactor coolant system which is used in the justification of the cooldown.

SEQUENCE OF EVENTS - 04:25(AM) to 05:34(AM)

(TAKEN FROM REF D-2)

TIME	EVENT
4:25:35	- Lost NNI power supply cabinets 5,6, & 7 (B&W Channel "Y")
	- This caused a loss of T_H signals to the ICS. BTU limits ran back feedwater, resulting in a loss of feedwater (actual Rx power was 72%).
4:25:46	- Reactor trip on high pressure, turbine trip on interlock.
	- Pressurizer code relief setting was known to be low (≈2225 psig). The electromatic relief was isolated due to previous leakage problems. The data indicates primary pressure went ≈2400 psig =>code relief valve lifted.
4:26:17	- Operator starts HPI pump "B" to maintain pzr. level.
4:28:23	- Operator stops HPI pump "B".
4:30	- OTSG "B" goes dry. Data indicates that "A" OTSG probably also went dry.
4:34:25	- RC pressure ≈1900 PSI (low pressure trip setpoint.
4:34	- Operator increases speed of a MFP and feeds "A" OTSG. This starts RCS on pressure and temperature decrease.
4:37:16	- SFAS actuation at 1600 psig This starts HPI, LPI and initiates aux. feed. Aux. FW valves are opened to full open position. The system makes no automatic attempt to control steam generator water level.
4:40	- RC pressure at 1475 psig. It starts to recover from this point due to HPI. T_{ave} = 528°F.
4:43:56	- "A" HPI pump secured.
4:46:09	- LPI secured.
4:59:54	- "A" HPI initiated. From this point on, the operator started and stopped HPI pumps as necessary to maintain pressurized level.

TIME	EVENT
4:51:25	- Secured RCP-D (T_{ave} =435°F) This reduced #RCP's to three
4:57:27	- OTSG "A" water level - 599.7"
	Speculate that ≈2 ft of tubes are not flooded (at top) due to steam line arrangement.
5:00:00	- Hourly computer log printout Steam temp 380°F (OTSG "B") Steam pressure 171 psig (OTSG "B")
	Assuming $T_{ave} = T_{sat} \Rightarrow T_{ave} = 380°F$
5:13:47	- OTSG "B" level - 599.1"
5:34	- Power restored to NNI cabinets 5,6 & 7
	T_{ave} = 285°F
	RCS Pressure ≈2000 psig
	Both OTSG full level ranges pegged high
	* Operator begins to reduce RC pressure using Pzr spray.
	Operator stops electric aux FW pump.

(TAKEN FROM REF D-2)

*SEE PG A-5 + A-6

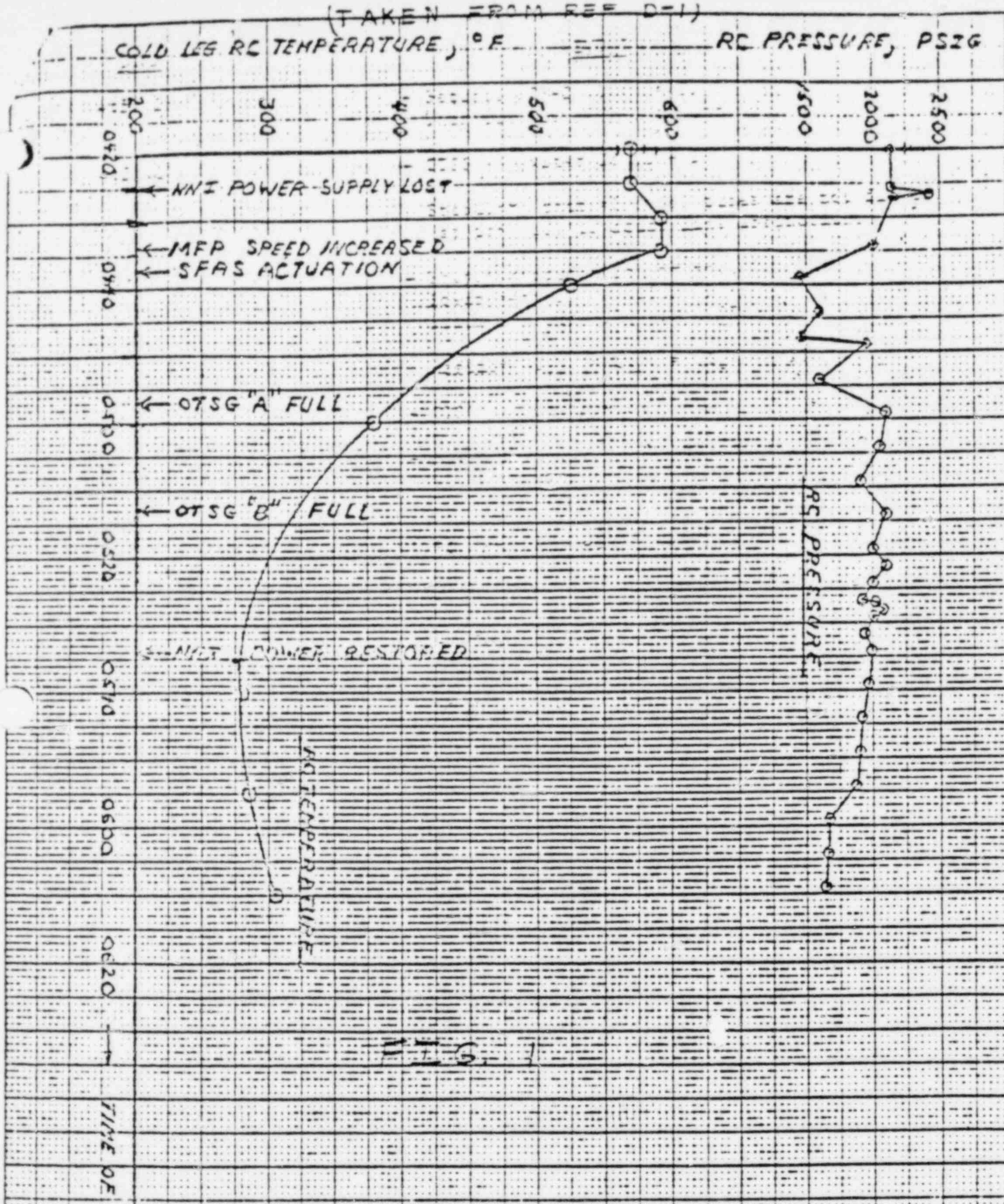

(TAKEN FROM REF D-1)
COLD LEG RC TEMPERATURE, °F
RC PRESSURE, PSIG
200
300
400
500
600
1500
2000
2500
0420
0440
0500
0520
0540
0600
0620
NNI POWER SUPPLY LOST
MFP SPEED INCREASED
SFAS ACTUATION
OTSG "A" FULL
OTSG "B" FULL
NNI POWER RESTORED
RC PRESSURE
RC TEMPERATURE
TIME OF EVENT

FIG. 1

THE BABCOCK & WILCOX COMPANY
POWER GENERATION GROUP

TAKEN FROM
REF D-3

To J.M. Burnett, RCS Components

From R.W. Moore, Control Analysis (2648)

BDS 643.5

Cust. SMUD

File No. or Ref.

Subj. Pressurizer Spray Following Rapid SMUD Cooldown of 3/20/78

Date May 23, 1978

This letter to cover one customer and one subject only.

Attached please find a description of spray line variables for the pressurizer spray down following the rapid cooldown at SMUD on 3/20/78. The RCS pressure may be taken to be saturation pressure for the stated pressurizer temperature. The source of spray water was taken from the cold leg (not auxiliary spray).

RWM/lp

PRESSURIZER SPRAY FLOW AND TEMP.

FOLLOWING SMUD RCS COOLDOWN TRANSIENT OF 3/20/78

Time Hr:Min	Elapsed Time, Min.	Pressurizer Steam, Temp., F	Spray Nozzle Fluid Temp., F	Spray Rate GPM
5:34	0.	637	280	1.0
5:56	22.0	633	280	1.0
5:56.1	22.1	633	280	150.
5:59.5	25.5	613	280	150.
5:59.6	25.6	613	280	1.0
6:05	31.0	613	280	1.0
6:05.1	31.1	613	280	25.
6:07	33.0	611.5	280	25.
6:07.1	33.1	611.5	280	1.0
6:15	41.0	610	280	1.0
6:15.1	41.1	610	280	20.
6:29	55.0	600	280	20.
6:29.1	55.1	600	280	1.0
7:05	91.0	591	280	1.0

TAKEN FROM REF D-3

- B -

PRESSURIZER

SPRAY NOZZLE

PRESSURIZER SPRAY NOZZLE

PRIMARY + SECONDARY STRESS

THE MAXIMUM PRI + SEC STRESS OCCURS AT THE INSIDE SURFACE OF THE SPRAY NOZZLE AT THE BEGINNING OF THE INTERNAL PIPING.

$S_n = 55.4$ KSI — REF. PG. B-16-17 OF THE SPRAY NOZZLE STRESS REPORT (REF B-3)

TO THIS S_n VALUE WILL BE ADDED AN ADDITIONAL RADIAL GRADIENT AND DISCONTINUITY STRESS.

$$\sigma_{R.G.} = \frac{1}{2(1-\nu)} E \alpha \Delta T_1 = \frac{1}{2(1-\nu)} (29.67 \times 10^6)\, 6.12 \times 10^{-6} (24.1)$$

$$\sigma_{R.G.} = 3.1 \text{ KSI}$$

SEE CALCULATION OF ΔT_1 ON PG B-5

REF PG Y-13

$$\sigma_{DISCONT} = C_3 E_{ab} |\alpha_a T_a - \alpha_b T_b| = 1.8 (30.5 \times 10^6) |(7.13 \times 10^{-6}) 631° - (6.12 \times 10^{-6}) 650°|$$
$$= 28.6 \text{ KSI}$$

THE FOLLOWING ASSUMPTIONS HAVE BEEN MADE. $C_3 = 1.8$ FOR A BRANCH CONNECTION. THE ΔT BETWEEN THE PRESSURIZER SHELL

AND THE INTERNAL EXTENSION IS 19°. THIS IS ASSUMING THE PRESSURIZER SHELL IN THE AREA OF THE NOZZLE REMAINS AT 650°F WHILE THE AVERAGE TEMP OF THE INTERNAL EXTENSION IS 631°F, REF PG Y-13.

$S_n = 55.4 + 3.1 + 28.6 = 87.1 \text{ KSI} > 3S_m = 51.0 \text{ KSI}$

$S_p = 58.2 \text{ KSI}$ REF PG C-13-1 OF THE SPRAY NOZZLE STRESS REPORT (REF B-3)

TO THIS S_p VALUE WILL BE ADDED AN ADDITIONAL RADIAL GRADIENT AND DISCONTINUITY STRESS.

$\sigma_{R.G.} = \frac{1}{2(1-\nu)} K_3 \; E\alpha\Delta T_1 + \frac{1}{1-\nu} \; E\alpha\Delta T_2 = 1.7(3.1) + \frac{1}{1-\nu}(29.27\times10^6)6.12\times10^{-6}(.6)$

$= 5.3 + .2 = 5.5 \text{ KSI}$

($\Delta T_2 = .6$ REF PG B-5)

$\sigma_{DISCONT} = C_3 K_3 E_{ab} |\alpha_a T_a - \alpha_b T_b| = 1.7(28.6) = 48.6 \text{ KSI}$

$S_p = 58.2 + 5.5 + 48.6 = 112.3 \text{ KSI}$

USING THE SIMPLIFIED ELASTIC PLASTIC

$K_e = 1.0 + \frac{1-.2}{.2(3-1)}\left(\frac{87.1}{51.0} - 1\right) = 2.4$

BABCOCK & WILCOX		REVISION
DEPARTMENT	DATE BY	
	CHECKED DATE BY	
	JOB NO	SHEET B-2 OF

$$S_{ALT} = K_e \frac{S_P}{2} = 2.4\left(\frac{112.3}{2}\right)$$

$$= 135.6 \text{ KSI}$$

$n_1 = 3$ (REF PG A-6)

$N_1 = 200$

$$U_1 = \frac{n_1}{N_1} = \frac{3}{200} = .015$$

ADDING U_1 TO THE PREVIOUSLY CALCULATED U, REF PG C-13-1

$$U_{TOT} = .330 + .015 = .345 < 1.0$$

BABCOCK & WILCOX

DEPARTMENT DATE BY

CHECKED DATE BY

JOB NO.

REVISION

SHEET B-3 OF

PRESSURIZER SPRAY NOZZLE THERMAL GRADIENT CALCULATIONS

$$T_{AVER} = \frac{1}{t}\int_{-t/2}^{t/2} T(Y)\,dY$$

$$\Delta T_1 = \frac{12}{t^2}\int_{-t/2}^{t/2} Y\,T(Y)\,dY$$

$$\Delta T_2 = MAX \begin{cases} |T_o - T| - \frac{1}{2}|\Delta T_1| \\ |T_i - T| - \frac{1}{2}|\Delta T_1| \end{cases}$$

SIMPSON'S RULE IS USED TO EVALUATE THE INTEGRALS LISTED ABOVE FOR TIME 0540, SEE PRESSURIZER SPRAY NOZZLE THERMAL DISTRIBUTION PROGRAM PG Y-13

SIMPSON'S RULE $\int_{x_0}^{x_2} f(x)\,dx = \frac{h}{3}\left[f_0 + 4f_1 + f_2\right]$

$$h = \frac{t}{4} = .1171$$

$$T = \frac{1}{.4685}(.1171)\tfrac{1}{3}\left[618.8 + 4(625.4) + 2(631.7) + 4(637.7) + 643.4\right]$$

REF PG Y-13

$$= 631.4\ °F$$

Y	T(Y) REF PG Y-13	YT(Y)
$-\frac{t}{2}$	618.8	$-309.4t$
$-\frac{t}{4}$	625.4	$-156.4t$
0	631.7	0
$\frac{t}{4}$	637.7	$159.4t$
$\frac{t}{2}$	643.3	$321.7t$

$$\Delta T_1 = \frac{12}{(.4685)^2}(.1171)\frac{1}{3}\left(-145.0 - 4(73.3) + 2(0) + 4(74.7) + 150.7\right)$$

$$= 24.1$$

$$\Delta T_2 = MAX \begin{cases} |643.3 - 631.4| - \frac{1}{2}(24.1) = -.2 \\ |618.8 - 631.4| - \frac{1}{2}(24.1) = .6 \end{cases}$$

$$\therefore \Delta T_2 = .6$$

APPENDIX

SLAB TEMPERATION DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

TIME (I2) FOR THIS RUN IS INPUT IN SECONDS

NOTE * * * FLUID FOR THIS RUN IS ON THE INSIDE AND OUTSIDE SURFACES * * *

INSIDE RADIUS (TO BASE METAL) OF SLAB	RI =	1.8125	INCHES	REF A-2
RADIAL THICKNESS OF SLAB (BASE METAL)	SLBT =	.4685	INCHES	" "
CLADDING THICKNESS	CLAD =	0.0000	INCHES	
AXIAL THICKNESS OF SLAB	YY =	6.0000	INCHES	
NUMBER OF CYCLES	Q =	1		
STARTING TIME FOR THIS RUN	TIME =	0.0000	HOURS	
STARTING ITERATION FOR THIS RUN	ITER =	0		
STARTING TEMPERATURE OF SOLID BLOCKS	STEMP =	650.0	DEGREES	
AVERAGE TEMPERATURE OF SOLID BLOCKS	BT =	650.0	DEGREES	

I-Y

SLAB TEMPERATION DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

REF Pg B-3-2 OF B-3

FILM COEFFICIENTS - INSIDE AND OUTSIDE - PER CYCLE

(0.0 INDICATES INSULATION)

INSIDE	OUTSIDE
.2900000E+02	.2000000E+04

EQUATIONS WILL BE RECALCULATED AT TIMES

1.86111

OUTPUT PRINTOUT DATA

PRINTOUT LIMIT 1 WILL BE TO TIME 1.33333 IN INCREMENTS OF .08417

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

REF PS A-4

POINT NO. 1 TYPE 1

TIME	0.00000	.08333	.16667	.25000	.33333	.66667	1.00000	1.33333	9.00000
TEMP	570.00000	570.00000	590.00000	690.00000	525.00000	380.00000	300.00000	280.00000	0.00000

POINT NO. 7 TYPE 1

TIME	0.00000	1.93333	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TEMP	650.00000	650.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TEMPERATURE PER NODE AT START OF RUN

T(1)	T(2)	T(3)	T(4)	T(5)	T(6)	T(7)
570.0	650.0	650.0	650.0	650.0	650.0	650.0

NOTE * * * * TEMPERATURES T(1) AND T(7) ARE FLUID TEMPERATURES

Y-3

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

POINT NO.	K T	COEFFICIENT INSIDE	NODE	COEFFICIENT OUTSIDE	NODE	COEFFICIENT OF POINT NO	NODE
1	1.0			0.0000	2	1.0000	1
2	1.0	.0100	1	.5126	3	.4774	2
3	1.0	.4880	2	.5120	4	0.0000	3
4	1.0	.4886	3	.5114	5	.0000	4
5	1.0	.4891	4	.5109	6	0.0000	5
6	1.0	.4895	5	.4248	7	.0857	6
7	1.0	0.0000	6			1.0000	7

DELTA THETA = .17772E-03 HOURS/ITERATION BASED ON BLOCK 3

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

ITERATION	1	2	3	4	5	6	7	8	TIME
24	570.0	645.1	646.4	647.5	648.4	649.2	650.0	0.0	.00427
47	570.0	643.9	645.3	646.5	647.7	648.8	650.0	0.0	.00835
71	570.0	643.5	644.9	646.2	647.5	648.6	650.0	0.0	.01262
94	570.0	643.3	644.7	646.1	647.4	648.6	650.0	0.0	.01671
118	570.0	643.3	644.7	646.1	647.3	648.6	650.0	0.0	.02097
141	570.0	643.3	644.7	646.0	647.3	648.6	650.0	0.0	.02506
165	570.0	643.3	644.7	646.0	647.3	648.6	650.0	0.0	.02932
188	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.03341
212	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.03768
235	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.04176
258	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.04585
282	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.05012
305	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.05420
329	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.05847
352	570.0	643.2	644.7	645.0	647.3	648.6	650.0	0.0	.06256
376	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.06682
399	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.07091
423	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.07517
446	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.07926
469	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.08335
493	571.0	643.3	644.7	645.0	647.3	648.6	650.0	0.0	.08761
516	572.0	643.4	644.8	646.1	647.4	648.6	650.0	0.0	.09170
540	573.0	643.4	644.8	646.1	647.4	649.6	650.0	0.0	.09597
563	574.0	643.5	644.9	646.2	647.4	648.6	650.0	0.0	.10006
587	575.0	643.6	644.9	646.2	647.5	648.6	650.0	0.0	.10432
610	576.0	643.7	645.0	646.3	647.5	648.7	650.0	0.0	.10841
634	577.0	643.8	645.1	646.3	647.5	648.7	650.0	0.0	.11267
657	578.0	643.9	645.1	646.4	647.6	648.7	650.0	0.0	.11676
680	579.0	643.9	645.2	646.4	647.6	648.7	650.0	0.0	.12085
704	580.0	644.0	645.3	646.5	647.6	648.7	650.0	0.0	.12511
727	581.0	644.1	645.3	646.5	647.7	648.7	650.0	0.0	.12920
751	582.0	644.2	645.4	646.6	647.7	648.8	650.0	0.0	.13347
774	583.0	644.3	645.5	646.6	647.7	648.8	650.0	0.0	.13755
798	584.0	644.4	645.5	646.7	647.8	648.8	650.0	0.0	.14182
821	585.0	644.4	645.6	646.7	647.8	648.8	650.0	0.0	.14591
845	586.0	644.5	645.7	646.8	647.8	648.8	650.0	0.0	.15017

TIME
0420 FIG 1 Pg A-4

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT **** FULL CERTIFICATION **** FULL CERTIFICATION **** 91213 REV 2 12-15-74 05/23/78 14.08.24 PAGE 7
**** **** **** FULL CERTIFICATION **** 501CCS2

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

ITERATION	1	2	3	4	5	6	7	8	TIME
868	587.0	644.6	645.7	646.8	647.9	648.9	650.0	0.0	15426
891	588.0	644.7	645.8	646.9	647.9	648.9	650.0	0.0	15835
915	589.0	644.8	645.9	646.9	647.9	648.9	650.0	0.0	16261
939	590.0	644.9	645.9	647.0	648.0	648.9	650.0	0.0	16670
962	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	17096
985	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	17505
1009	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	17932
1032	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	18340
1056	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	18767
1079	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	19176
1102	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	19584
1126	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	20011
1149	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	20420
1173	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	20846
1196	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	21255
1220	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	21682
1243	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	22090
1267	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	22517
1290	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	22926
1313	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	23334
1337	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	23761
1360	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	24170
1384	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	24596
1407	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	25005
1431	586.7	644.8	645.9	647.0	648.0	648.9	650.0	0.0	25431
1454	583.5	644.6	645.8	646.9	647.9	648.9	650.0	0.0	25840
1478	580.2	644.3	645.5	646.7	647.8	648.8	650.0	0.0	26267
1501	577.0	644.1	645.3	646.5	647.7	648.8	650.0	0.0	26675
1524	573.8	643.8	645.1	646.4	647.6	648.7	650.0	0.0	27084
1548	570.5	643.5	644.9	646.2	647.5	648.6	650.0	0.0	27511
1571	567.3	643.2	644.7	646.1	647.4	648.6	650.0	0.0	27919
1595	563.9	643.0	644.5	645.9	647.2	648.5	650.0	0.0	28346
1618	560.8	642.7	644.3	645.7	647.1	648.5	650.0	0.0	28755
1642	557.4	642.4	644.0	645.6	647.0	648.4	650.0	0.0	29181
1665	554.2	642.1	643.8	645.4	646.9	648.4	650.0	0.0	29590
1689	550.9	641.9	643.6	645.3	646.8	648.3	650.0	0.0	30017
1712	547.7	641.6	643.4	645.1	646.7	648.2	650.0	0.0	30425

Y-6

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

ITERATION	1	2	3	4	5	6	7	8	TIME
1735	544.5	641.3	643.2	644.9	646.6	648.2	650.0	0.0	.30834
1759	541.2	641.0	643.0	644.8	646.5	648.1	650.0	0.0	.31261
1782	538.0	640.8	642.7	644.6	646.4	648.1	650.0	0.0	.31669
1806	534.7	640.5	642.5	644.4	646.3	648.0	650.0	0.0	.32096
1829	531.5	640.2	642.3	644.3	646.2	647.9	650.0	0.0	.32505
1853	528.2	639.9	642.1	644.1	646.1	647.9	650.0	0.0	.32931
1876	525.0	639.7	641.9	644.0	645.9	647.8	650.0	0.0	.33340
1900	523.1	639.5	641.7	643.9	645.9	647.8	650.0	0.0	.33766
1923	521.4	639.3	641.6	643.7	645.8	647.7	650.0	0.0	.34175
1946	519.6	639.1	641.4	643.6	645.7	647.7	650.0	0.0	.34594
1970	517.7	639.0	641.3	643.5	645.7	647.7	650.0	0.0	.35010
1993	516.0	638.8	641.2	643.4	645.6	647.6	650.0	0.0	.35419
2017	514.1	638.7	641.1	643.4	645.5	647.6	650.0	0.0	.35846
2040	512.3	638.5	640.9	643.3	645.5	647.6	650.0	0.0	.36254
2064	510.5	638.3	640.8	643.2	645.4	647.5	650.0	0.0	.36581
2087	508.7	638.2	640.7	643.1	645.3	647.5	650.0	0.0	.37090
2111	506.8	638.0	640.6	643.0	645.3	647.5	650.0	0.0	.37516
2134	505.1	637.9	640.5	642.9	645.2	647.4	650.0	0.0	.37925
2157	503.3	637.7	640.3	642.8	645.2	647.4	650.0	0.0	.38334
2181	501.4	637.6	640.2	642.7	645.1	647.4	650.0	0.0	.38760
2204	499.6	637.4	640.1	642.6	645.0	647.3	650.0	0.0	.39169
2228	497.8	637.3	640.0	642.5	645.0	647.3	650.0	0.0	.39595
2251	496.0	637.1	639.9	642.5	644.9	647.3	650.0	0.0	.40004
2275	494.2	637.0	639.7	642.4	644.9	647.3	650.0	0.0	.40431
2298	492.4	636.8	639.6	642.3	644.8	647.2	650.0	0.0	.40840
2322	490.5	636.7	639.5	642.2	644.7	647.2	650.0	0.0	.41266
2345	488.7	636.5	639.4	642.1	644.7	647.2	650.0	0.0	.41675
2368	487.0	636.4	639.3	642.0	644.6	647.1	650.0	0.0	.42084
2392	485.1	636.2	639.1	641.9	644.6	647.1	650.0	0.0	.42510
2415	483.3	636.1	639.0	641.8	644.5	647.1	650.0	0.0	.42919
2437	481.5	635.9	638.9	641.7	644.4	647.0	650.0	0.0	.43345
2462	479.7	635.8	638.8	641.6	644.4	647.0	650.0	0.0	.43754
2485	477.8	635.6	638.7	641.6	644.3	647.0	650.0	0.0	.44181
2509	476.1	635.4	638.5	641.5	644.3	646.9	650.0	0.0	.44589
2533	474.2	635.3	638.4	641.4	644.2	646.9	650.0	0.0	.45016
2556	472.4	635.1	638.3	641.3	644.1	646.9	650.0	0.0	.45425
2579	470.7	635.0	638.2	641.2	644.1	646.8	650.0	0.0	.45833

TIME 0.440, FIG 1 Pg A-4

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT **** FULL CERTIFICATION **** **** FULL CERTIFICATION **** 91218 REV 2 12-15-74 05/23/78 14.08.24 PAGE 9
**** FULL CERTIFICATION **** S01CCS2

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

ITERATION	1	2	3	4	5	6	7	8	TIME
2603	468.8	634.8	638.0	641.1	644.0	646.8	650.0	0.0	.46260
2626	467.0	634.7	637.9	641.0	644.0	646.8	650.0	0.0	.46669
2650	465.2	634.5	637.8	640.9	643.9	646.7	650.0	0.0	.47095
2673	463.4	634.4	637.7	640.8	643.8	646.7	650.0	0.0	.47[illegible]
2697	461.5	634.2	637.6	640.7	643.8	646.7	650.0	0.0	.47930
2720	459.8	634.1	637.4	640.7	643.7	646.6	650.0	0.0	.48339
2744	457.9	633.9	637.3	640.6	643.7	646.6	650.0	0.0	.48766
2767	456.1	633.8	637.2	640.5	643.6	646.6	650.0	0.0	.49174
2791	454.3	633.6	637.1	640.4	643.5	646.5	650.0	0.0	.49601
2814	452.5	633.5	637.0	640.3	643.5	646.5	650.0	0.0	.50010
2837	450.7	633.3	636.8	640.2	643.4	646.5	650.0	0.0	.50418
2861	448.9	633.2	636.7	640.1	643.4	646.4	650.0	0.0	.50845
2884	447.1	633.0	636.6	640.0	643.3	646.4	650.0	0.0	.51254
2908	445.2	632.8	636.5	639.9	643.2	646.4	650.0	0.0	.51680
2931	443.4	632.7	636.4	639.8	643.2	646.3	650.0	0.0	.52089
2955	441.6	632.5	636.2	639.8	643.1	646.3	650.0	0.0	.52516
2978	439.9	632.4	636.1	639.7	643.0	646.3	650.0	0.0	.52924
3002	438.0	632.2	636.0	639.6	643.0	646.2	650.0	0.0	.53351
3025	436.2	632.1	635.9	639.5	642.9	646.2	650.0	0.0	.53760
3049	434.4	631.9	635.8	639.4	642.9	646.2	650.0	0.0	.54168
3072	432.5	631.8	635.6	639.3	642.8	646.1	650.0	0.0	.54595
3095	430.8	631.6	635.5	639.2	642.7	646.1	650.0	0.0	.55004
3119	428.9	631.5	635.4	639.1	642.7	646.1	650.0	0.0	.55430
3142	427.1	631.3	635.3	639.0	642.6	646.1	650.0	0.0	.55839
3166	425.3	631.2	635.2	638.9	642.6	646.0	650.0	0.0	.56265
3189	423.5	631.0	635.0	638.9	642.5	646.0	650.0	0.0	.56674
3213	421.6	630.9	634.9	638.8	642.4	646.0	650.0	0.0	.57101
3236	419.9	630.7	634.8	638.7	642.4	645.9	650.0	0.0	.57509
3259	418.1	630.6	634.7	638.6	642.3	645.9	650.0	0.0	.57918
3283	416.2	630.4	634.5	638.5	642.3	645.9	650.0	0.0	.58345
3306	414.5	630.2	634.4	638.4	642.2	645.8	650.0	0.0	.58753
3330	412.6	630.1	634.3	638.3	642.1	645.8	650.0	0.0	.59180
3353	410.8	629.9	634.2	638.2	642.1	645.8	650.0	0.0	.59589
3377	409.0	629.8	634.1	638.1	642.0	645.7	650.0	0.0	.60015
3400	407.2	629.6	633.9	638.0	642.0	645.7	650.0	0.0	.60424
3424	405.3	629.5	633.8	638.0	641.9	645.7	650.0	0.0	.60851
3447	403.6	629.3	633.7	637.9	641.8	645.6	650.0	0.0	.61259

SLAB TEMPERATURE DISTRIBUTION   PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

ITERATION	1	2	3	4	5	6	7	8	TIME
3470	401.8	629.2	633.6	637.8	641.8	645.6	650.0	0.0	.61668
3494	399.9	629.0	633.5	637.7	641.7	645.6	650.0	0.0	.62095
3517	398.1	628.9	633.3	637.6	641.7	645.5	650.0	0.0	.62503
3541	396.3	628.7	633.2	637.5	641.6	645.5	650.0	0.0	.62930
3564	394.5	628.6	633.1	637.4	641.5	645.5	650.0	0.0	.63339
3588	392.7	628.4	633.0	637.3	641.5	645.4	650.0	0.0	.63765
3611	390.9	628.3	632.9	637.2	641.4	645.4	650.0	0.0	.64174
3635	389.0	628.1	632.7	637.1	641.4	645.4	650.0	0.0	.64600
3658	387.2	628.0	632.6	637.1	641.3	645.3	650.0	0.0	.65009
3681	385.5	627.8	632.5	637.0	641.2	645.3	650.0	0.0	.65418
3705	383.6	627.6	632.4	636.9	641.2	645.3	650.0	0.0	.65844
3728	381.8	627.5	632.3	636.8	641.1	645.2	650.0	0.0	.66253
3752	380.0	627.3	632.1	636.7	641.0	645.2	650.0	0.0	.66680
3775	379.0	627.2	632.0	636.6	641.0	645.2	650.0	0.0	.67088
3799	378.0	627.1	632.0	636.6	641.0	645.2	650.0	0.0	.67515
3822	377.0	627.0	631.9	636.5	640.9	645.1	650.0	0.0	.67924
3845	376.0	626.9	631.8	636.5	640.9	645.1	650.0	0.0	.68350
3869	375.0	626.9	631.8	636.4	640.9	645.1	650.0	0.0	.68759
3892	374.0	626.8	631.7	636.4	640.8	645.1	650.0	0.0	.69168
3915	373.0	626.7	631.6	636.3	640.8	645.1	650.0	0.0	.69594
3939	372.0	626.6	631.6	636.3	640.8	645.1	650.0	0.0	.70003
3963	371.0	626.5	631.5	636.2	640.7	645.0	650.0	0.0	.70429
3986	370.0	626.4	631.4	636.2	640.7	645.0	650.0	0.0	.70838
4010	369.0	626.4	631.4	636.1	640.7	645.0	650.0	0.0	.71265
4033	368.0	626.3	631.3	636.1	640.6	645.0	650.0	0.0	.71674
4057	367.0	626.2	631.2	636.0	640.6	645.0	650.0	0.0	.72100
4080	366.0	626.1	631.2	636.0	640.6	644.9	650.0	0.0	.72509
4103	365.0	626.0	631.1	635.9	640.5	644.9	650.0	0.0	.72918
4127	364.0	625.9	631.0	635.9	640.5	644.9	650.0	0.0	.73344
4150	363.0	625.9	631.0	635.8	640.5	644.9	650.0	0.0	.73753
4174	362.0	625.8	630.9	635.8	640.4	644.9	650.0	0.0	.74179
4197	361.0	625.7	630.8	635.7	640.4	644.9	650.0	0.0	.74588
4221	360.0	625.6	630.8	635.7	640.4	644.8	650.0	0.0	.75015
4244	359.0	625.5	630.7	635.6	640.3	644.8	650.0	0.0	.75423
4268	358.0	625.4	630.6	635.6	640.3	644.8	650.0	0.0	.75850
4291	357.0	625.3	630.6	635.5	640.3	644.8	650.0	0.0	.76259
4314	356.0	625.3	630.5	635.5	640.2	644.8	650.0	0.0	.76667

TIME 0500, FIG 1 Pg A-4

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

ITERATION	1	2	3	4	5	6	7	8	TIME
4338	355.0	625.2	630.4	635.4	640.2	644.7	650.0	0.0	.77094
4361	354.0	625.1	630.4	635.4	640.2	644.7	650.0	0.0	.77503
4385	353.0	625.0	630.3	635.3	640.1	644.7	650.0	0.0	.77929
4409	352.0	624.9	630.3	635.3	640.1	644.7	650.0	0.0	.78338
4432	351.0	624.8	630.2	635.2	640.1	644.7	650.0	0.0	.78764
4455	350.0	624.8	630.1	635.2	640.0	644.7	650.0	0.0	.79173
4479	349.0	624.7	630.0	635.1	640.0	644.6	650.0	0.0	.79600
4502	348.0	624.6	630.0	635.1	640.0	644.6	650.0	0.0	.80008
4525	347.0	624.5	629.9	635.0	639.9	644.6	650.0	0.0	.80417
4549	346.0	624.4	629.8	635.0	639.9	644.6	650.0	0.0	.80844
4572	345.0	624.3	629.8	634.9	639.9	644.6	650.0	0.0	.81252
4596	344.0	624.2	629.7	634.9	639.8	644.5	650.0	0.0	.81679
4619	343.0	624.2	629.6	634.8	639.8	644.5	650.0	0.0	.82088
4643	342.0	624.1	629.6	634.8	639.8	644.5	650.0	0.0	.82514
4666	341.0	624.0	629.5	634.7	639.7	644.5	650.0	0.0	.82923
4690	340.0	623.9	629.4	634.7	639.7	644.5	650.0	0.0	.83350
4713	339.0	623.8	629.4	634.6	639.7	644.5	650.0	0.0	.83758
4736	338.0	623.7	629.3	634.6	639.6	644.4	650.0	0.0	.84167
4760	337.0	623.7	629.2	634.5	639.6	644.4	650.0	0.0	.84594
4783	336.0	623.6	629.2	634.5	639.6	644.4	650.0	0.0	.85002
4807	335.0	623.5	629.1	634.4	639.5	644.4	650.0	0.0	.85429
4830	334.0	623.4	629.0	634.4	639.5	644.4	650.0	0.0	.85838
4854	333.0	623.3	629.0	634.3	639.5	644.4	650.0	0.0	.86264
4877	332.0	623.2	628.9	634.3	639.4	644.3	650.0	0.0	.86673
4901	331.0	623.1	628.8	634.2	639.4	644.3	650.0	0.0	.87099
4924	330.0	623.1	628.8	634.2	639.4	644.3	650.0	0.0	.87508
4947	329.0	623.0	628.7	634.1	639.3	644.3	650.0	0.0	.87917
4971	328.0	622.9	628.6	634.1	639.3	644.3	650.0	0.0	.88343
4994	327.0	622.8	628.5	634.0	639.3	644.2	650.0	0.0	.88752
5018	326.0	622.7	628.5	634.0	639.2	644.2	650.0	0.0	.89179
5041	325.0	622.6	628.4	633.9	639.2	644.2	650.0	0.0	.89587
5065	324.0	622.6	628.4	633.9	639.1	644.2	650.0	0.0	.90014
5088	323.0	622.5	628.3	633.8	639.1	644.2	650.0	0.0	.90423
5112	322.0	622.4	628.2	633.8	639.1	644.2	650.0	0.0	.90849
5135	321.0	622.3	628.2	633.7	639.0	644.1	650.0	0.0	.91258
5158	320.0	622.2	628.1	633.7	639.0	644.1	650.0	0.0	.91667
5182	319.0	622.1	628.0	633.6	639.0	644.1	650.0	0.0	.92093

Y-10

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

ITERATION	1	2	3	4	5	6	7	8	TIME
5205	318.0	622.1	628.0	633.6	638.9	644.1	650.0	0.0	.92502
5229	317.0	622.0	627.9	633.5	638.9	644.1	650.0	0.0	.92929
5252	316.0	621.9	627.8	633.5	638.9	644.0	650.0	0.0	.93337
5276	315.0	621.8	627.8	633.4	638.8	644.0	650.0	0.0	.93764
5299	314.0	621.7	627.7	633.4	638.8	644.0	650.0	0.0	.94173
5323	313.0	621.6	627.6	633.3	638.8	644.0	650.0	0.0	.94599
5346	312.0	621.5	627.6	633.3	638.7	644.0	650.0	0.0	.95008
5370	311.0	621.5	627.5	633.2	638.7	644.0	650.0	0.0	.95434
5393	310.0	621.4	627.4	633.2	638.7	643.9	650.0	0.0	.95843
5416	309.0	621.3	627.4	633.1	638.6	643.9	650.0	0.0	.96252
5440	308.0	621.2	627.3	633.1	638.6	643.9	650.0	0.0	.96678
5463	307.0	621.1	627.2	633.0	638.6	643.9	650.0	0.0	.97087
5487	306.0	621.0	627.2	633.0	638.5	643.9	650.0	0.0	.97514
5510	305.0	621.0	627.1	632.9	638.5	643.9	650.0	0.0	.97922
5534	304.0	620.9	627.0	632.9	638.5	643.8	650.0	0.0	.98349
5557	303.0	620.8	627.0	632.8	638.4	643.8	650.0	0.0	.98758
5581	302.0	620.7	626.9	632.8	638.4	643.8	650.0	0.0	.99184
5604	301.0	620.6	626.8	632.7	638.4	643.8	650.0	0.0	.99593
5627	300.0	620.5	626.8	632.7	638.3	643.8	650.0	0.0	.00002
5651	299.7	620.5	626.7	632.6	638.3	643.7	650.0	0.0	.00428
5674	299.5	620.4	626.7	632.6	638.3	643.7	650.0	0.0	.00837
5698	299.2	620.4	626.7	632.6	638.3	643.7	650.0	0.0	.01263
5721	299.0	620.4	626.6	632.6	638.3	643.7	650.0	0.0	.01672
5745	298.7	620.4	626.6	632.6	638.3	643.7	650.0	0.0	.02099
5769	298.5	620.4	626.6	632.6	638.3	643.7	650.0	0.0	.02508
5792	298.2	620.3	626.6	632.6	638.3	643.7	650.0	0.0	.02934
5815	298.0	620.3	626.6	632.5	638.3	643.7	650.0	0.0	.03343
5838	297.8	620.3	626.5	632.5	638.2	643.7	650.0	0.0	.03752
5862	297.5	620.3	626.5	632.5	638.2	643.7	650.0	0.0	.04178
5885	297.2	620.2	626.5	632.5	638.2	643.7	650.0	0.0	.04587
5909	297.0	620.2	626.5	632.5	638.2	643.7	650.0	0.0	.05013
5932	296.7	620.2	626.5	632.5	638.2	643.7	650.0	0.0	.05422
5956	296.5	620.2	[illegible]	632.5	638.2	643.7	650.0	0.0	.05849
5979	296.2	620.2	626.5	632.5	638.2	643.7	650.0	0.0	.06257
6003	296.0	620.1	626.4	632.4	638.2	643.7	650.0	0.0	.06684
6026	295.7	620.1	626.4	632.4	638.2	643.7	650.0	0.0	.07093
6049	295.5	620.1	626.4	632.4	638.2	643.7	650.0	0.0	.07501

TIME 0520, FIG 1 PJ A-4

PRESSURIZER SPRAY NOZZLE, SHUD COOLDOWN INCIDENT **** FULL CERTIFICATION **** 91213 REV 2 12-15-74 05/23/78 14.08.24 PAGE 13
**** FULL CERTIFICATION **** FULL CERTIFICATION **** S01CC52

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SHUD COOLDOWN INCIDENT

ITERATION	1	2	3	4	5	6	7	8	TIME
6073	295.2	620.1	626.4	632.4	638.2	643.7	650.0	0.0	.07928
6096	295.0	620.1	626.4	632.4	638.2	643.7	650.0	0.0	.08337
6120	294.7	620.0	626.4	632.4	638.1	643.7	650.0	0.0	.08763
6143	294.5	620.0	626.3	632.4	638.1	643.6	650.0	0.0	.09172
6167	294.2	620.0	626.3	632.4	638.1	643.6	650.0	0.0	.09548
6190	294.0	620.0	626.3	632.4	638.1	643.6	650.0	0.0	.10007
6214	293.7	620.0	626.3	632.3	638.1	643.6	650.0	0.0	.10434
6237	293.5	619.9	626.3	632.3	638.1	643.6	650.0	0.0	.10842
6260	293.3	619.9	626.3	632.3	638.1	643.6	650.0	0.0	.11251
6284	293.0	619.9	626.2	632.3	638.1	643.6	650.0	0.0	.11678
6307	292.7	619.9	626.2	632.3	638.1	643.6	650.0	0.0	.12086
6331	292.5	619.8	626.2	632.3	638.1	643.6	650.0	0.0	.12513
6354	292.2	619.8	626.2	632.3	638.1	643.6	650.0	0.0	.12922
6378	292.0	619.8	626.2	632.3	638.1	643.6	650.0	0.0	.13348
6401	291.7	619.8	626.2	632.2	638.0	643.6	650.0	0.0	.13757
6425	291.5	619.8	626.1	632.2	638.0	643.6	650.0	0.0	.14184
6449	291.2	619.7	626.1	632.2	638.0	643.6	650.0	0.0	.14592
6471	291.0	619.7	626.1	632.2	638.0	643.6	650.0	0.0	.15001
6495	290.7	619.7	626.1	632.2	638.0	643.6	650.0	0.0	.15428
6519	290.5	619.7	626.1	632.2	638.0	643.6	650.0	0.0	.15836
6542	290.2	619.7	626.1	632.2	638.0	643.6	650.0	0.0	.16263
6565	290.0	619.6	626.0	632.2	638.0	643.6	650.0	0.0	.16672
6589	289.7	619.6	626.0	632.1	638.0	643.6	650.0	0.0	.17098
6612	289.5	619.6	626.0	632.1	638.0	643.6	650.0	0.0	.17507
6635	289.2	619.6	626.0	632.1	638.0	643.6	650.0	0.0	.17933
6659	289.0	619.6	626.0	632.1	637.9	643.5	650.0	0.0	.18342
6682	288.8	619.5	626.0	632.1	637.9	643.5	650.0	0.0	.18751
6706	288.5	619.5	625.9	632.1	637.9	643.5	650.0	0.0	.19177
6729	288.2	619.5	625.9	632.1	637.9	643.5	650.0	0.0	.19586
6753	288.0	619.5	625.9	632.0	637.9	643.5	650.0	0.0	.20013
6776	287.7	619.4	625.9	632.0	637.9	643.5	650.0	0.0	.20421
6800	287.5	619.4	625.9	632.0	637.9	643.5	650.0	0.0	.20848
6823	287.3	619.4	625.9	632.0	637.9	643.5	650.0	0.0	.21257
6847	287.0	619.4	625.8	632.0	637.9	643.5	650.0	0.0	.21683
6870	286.7	619.4	625.8	632.0	637.9	643.5	650.0	0.0	.22092
6893	286.5	619.3	625.8	632.0	637.9	643.5	650.0	0.0	.22501
6917	286.2	619.3	625.8	632.0	637.9	643.5	650.0	0.0	.22927

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SHUD COOLDOWN INCIDENT

ITERATION	INSIDE FLUID 1	2	3	4	5	6	OUTSIDE FLUID 7	8	TIME
6940	286.0	619.3	625.8	632.0	637.9	643.5	650.0	0.0	.23336
6964	285.7	619.3	625.8	631.9	637.8	643.5	650.0	0.0	.23763
6987	285.5	619.3	625.7	631.9	637.8	643.5	650.0	0.0	.24171
7011	285.2	619.2	625.7	631.9	637.8	643.5	650.0	0.0	.24598
7034	285.0	619.2	625.7	631.9	637.8	643.5	650.0	0.0	.25007
7058	284.7	619.2	625.7	631.9	637.8	643.5	650.0	0.0	.25433
7081	284.5	619.2	625.7	631.9	637.8	643.5	650.0	0.0	.25842
7104	284.3	619.2	625.7	631.9	637.8	643.5	650.0	0.0	.26251
7128	284.0	619.1	625.6	631.9	637.8	643.5	650.0	0.0	.26677
7151	283.7	619.1	625.6	631.8	637.8	643.5	650.0	0.0	.27086
7175	283.5	619.1	625.6	631.8	637.8	643.5	650.0	0.0	.27512
7198	283.2	619.1	625.6	631.8	637.8	643.4	650.0	0.0	.27921
7222	283.0	619.0	625.6	631.8	637.8	643.4	650.0	0.0	.28348
7245	282.7	619.0	625.6	631.8	637.7	643.4	650.0	0.0	.28756
7269	282.5	619.0	625.5	631.8	637.7	643.4	650.0	0.0	.29183
7292	282.2	619.0	625.5	631.8	637.7	643.4	650.0	0.0	.29592
7315	282.0	619.0	625.5	631.8	637.7	643.4	650.0	0.0	.30000
7339	281.7	618.9	625.5	631.7	637.7	643.4	650.0	0.0	.30427
7362	281.5	618.9	625.5	631.7	637.7	643.4	650.0	0.0	.30836
7385	281.2	618.9	625.5	631.7	637.7	643.4	650.0	0.0	.31262
7409	281.0	618.9	625.4	631.7	637.7	643.4	650.0	0.0	.31671
7433	280.7	618.9	625.4	631.7	637.7	643.4	650.0	0.0	.32097
7456	280.5	618.8	625.4	631.7	637.7	643.4	650.0	0.0	.32506
7480	280.2	618.8	625.4	631.7	637.7	643.4	650.0	0.0	.32933
7503	280.0	618.8	625.4	631.7	637.7	643.4	650.0	0.0	.33342

TIME 0540, FIG 1 PG A-4

CONTRACT NO. 595-7072 620-0011	DOCUMENT COMMENT FORM	RELEASED BY J M Burnett 11/8/78 TASK ENGINEER DATE
SUPPLIER B&W	PREPARED BY: J M Burnett (NAME) 11/8/78 (DATE)	REL. DATE 11-17-78
PO. NO.		PAGE 1 OF 1

PART/TGS	B&W DOC. NO.	DOCUMENT TITLE	CUSTOMER/ SUPPLIER DOC. NO.	STATUS	RRL NUMBER
59-01-001		SMUD COOLDOWN INCIDENT, JUSTIFICATION OF PRESSURIZER FOR SACRAMENTO MUNICIPAL UTILITY DISTRICT (RANCHO SECO), B&W CONTRACT 620-0011-59	620-0011-59	APPROVED	N/A

33 0276 00

DISTRIBUTION:

J.M. BURNETT (W/ 1 ATTACH)
R.R. SCHAEFER (W/1 ATTACH) - MTV
J.J. KELLY (W/6 ATTACH)
J.T. JANIS (W/0 ATTACH)

SMUD COOLDOWN INCIDENT

JUSTIFICATION OF PRESSURIZER

FOR

SACRAMENTO MUNICIPAL UTILITY DISTRICT
RANCHO SECO

B&W CONTRACT NO: 620-0011-59

PREPARED BY: John N. Stidham / Associate Engr. / 6-5-78

CHECKED BY: David M. Wolfmi / associate Eng. / 6-6-78

APPROVED BY: R.P. Schaefer / Senior Engr. / 6-7-78

Mt. Vernon Engineering
The Babcock & Wilcox Company
Mt. Vernon, Indiana

B & W DOCUMENT NUMBER
33 0276 00

TABLE OF CONTENTS

	PAGE NO.
Introduction..	1
Discussion..	1
Results...	2
Conclusion..	3
References..	4
Transient Description...	A-1 Thru A-6
Pressurizer Spray Nozzle Justification.......................	B-1 Thur B-5

APPENDIX

Spray Nozzle, 91213 Output................................ Y-1 Thru Y-13

INTRODUCTION:

The purpose of this discussion is to provide an assessment of the affect that the accelerated cooldown, experienced at SMUD, had upon the Pressurizer and to determine what analytical work should be done, if any, to justify the structural integrity of the Pressurizer and to show that the Pressurizer is still in accordance with Section III of the ASME Boiler and Pressure Vessel Code.

This rapid cooldown transient is being analyzed since it was not defined in the Reactor Coolant System Functional Specification, CS(F)-3-92/NSS-11, and was therefore not analyzed in the Pressurizer Stress Report, 620-0011-59.

DISCUSSION:

In order to determine what thermal/pressure transient the Pressurizer was subjected to, it is necessary to look at the sequence of events and descriptive curves contained in reference D-1.

From reference D-1, it can be seen that the reactor coolant pressure transient consists of a ΔP of approximately 900 psi due to a pressure drop from 2400 psi to 1500 psi in approximately 15 minutes. The reactor coolant thermal transient describes an accelerated temperature drop from 590°F to 280°F in approximately 1 hour. However, this thermal transient is not applicable when considering the bulk fluid temperature of the Pressurizer. The bulk fluid temperature may be determined from standard steam tables using the pressure transient for the accelerated cooldown since the Pressurizer is considered to remain at saturation. Thus, at saturation a temperature of ≈660°F exists for a pressure of 2400 psi while a temperature of ≈600°F corresponds to a pressure of 1500 psi.

Therefore, it is concluded that the Pressurizer was not subjected to the accelerated thermal cooldown transient shown for the reactor coolant.

Comparison of the thermal/pressure transient experienced by the bulk fluid of the Pressurizer with the thermal/pressure transients described in the Functional Specification, reference B-5, reveals that a more severe condition is depicted by Transient 9, "Rapid Depressurization".

Transient 9 describes a thermal/pressure transient that consists of a pressure drop from 2200 psi to 800 psi and a temperature drop from 650°F to 520°F with both conditions occurring simultaneously over a 15 minute period.

DISCUSSION: (Continued)

Note that, with the exception of the Pressurizer Spray Nozzle, none of the cumulative usage factors of the components of the pressurizer are increased by analyzing an additional cycle of "Rapid Depressurization". However, for the Pressurizer Spray Nozzle a new cumulative usage factor has been calculated for the SMUD accelerated cooldown transient.

RESULTS:

The following is a tabulation of the original and new cumulative usage factors for the affected pressurizer components:

LOCATION	ORIGINAL C.U.F.	NEW C.U.F.
Pressurizer Spray Nozzle	.330	.345

CONCLUSION:

It has been concluded that the Pressurizer still meets all of the requirements of the ASME Boiler and Pressure Vessel Code, Section III; and that the accelerated cooldown of the system does not reduce any of the number of cycles originally designed for and defined in the Functional Specification, Ref. B-5.

REFERENCES:

A. Drawings

1. B&W Drawing #135483E7 - Pressurizer List of Material
2. B&W Drawing #135493E5 - 4" Spray Nozzle Details

B. Codes, Specifications, and Reports

1. USAS B31.7 - 1969.
2. ASME Boiler and Pressure Vessel Code, Section III, 1965 Edition thru Summer 1967 Addenda.
3. "Design Analysis of 4" SCH 120 Spray Nozzle, Report No. 9, prepared by R.C. Bodell, dated December 1971.
4. "Pressurizer Stress Report for SMUD, Rancho Seco #1, B&W contract #620-0011-59, SMUD Order #3075, dated August 1974.
5. B&W Reactor Coolant System Functional CS(F)3-92/NSS-11.

C. Computer Programs

1. B&W Program #91213 - Slab Temperature Distribution.

D. General

1. Letter from J.M. Burnett to Distribution, subject - SMUD Cooldown Incident, 620-0011-50/59, dated 4-4-78.

2. Letter from J.M. Burnett to Distribution, subject - SMUD Cooldown Incident, 620-0011-50/59, dated 4-7-78.

3. Letter from R.W. Moore to J.M. Burnett, subject - Pressurizer Spray Following Rapid SMUD Cooldown of 3-20-78, 620-0011-50/59, dated 5-23-78.

4. Letter from J. M. Burnett to Distribution, subject - SMUD Cooldown Incident, 620-0011-50/59, dated 4/20/78.

- A -

TRANSIENT DESCRIPTION

The following pages of this section contain a description of the sequence of events of the SMUD Cooldown Incident. Also contained herein is a time-temperature and time-pressure plot of the reactor coolant system which is used in the justification of the cooldown.

SEQUENCE OF EVENTS - 04:25(AM) to 05:34(AM)

(TAKEN FROM REF D-2)

TIME	EVENT
4:25:35	- Lost NNI power supply cabinets 5,6, & 7 (B&W Channel "Y")
	- This caused a loss of T_H signals to the ICS. BTU limits ran back feedwater, resulting in a loss of feedwater (actual Rx power was 72%).
4:25:46	- Reactor trip on high pressure, turbine trip on interlock.
	- Pressurizer code relief setting was known to be low (≈2225 psig). The electromatic relief was isolated due to previous leakage problems. The data indicates primary pressure went ≈2400 psig =>code relief valve lifted.
4:26:17	- Operator starts HPI pump "B" to maintain pzr. level.
4:28:23	- Operator stops HPI pump "B".
4:30	- OTSG "B" goes dry. Data indicates that "A" OTSG probably also went dry.
4:34:25	- RC pressure ≈1900 PSI (low pressure trip set-point.
4:34	- Operator increases speed of a MFP and feeds "A" OTSG. This starts RCS on pressure and temperature decrease.
4:37:16	- SFAS actuation at 1600 psig This starts HPI, LPI and initiates aux. feed. Aux. FW valves are opened to full open position. The system makes no automatic attempt to control steam generator water level.
4:40	- RC pressure at 1475 psig. It starts to recover from this point due to HPI. T_{ave} = 528°F.
4:43:56	- "A" HPI pump secured.
4:46:09	- LPI secured.
4:59:54	- "A" HPI initiated. From this point on, the operator started and stopped HPI pumps as necessary to maintain pressurized level.

TIME	EVENT
4:51:25	- Secured RCP-D (T_{ave} =435°F) This reduced #RCP's to three
4:57:27	- OTSG "A" water level - 599.7"
	Speculate that ≈2 ft of tubes are not flooded (at top) due to steam line arrangement.
5:00:00	- Hourly computer log printout Steam temp 380°F (OTSG "B") Steam pressure 171 psig (OTSG "B")
	Assuming $T_{ave} = T_{sat} \Rightarrow T_{ave} = 380^{\circ}F$
5:13:47	- OTSG "B" level - 599.1"
5:34	- Power restored to NNI cabinets 5,6 & 7
	$T_{ave} = 285^{\circ}F$
	RCS Pressure ≈2000 psig
	Both OTSG full level ranges pegged high
	* Operator begins to reduce RC pressure using Pzr spray.
	Operator stops electric aux FW pump.

(TAKEN FROM REF D-2)

*SEE PG A-5 + A-6

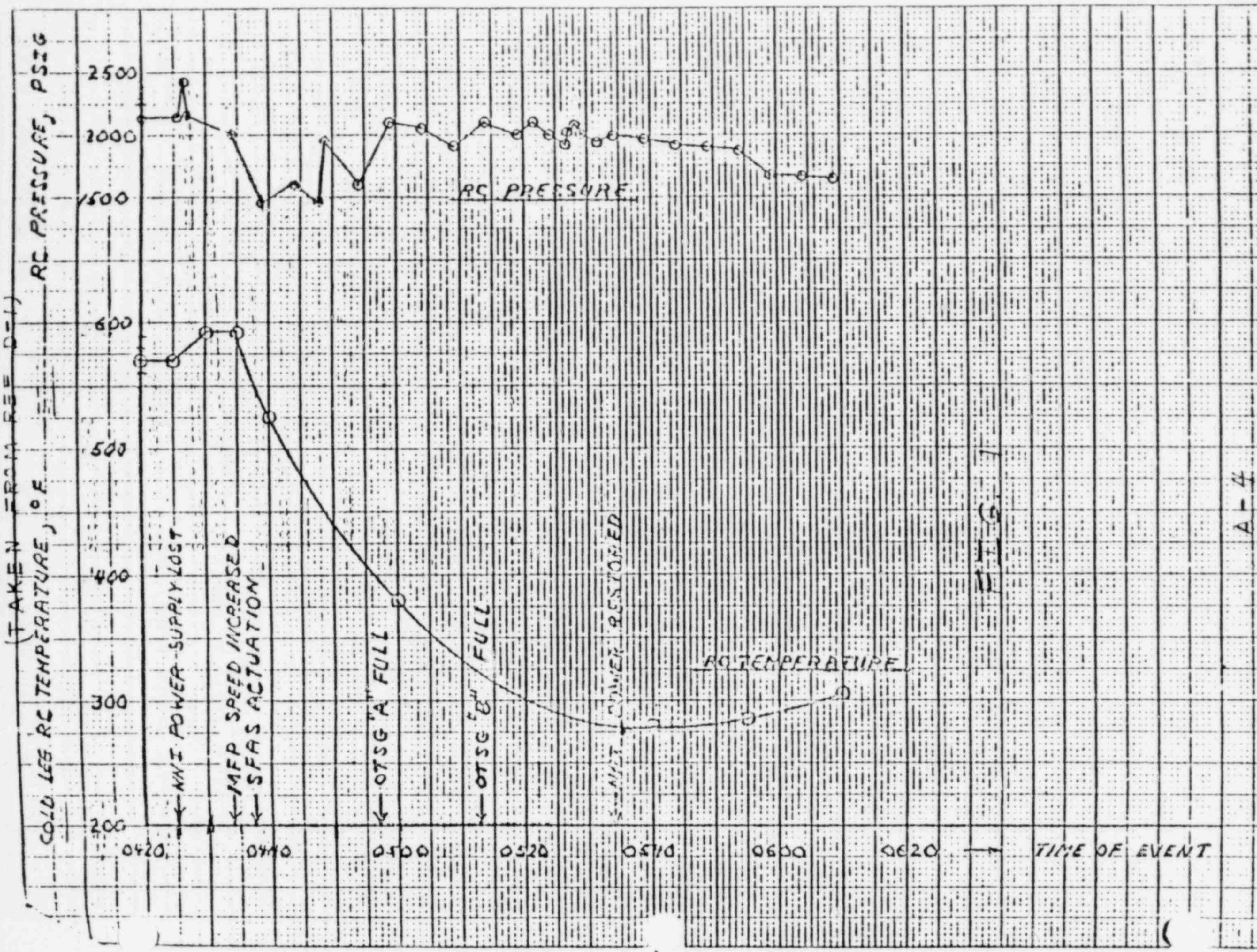

RC PRESSURE, PSIG
COLD LEG RC TEMPERATURE, °F
(TAKEN FROM REF D-1)
2500
2000
1500
600
500
400
300
200
RC PRESSURE
RC TEMPERATURE
NNI POWER SUPPLY LOST
MFP SPEED INCREASED
SFAS ACTUATION
OTSG "A" FULL
OTSG "B" FULL
NNI POWER RESTORED
0420
0440
0500
0520
0540
0600
0620
TIME OF EVENT

FIG. 1

A-4

THE BABCOCK & WILCOX COMPANY
POWER GENERATION GROUP

TAKEN FROM
REF D-3

To
J.M. Burnett, RCS Components

From
R.W. Moore, Control Analysis (2648)

BDS 643.5

Cust.
SMUD

File No.
or Ref.

Subj. Pressurizer Spray Following Rapid SMUD Cooldown of 3/20/78

Date
May 23, 1978

This letter to cover one customer and one subject only.

Attached please find a description of spray line variables for the pressurizer spray down following the rapid cooldown at SMUD on 3/20/78. The RCS pressure may be taken to be saturation pressure for the stated pressurizer temperature. The source of spray water was taken from the cold leg (not auxiliary spray).

RWM/lp

PRESSURIZER SPRAY FLOW AND TEMP.

FOLLOWING SMUD RCS COOLDOWN TRANSIENT OF 3/20/78

Time Hr:Min	Elapsed Time, Min.	Pressurizer Steam, Temp., F	Spray Nozzle Fluid Temp., F	Spray Rate GPM
5:34	0.	637	280	1.0
5:56	22.0	633	280	1.0
5:56.1	22.1	633	280	150.
5:59.5	25.5	613	280	150.
5:59.6	25.6	613	280	1.0
6:05	31.0	613	280	1.0
6:05.1	31.1	613	280	25.
6:07	33.0	611.5	280	25.
6:07.1	33.1	611.5	280	1.0
6:15	41.0	610	280	1.0
6:15.1	41.1	610	280	20.
6:29	55.0	600	280	20.
6:29.1	55.1	600	280	1.0
7:05	91.0	591	280	1.0

TAKEN FROM REF D-3

– B –

PRESSURIZER

SPRAY NOZZLE

PRESSURIZER SPRAY NOZZLE

PRIMARY + SECONDARY STRESS

THE MAXIMUM PRI + SEC STRESS OCCURS AT THE INSIDE SURFACE OF THE SPRAY NOZZLE AT THE BEGINNING OF THE INTERNAL PIPING.

$S_n = 55.4$ KSI — REF. PG. B-16-17 OF THE SPRAY NOZZLE STRESS REPORT (REF B-3)

TO THIS S_n VALUE WILL BE ADDED AN ADDITIONAL RADIAL GRADIENT AND DISCONTINUITY STRESS.

$$\sigma_{R.G.} = \frac{1}{2(1-\nu)} E\alpha \Delta T_1 = \frac{1}{2(1-\nu)}(29.67\times10^6)\, 6.12\times10^{-6}(24.1)$$

$$\sigma_{R.G.} = 3.1 \text{ KSI}$$

SEE CALCULATION OF ΔT_1 ON PG B-5

REF PG Y-13

$$\sigma_{DISCONT} = C_3 E_{ab} \left| \alpha_a T_a - \alpha_b T_b \right| = 1.8\,(30.5\times10^6)\left|(7.13\times10^{-6})\,631^\circ - (6.12\times10^{-6})\,650^\circ\right|$$
$$= 28.6 \text{ KSI}$$

THE FOLLOWING ASSUMPTIONS HAVE BEEN MADE. $C_3 = 1.8$ FOR A BRANCH CONNECTION. THE ΔT BETWEEN THE PRESSURIZER SHELL

AND THE INTERNAL EXTENSION IS 19°. THIS IS ASSUMING THE PRESSURIZER SHELL IN THE AREA OF THE NOZZLE REMAINS AT 650°F WHILE THE AVERAGE TEMP OF THE INTERNAL EXTENSION IS 631°F, REF PG Y-13.

$$S_n = 55.4 + 3.1 + 28.6 = 87.1 \text{ KSI} > 3S_m = 51.0 \text{ KSI}$$

S_p = 58.2 KSI REF PG C-13-1 OF THE SPRAY NOZZLE STRESS REPORT (REF B-3)

TO THIS S_p VALUE WILL BE ADDED AN ADDITIONAL RADIAL GRADIENT AND DISCONTINUITY STRESS.

$$\sigma_{R.G.} = \frac{1}{2(1-\nu)} K_3 \; E\alpha\Delta T_1 + \frac{1}{1-\nu} E\alpha\Delta T_2 = 1.7(3.1) + \frac{1}{1-\nu}(29.67\times10^6)\,6.2\times10^{-6}\,(.6)$$

$$= 5.3 + .2 = 5.5 \text{ KSI}$$

$(\Delta T_2 = .6$ REF PG B-5 $)$

$$\sigma_{DISCONT} = C_3 K_3 E_{ab} |\alpha_a T_a - \alpha_b T_b| = 1.7(28.6) = 48.6 \text{ KSI}$$

$$S_p = 58.2 + 5.5 + 48.6 = 112.3 \text{ KSI}$$

USING THE SIMPLIFIED ELASTIC PLASTIC

$$K_e = 1.0 + \frac{1-.2}{.2(3-1)}\left(\frac{87.1}{51.0} - 1\right) = 2.4$$

BABCOCK & WILCOX

DEPARTMENT | DATE | BY

CHECKED DATE | BY

JOB NO. | REVISION | SHEET B-2 OF

$$S_{ALT} = K_e \frac{S_P}{2} = 2.4 \left(\frac{113.0}{2} \right)$$

$$= 135.6 \text{ KSI}$$

$$n_1 = 3 \quad \text{(REF PG A-6)}$$

$$N_1 = 200$$

$$U_1 = \frac{n_1}{N_1} = \frac{3}{200} = .015$$

ADDING U_1 TO THE PREVIOUSLY CALCULATED U, REF PG C-13-1

$$U_{TOT} = .330 + .015 = .345 < 1.0$$

BABCOCK & WILCOX

DEPARTMENT

DATE BY

CHECKED DATE BY

JOB NO.

REVISION

SHEET B-3 OF

BWS-2412

PRESSURIZER SPRAY NOZZLE
THERMAL GRADIENT CALCULATIONS

$$T_{AVER} = \frac{1}{t}\int_{-t/2}^{t/2} T(Y)\,dY$$

$$\Delta T_1 = \frac{12}{t^2}\int_{-t/2}^{t/2} Y\,T(Y)\,dY$$

$$\Delta T_2 = \text{MAX}\begin{cases} |T_o - \bar{T}| - \tfrac{1}{2}|\Delta T_1| \\ |T_i - \bar{T}| - \tfrac{1}{2}|\Delta T_1| \end{cases}$$

SIMPSON's RULE IS USED TO EVALUATE THE INTEGRALS LISTED ABOVE FOR TIME 0540 , SEE PRESSURIZER SPRAY NOZZLE THERMAL DISTRIBUTION PROGRAM PG Y-13

SIMPSON's RULE $\int_{x_0}^{x_2} f(x)\,dx = \frac{h}{3}\left[f_0 + 4f_1 + f_2\right]$

$h = \frac{t}{4} = .1171$

$$\bar{T} = \frac{1}{.4685}(.1171)\,\tfrac{1}{3}\left[618.8 + 4(625.4) + 2(631.7) + 4(637.7) + 643.4\right]$$

REF PG Y-13

$= 631.4\ °F$

Y	T(Y) REF PG Y-13	Y T(Y)
$-\frac{t}{2}$	618.8	$-309.4t$
$-\frac{t}{4}$	625.4	$-156.4t$
0	631.7	0
$\frac{t}{4}$	637.7	$159.4t$
$\frac{t}{2}$	643.3	$321.7t$

BABCOCK & WILCOX

DEPARTMENT DATE BY

CHECKED DATE BY

JOB NO.

REVISION

SHEET B-4 OF

$$\Delta T_1 = \frac{12}{(.4685)^2}(.1171)\frac{1}{3}\left(-145.0 - 4(73.3) + 2(0) + 4(74.7) + 150.7\right)$$

$$= 24.1$$

$$\Delta T_2 = MAX\begin{cases}|643.3 - 631.4| - \frac{1}{2}(24.1) = -.2 \\ |618.8 - 631.4| - \frac{1}{2}(24.1) = .6\end{cases}$$

$$\therefore \Delta T_2 = .6$$

APPENDIX

SLAB TEMPERATION DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

TIME (12) FOR THIS RUN IS INPUT IN SECONDS

NOTE * */* THE FLUID FOR THIS RUN IS ON THE INSIDE AND OUTSIDE SURFACES * * *

INSIDE RADIUS (TO BASE METAL) OF SLAB	RI =	1.0125 INCHES	REF A-2
RADIAL THICKNESS OF SLAB (BASE METAL)	SLBT =	.4685 INCHES	" "
CLADDING THICKNESS	CLAD =	0.0000 INCHES	
AXIAL THICKNESS OF SLAB	YY =	6.0000 INCHES	
NUMBER OF CYCLES	Q =	1	
STARTING TIME FOR THIS RUN	TIME =	0.0000 HOURS	
STARTING ITERATION FOR THIS RUN	ITER =	0	
STARTING TEMPERATURE OF SOLID BLOCKS	STEMP =	650.0 DEGREES	
AVERAGE TEMPERATURE OF SOLID BLOCKS	BT =	650.0 DEGREES	

SLAB TEMPERATION DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

REF Pg B-3-2 OF B-3

FILM COEFFICIENTS - INSIDE AND OUTSIDE - PER CYCLE

(0.0 INDICATES INSULATION)

INSIDE	OUTSIDE
.2900000E+02	.2000000E+04

EQUATIONS WILL BE RECALCULATED AT TIMES

1.86111

OUTPUT PRINTOUT DATA

PRINTOUT LIMIT 1 WILL BE TO TIME 1.35333 IN INCREMENTS OF .00417

Y-2

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SHUD COOLDOWN INCIDENT

REF PS A-4

POINT NO. 1 TYPE 1

TIME	0.00000	.08333	.16667	.25000	.33333	.66667	1.00000	1.33333	0.00000
TEMP	570.00000	570.00000	590.00000	690.00000	525.00000	380.00000	300.00000	280.00000	0.00000

POINT NO. 7 TYPE 1

TIME	0.00000	1.83333	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TEMP	650.00000	650.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

TEMPERATURE PER NODE AT START OF RUN

T(1)	T(2)	T(3)	T(4)	T(5)	T(6)	T(7)
570.0	650.0	650.0	650.0	650.0	650.0	650.0

NOTE * * * * TEMPERATURES T(1) AND T(7) ARE FLUID TEMPERATURES

4-3

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SHUD COOLDOWN INCIDENT

POINT NO.	K T	COEFFICIENT INSIDE	NODE	COEFFICIENT OUTSIDE	NODE	COEFFICIENT OF POINT NO	NODE
1	1.0			0.0000	2	1.0000	1
2	1.0	.0100	1	.5126	3	.4774	2
3	1.0	.4880	2	.5120	4	0.0000	3
4	1.0	.4886	3	.5114	5	.0000	4
5	1.0	.4891	4	.5109	6	0.0000	5
6	1.0	.4895	5	.4248	7	.0857	6
7	1.0	0.0000	6			1.0000	7

DELTA THETA = .17772E-03 HOURS/ITERATION BASED ON BLOCK 3

PRESSURIZER SPRAY NOZZLE, SHUD COOLDOWN INCIDENT. 91213 REV 2 12-15-74 05/23/78 14.08.24 PAGE 8
**** FULL CERTIFICATION **** **** FULL CERTIFICATION **** **** FULL CERTIFICATION **** S01CCS2

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SHUD COOLDOWN INCIDENT

ITERATION	1	2	3	4	5	6	7	8	TIME
24	570.0	645.1	646.4	647.5	648.4	649.2	650.0	0.0	.00427
47	570.0	643.9	645.3	646.5	647.7	648.8	650.0	0.0	.00835
71	570.0	643.5	644.9	646.2	647.5	648.6	650.0	0.0	.01262
94	570.0	643.3	644.7	646.1	647.4	648.6	650.0	0.0	.01671
118	570.0	643.3	644.7	646.1	647.3	648.6	650.0	0.0	.02097
141	570.0	643.3	644.7	646.0	647.3	648.6	650.0	0.0	.02506
165	570.0	643.3	644.7	646.0	647.3	648.6	650.0	0.0	.02932
188	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.03341
212	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.03768
235	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.04176
258	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.04585
282	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.05012
305	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.05420
329	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.05847
352	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.06256
376	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.06682
399	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.07091
423	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.07517
446	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.07926
469	570.0	643.2	644.7	646.0	647.3	648.6	650.0	0.0	.08335
493	571.0	643.3	644.7	646.0	647.3	648.6	650.0	0.0	.08761
516	572.0	643.4	644.8	646.1	647.4	648.6	650.0	0.0	.09170
540	573.0	643.4	644.8	646.1	647.4	648.6	650.0	0.0	.09597
563	574.0	643.5	644.9	646.2	647.4	648.6	650.0	0.0	.10006
587	575.0	643.6	644.9	646.2	647.5	648.6	650.0	0.0	.10432
610	576.0	643.7	645.0	646.3	647.5	648.7	650.0	0.0	.10841
634	577.0	643.8	645.1	646.3	647.5	648.7	650.0	0.0	.11267
657	578.0	643.9	645.1	646.4	647.6	648.7	650.0	0.0	.11676
680	579.0	643.9	645.2	646.4	647.6	648.7	650.0	0.0	.12085
704	580.0	644.0	645.3	646.5	647.6	648.7	650.0	0.0	.12511
727	581.0	644.1	645.3	646.5	647.7	648.7	650.0	0.0	.12920
751	582.0	644.2	645.4	646.6	647.7	648.8	650.0	0.0	.13347
774	583.0	644.3	645.5	646.6	647.7	648.8	650.0	0.0	.13755
798	584.0	644.4	645.5	646.7	647.8	648.8	650.0	0.0	.14182
821	585.0	644.4	645.6	646.7	647.8	648.8	650.0	0.0	.14591
845	586.0	644.5	645.7	646.8	647.8	648.8	650.0	0.0	.15017

TIME 0420 FIG 1 Pg A-4

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

ITERATION	1	2	3	4	5	6	7	8	TIME
868	587.0	644.6	645.7	646.8	647.9	648.9	650.0	0.0	15426
891	588.0	644.7	645.8	646.9	647.9	648.9	650.0	0.0	15835
915	589.0	644.8	645.9	646.9	647.9	648.9	650.0	0.0	16261
939	590.0	644.9	645.9	647.0	648.0	648.9	650.0	0.0	16670
962	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	17096
985	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	17505
1009	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	17932
1032	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	18340
1056	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	18767
1079	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	19176
1102	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	19584
1126	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	20011
1149	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	20420
1173	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	20846
1196	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	21255
1220	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	21682
1243	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	22090
1267	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	22517
1290	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	22926
1313	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	23334
1337	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	23761
1360	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	24170
1384	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	24596
1407	590.0	644.9	646.0	647.0	648.0	648.9	650.0	0.0	25005
1431	586.7	644.8	645.9	647.0	648.0	648.9	650.0	0.0	25431
1454	583.5	644.6	645.8	646.9	647.9	648.9	650.0	0.0	25840
1478	580.2	644.3	645.5	646.7	647.8	648.8	650.0	0.0	26267
1501	577.0	644.1	645.3	646.5	647.7	648.8	650.0	0.0	26675
1524	573.8	643.8	645.1	646.4	647.6	648.7	650.0	0.0	27084
1548	570.5	643.5	644.9	646.2	647.5	648.6	650.0	0.0	27511
1571	567.3	643.2	644.7	646.1	647.4	648.6	650.0	0.0	27919
1595	563.9	643.0	644.5	645.9	647.2	648.5	650.0	0.0	28346
1618	560.8	642.7	644.3	645.7	647.1	648.5	650.0	0.0	28755
1642	557.4	642.4	644.0	645.6	647.0	648.4	650.0	0.0	29181
1665	554.2	642.1	643.8	645.4	646.9	648.4	650.0	0.0	29590
1689	550.9	641.9	643.6	645.3	646.8	648.3	650.0	0.0	30017
1712	547.7	641.6	643.4	645.1	646.7	648.2	650.0	0.0	30425

Y-6

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

TIME 0440, FIG 1 PG A-4

ITERATION	1	2	3	4	5	6	7	8	TIME
1735	544.5	641.3	643.2	644.9	646.6	648.2	650.0	0.0	.30834
1759	541.2	641.0	643.0	644.8	646.5	648.1	650.0	0.0	.31261
1782	538.0	640.8	642.7	644.6	646.4	648.1	650.0	0.0	.31669
1806	534.7	640.5	642.5	644.4	646.3	648.0	650.0	0.0	.32096
1829	531.5	640.2	642.3	644.3	646.2	647.9	650.0	0.0	.32505
1853	528.2	639.9	642.1	644.1	646.1	647.9	650.0	0.0	.32931
1876	525.0	639.7	641.9	644.0	645.9	647.8	650.0	0.0	.33340
1900	523.1	639.5	641.7	643.8	645.9	647.8	650.0	0.0	.33766
1923	521.4	639.3	641.6	643.7	645.8	647.7	650.0	0.0	.34175
1946	519.6	639.1	641.4	643.6	645.7	647.7	650.0	0.0	.34594
1970	517.7	639.0	641.3	643.5	645.7	647.7	650.0	0.0	.35010
1993	516.0	638.8	641.2	643.4	645.6	647.6	650.0	0.0	.35419
2017	514.1	638.7	641.1	643.4	645.5	647.6	650	0.0	.35846
2040	512.3	638.5	640.9	643.3	645.5	647.6	650.0	0.0	.36254
2064	510.5	638.3	640.8	643.2	645.4	647.5	650.0	0.0	.36681
2087	508.7	638.2	640.7	643.1	645.3	647.5	650.0	0.0	.37090
2111	506.8	638.0	640.6	643.0	645.3	647.5	650.0	0.0	.37516
2134	505.1	637.9	640.5	642.9	645.2	647.4	650.0	0.0	.37925
2157	503.3	637.7	640.3	642.8	645.2	647.4	650.0	0.0	.38334
2181	501.4	637.6	640.2	642.7	645.1	647.4	650.0	0.0	.38760
2204	499.6	637.4	640.1	642.6	645.0	647.3	650.0	0.0	.39169
2228	497.8	637.3	640.0	642.5	645.0	647.3	650.0	0.0	.39595
2251	496.0	637.1	639.9	642.5	644.9	647.3	650.0	0.0	.40004
2275	494.2	637.0	639.7	642.4	644.9	647.3	650.0	0.0	.40431
2298	492.4	636.8	639.6	642.3	644.8	647.2	650.0	0.0	.40840
2322	490.5	636.7	639.5	642.2	644.7	647.2	650.0	0.0	.41266
2345	488.7	636.5	639.4	642.1	644.7	647.2	650.0	0.0	.41675
2369	487.0	636.4	639.3	642.0	644.6	647.1	650.0	0.0	.42084
2392	485.1	636.2	639.1	641.9	644.6	647.1	650.0	0.0	.42510
2415	483.3	636.1	639.0	641.8	644.5	647.1	650.0	0.0	.42919
2439	481.5	635.9	638.9	641.7	644.4	647.0	650.0	0.0	.43345
2462	479.7	635.8	638.8	641.6	644.4	647.0	650.0	0.0	.43754
2486	477.8	635.6	638.7	641.6	644.3	647.0	650.0	0.0	.44181
2509	476.1	635.4	638.5	641.5	644.3	646.9	650.0	0.0	.44589
2533	474.2	635.3	638.4	641.4	644.2	646.9	650.0	0.0	.45016
2556	472.4	635.1	638.3	641.3	644.1	646.9	650.0	0.0	.45425
2579	470.7	635.0	638.2	641.2	644.1	646.8	650.0	0.0	.45833

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT **** FULL CERTIFICATION **** **** FULL CERTIFICATION **** 91213 REV 2 12-15-74 03/23/78 14.08.24 PAGE 9 **** FULL CERTIFICATION **** S01CCS2

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

ITERATION	1	2	3	4	5	6	7	8	TIME
2803	468.8	634.8	638.0	641.1	644.0	646.8	650.0	0.0	.46260
2626	467.0	634.7	637.9	641.0	644.0	646.8	650.0	0.0	.46669
2650	465.2	634.5	637.8	640.9	643.9	646.7	650.0	0.0	.47095
2673	463.4	634.4	637.7	640.8	643.8	646.7	650.0	0.0	.47504
2697	461.5	634.2	637.6	640.7	643.8	646.7	650.0	0.0	.47930
2720	459.8	634.1	637.4	640.7	643.7	646.6	650.0	0.0	.48339
2744	457.9	633.9	637.3	640.6	643.7	646.6	650.0	0.0	.48766
2767	456.1	633.8	637.2	640.5	643.6	646.6	650.0	0.0	.49174
2791	454.3	633.6	637.1	640.4	643.5	646.5	650.0	0.0	.49601
2814	452.5	633.5	637.0	640.3	643.5	646.5	650.0	0.0	.50010
2837	450.7	633.3	636.8	640.2	643.4	646.5	650.0	0.0	.50418
2861	448.9	633.2	636.7	640.1	643.4	646.4	650.0	0.0	.50845
2884	447.1	633.0	636.6	640.0	643.3	646.4	650.0	0.0	.51254
2908	445.2	632.8	636.5	639.9	643.2	646.4	650.0	0.0	.51680
2931	443.4	632.7	636.4	639.8	643.2	646.3	650.0	0.0	.52089
2955	441.6	632.5	636.2	639.8	643.1	646.3	650.0	0.0	.52516
2978	439.8	632.4	636.1	639.7	643.0	646.3	650.0	0.0	.52924
3002	438.0	632.2	636.0	639.6	643.0	646.2	650.0	0.0	.53351
3025	436.2	632.1	635.9	639.5	642.9	646.2	650.0	0.0	.53760
3049	434.4	631.9	635.8	639.4	642.9	646.2	650.0	0.0	.54168
3072	432.5	631.8	635.6	639.3	642.8	646.1	650.0	0.0	.54595
3095	430.8	631.6	635.5	639.2	642.7	646.1	650.0	0.0	.55004
3119	428.9	631.5	635.4	639.1	642.7	646.1	650.0	0.0	.55430
3142	427.1	631.3	635.3	639.0	642.6	646.1	650.0	0.0	.55439
3166	425.3	631.2	635.2	638.9	642.6	646.0	650.0	0.0	.56265
3189	423.5	631.0	635.0	638.9	642.5	646.0	650.0	0.0	.56674
3213	421.6	630.9	634.9	638.8	642.4	646.0	650.0	0.0	.57101
3236	419.9	630.7	634.8	638.7	642.4	645.9	650.0	0.0	.57509
3259	418.1	630.6	634.7	638.6	642.3	645.9	650.0	0.0	.57918
3283	416.2	630.4	634.5	638.5	642.3	645.9	650.0	0.0	.58345
3306	414.5	630.2	634.4	638.4	642.2	645.8	650.0	0.0	.58753
3330	412.6	630.1	634.3	638.3	642.1	645.8	650.0	0.0	.59180
3353	410.8	629.9	634.2	638.2	642.1	645.8	650.0	0.0	.59589
3377	409.0	629.8	634.1	638.1	642.0	645.7	650.0	0.0	.60015
3400	407.2	629.6	633.9	638.0	642.0	645.7	650.0	0.0	.60424
3424	405.3	629.5	633.8	638.0	641.9	645.7	650.0	0.0	.60851
3447	403.6	629.3	633.7	637.9	641.8	645.6	650.0	0.0	.61259

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

ITERATION	1	2	3	4	5	6	7	8	TIME
3470	401.8	629.2	633.6	637.8	641.8	645.6	650.0	0.0	.61668
3494	399.9	629.0	633.5	637.7	641.7	645.6	650.0	0.0	.62095
3517	398.1	628.9	633.3	637.6	641.7	645.5	650.0	0.0	.62503
3541	396.3	628.7	633.2	637.5	641.6	645.5	650.0	0.0	.62930
3564	394.5	628.6	633.1	637.4	641.5	645.5	650.0	0.0	.63339
3588	392.7	628.4	633.0	637.3	641.5	645.4	650.0	0.0	.63765
3611	390.9	628.3	632.9	637.2	641.4	645.4	650.0	0.0	.64174
3635	389.0	628.1	632.7	637.1	641.4	645.4	650.0	0.0	.64600
3658	387.2	628.0	632.6	637.1	641.3	645.3	650.0	0.0	.65009
3681	385.5	627.8	632.5	637.0	641.2	645.3	650.0	0.0	.65418
3705	383.6	627.6	632.4	636.9	641.2	645.3	650.0	0.0	.65844
3728	381.8	627.5	632.3	636.8	641.1	645.2	650.0	0.0	.66253
3752	380.0	627.3	632.1	636.7	641.0	645.2	650.0	0.0	.66680
3775	379.0	627.2	632.0	636.6	641.0	645.2	650.0	0.0	.67088
3799	379.0	627.1	632.0	636.6	641.0	645.2	650.0	0.0	.67515
3822	377.0	627.0	631.9	636.5	640.9	645.1	650.0	0.0	.67924
3845	376.0	626.9	631.8	636.5	640.9	645.1	650.0	0.0	.68350
3869	375.0	626.9	631.8	636.4	640.9	645.1	650.0	0.0	.68759
3892	374.0	626.8	631.7	636.4	640.8	645.1	650.0	0.0	.69168
3915	373.0	626.7	631.6	636.3	640.8	645.1	650.0	0.0	.69594
3939	372.0	626.6	631.6	636.3	640.8	645.1	650.0	0.0	.70003
3963	371.0	626.5	631.5	636.2	640.7	645.0	650.0	0.0	.70429
3986	370.0	626.4	631.4	636.2	640.7	645.0	650.0	0.0	.70838
4010	369.0	626.4	631.4	636.1	640.7	645.0	650.0	0.0	.71265
4033	368.0	626.3	631.3	636.1	640.6	645.0	650.0	0.0	.71674
4057	367.0	626.2	631.2	636.0	640.6	645.0	650.0	0.0	.72100
4080	366.0	626.1	631.2	636.0	640.6	644.9	650.0	0.0	.72509
4103	365.0	626.0	631.1	635.9	640.5	644.9	650.0	0.0	.72918
4127	364.0	625.9	631.0	635.9	640.5	644.9	650.0	0.0	.73344
4150	363.0	625.9	631.0	635.8	640.5	644.9	650.0	0.0	.73753
4174	362.0	625.8	630.9	635.8	640.4	644.9	650.0	0.0	.74179
4197	361.0	625.7	630.8	635.7	640.4	644.9	650.0	0.0	.74588
4221	360.0	625.6	630.9	635.7	640.4	644.8	650.0	0.0	.75015
4244	359.0	625.5	630.7	635.6	640.3	644.8	650.0	0.0	.75423
4268	358.0	625.4	630.6	635.6	640.3	644.8	650.0	0.0	.75850
4291	357.0	625.3	630.6	635.5	640.3	644.8	650.0	0.0	.76259
4314	356.0	625.3	630.5	635.5	640.2	644.8	650.0	0.0	.76667

TIME 0500, FIG 1 Pg A-4

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

ITERATION	1	2	3	4	5	6	7	8	TIME
4338	355.0	625.2	630.4	635.4	640.2	644.7	650.0	0.0	.77094
4361	354.0	625.1	630.4	635.4	640.2	644.7	650.0	0.0	.77503
4385	353.0	625.0	630.3	635.3	640.1	644.7	650.0	0.0	.77929
4409	352.0	624.9	630.2	635.3	640.1	644.7	650.0	0.0	.78338
4432	351.0	624.8	630.2	635.2	640.1	644.7	650.0	0.0	.78764
4455	350.0	624.8	630.1	635.2	640.0	644.7	650.0	0.0	.79173
4479	349.0	624.7	630.0	635.1	640.0	644.6	650.0	0.0	.79600
4502	348.0	624.6	630.0	635.1	640.0	644.6	650.0	0.0	.80008
4525	347.0	624.5	629.9	635.0	639.9	644.6	650.0	0.0	.80417
4549	346.0	624.4	629.8	635.0	639.9	644.6	650.0	0.0	.80844
4572	345.0	624.3	629.8	634.9	639.9	644.6	650.0	0.0	.81252
4596	344.0	624.2	629.7	634.9	639.8	644.5	650.0	0.0	.81679
4619	343.0	624.2	629.6	634.8	639.8	644.5	650.0	0.0	.82088
4643	342.0	624.1	629.6	634.8	639.8	644.5	650.0	0.0	.82514
4666	341.0	624.0	629.5	634.7	639.7	644.5	650.0	0.0	.82923
4690	340.0	623.9	629.4	634.7	639.7	644.5	650.0	0.0	.83350
4713	339.0	623.8	629.4	634.6	639.7	644.5	650.0	0.0	.83758
4736	338.0	623.7	629.3	634.6	639.6	644.4	650.0	0.0	.84167
4760	337.0	623.7	629.2	634.5	639.6	644.4	650.0	0.0	.84594
4783	336.0	623.6	629.2	634.5	639.6	644.4	650.0	0.0	.85002
4807	335.0	623.5	629.1	634.4	639.5	644.4	650.0	0.0	.85429
4830	334.0	623.4	629.0	634.4	639.5	644.4	650.0	0.0	.85838
4854	333.0	623.3	629.0	634.3	639.5	644.4	650.0	0.0	.86264
4877	332.0	623.2	628.9	634.3	639.4	644.3	650.0	0.0	.86673
4901	331.0	623.1	628.8	634.2	639.4	644.3	650.0	0.0	.87099
4924	330.0	623.1	628.8	634.2	639.4	644.3	650.0	0.0	.87508
4947	329.0	623.0	628.7	634.1	639.3	644.3	650.0	0.0	.87917
4971	328.0	622.9	628.6	634.1	639.3	644.3	650.0	0.0	.88343
4994	327.0	622.8	628.5	634.0	639.3	644.2	650.0	0.0	.88752
5018	326.0	622.7	628.5	634.0	639.2	644.2	650.0	0.0	.89179
5041	325.0	622.6	628.4	633.9	639.2	644.2	650.0	0.0	.89587
5065	324.0	622.6	628.4	633.9	639.1	644.2	650.0	0.0	.90014
5088	323.0	622.5	628.3	633.8	639.1	644.2	650.0	0.0	.90423
5112	322.0	622.4	628.2	633.8	639.1	644.2	650.0	0.0	.90849
5135	321.0	622.3	628.2	633.7	639.0	644.1	650.0	0.0	.91258
5158	320.0	622.2	628.1	633.7	639.0	644.1	650.0	0.0	.91667
5182	319.0	622.1	628.0	633.6	639.0	644.1	650.0	0.0	.92093

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

ITERATION	1	2	3	4	5	6	7	8	TIME
5205	318.0	622.1	628.0	633.6	638.9	644.1	650.0	0.0	.92502
5229	317.0	622.0	627.9	633.5	638.9	644.1	650.0	0.0	.92929
5252	316.0	621.9	627.8	633.5	638.9	644.0	650.0	0.0	.93337
5276	315.0	621.8	627.8	633.4	638.8	644.0	650.0	0.0	.93764
5299	314.0	621.7	627.7	633.4	638.8	644.0	650.0	0.0	.94173
5323	313.0	621.6	627.6	633.3	638.8	644.0	650.0	0.0	.94599
5346	312.0	621.5	627.6	633.3	638.7	644.0	650.0	0.0	.95008
5370	311.0	621.5	627.5	633.2	638.7	644.0	650.0	0.0	.95434
5393	310.0	621.4	627.4	633.2	638.7	643.9	650.0	0.0	.95843
5416	309.0	621.3	627.4	633.1	638.6	643.9	650.0	0.0	.96252
5440	308.0	621.2	627.3	633.1	638.6	643.9	650.0	0.0	.96678
5463	307.0	621.1	627.2	633.0	638.5	643.9	650.0	0.0	.97087
5487	306.0	621.0	627.2	633.0	638.5	643.9	650.0	0.0	.97514
5510	305.0	621.0	627.1	632.9	638.5	643.9	650.0	0.0	.97922
5534	304.0	620.9	627.0	632.9	638.5	643.8	650.0	0.0	.98349
5557	303.0	620.8	627.0	632.8	638.4	643.8	650.0	0.0	.98758
5581	302.0	620.7	626.9	632.8	638.4	643.8	650.0	0.0	.99184
5604	301.0	620.6	626.9	632.7	638.4	643.8	650.0	0.0	.99593
5627	300.0	620.5	626.8	632.7	638.3	643.8	650.0	0.0	.00002
5651	299.7	620.5	626.7	632.6	638.3	643.7	650.0	0.0	.00428
5674	299.5	620.4	626.7	632.6	638.3	643.7	650.0	0.0	.00837
5698	299.2	620.4	626.7	632.6	638.3	643.7	650.0	0.0	.01263
5721	299.0	620.4	626.6	632.6	638.3	643.7	650.0	0.0	.01672
5745	298.7	620.4	626.6	632.6	638.3	643.7	650.0	0.0	.02049
5769	298.5	620.4	626.6	632.6	638.3	643.7	650.0	0.0	.02508
5792	298.2	620.3	626.6	632.6	638.3	643.7	650.0	0.0	.02934
5815	298.0	620.3	626.6	632.5	638.3	643.7	650.0	0.0	.03343
5838	297.8	620.3	626.6	632.5	638.2	643.7	650.0	0.0	.03752
5862	297.5	620.3	626.5	632.5	638.2	643.7	650.0	0.0	.04178
5885	297.2	620.2	626.5	632.5	638.2	643.7	650.0	0.0	.04587
5909	297.0	620.2	626.5	632.5	638.2	643.7	650.0	0.0	.05013
5932	296.7	620.2	626.5	632.5	638.2	643.7	650.0	0.0	.05422
5956	296.5	620.2	626.5	632.5	638.2	643.7	650.0	0.0	.05849
5979	296.2	620.2	626.5	632.5	638.2	643.7	650.0	0.0	.06257
6003	296.0	620.1	626.4	632.4	638.2	643.7	650.0	0.0	.06684
6026	295.7	620.1	626.4	632.4	638.2	643.7	650.0	0.0	.07093
6049	295.5	620.1	626.4	632.4	638.2	643.7	650.0	0.0	.07501

TIME 0520, FIG 1 PJ A-4

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SHUD COOLDOWN INCIDENT

ITERATION	1	2	3	4	5	6	7	8	TIME
6073	295.2	620.1	626.4	632.4	638.2	643.7	650.0	0.0	.07924
6096	295.0	620.1	626.4	632.4	638.2	643.7	650.0	0.0	.08337
6120	294.7	620.0	626.4	632.4	638.1	643.7	650.0	0.0	.08763
6143	294.5	620.0	626.3	632.4	638.1	643.6	650.0	0.0	.09172
6167	294.2	620.0	626.3	632.4	638.1	643.6	650.0	0.0	.09548
6190	294.0	620.0	626.3	632.4	638.1	643.6	650.0	0.0	.10007
6214	293.7	620.0	626.3	632.3	638.1	643.6	650.0	0.0	.10434
6237	293.5	619.9	626.3	632.3	638.1	643.6	650.0	0.0	.10842
6260	293.3	619.9	626.3	632.3	638.1	643.6	650.0	0.0	.11251
6284	293.0	619.9	626.2	632.3	638.1	643.6	650.0	0.0	.11678
6307	292.7	619.9	626.2	632.3	638.1	643.6	650.0	0.0	.12086
6331	292.5	619.8	626.2	632.3	638.1	643.6	650.0	0.0	.12513
6354	292.2	619.8	626.2	632.3	638.1	643.6	650.0	0.0	.12922
6378	292.0	619.8	626.2	632.3	638.1	643.6	650.0	0.0	.13348
6401	291.7	619.8	626.2	632.2	638.0	643.6	650.0	0.0	.13757
6425	291.5	619.8	626.1	632.2	638.0	643.6	650.0	0.0	.14184
6449	291.2	619.7	626.1	632.2	638.0	643.6	650.0	0.0	.14592
6471	291.0	619.7	626.1	632.2	638.0	643.6	650.0	0.0	.15001
6495	290.7	619.7	626.1	632.2	638.0	643.6	650.0	0.0	.15428
6519	290.5	619.7	626.1	632.2	638.0	643.6	650.0	0.0	.15836
6542	290.2	619.7	626.1	632.2	638.0	643.6	650.0	0.0	.16263
6565	290.0	619.6	626.0	632.2	638.0	643.6	650.0	0.0	.16672
6589	289.7	619.6	626.0	632.1	638.0	643.6	650.0	0.0	.17098
6612	289.5	619.6	626.0	632.1	638.0	643.6	650.0	0.0	.17507
6635	289.2	619.6	626.0	632.1	638.0	643.5	650.0	0.0	.17933
6659	289.0	619.6	626.0	632.1	638.0	643.5	650.0	0.0	.18342
6682	288.8	619.5	625.9	632.1	637.9	643.5	650.0	0.0	.18751
6706	288.5	619.5	625.9	632.1	637.9	643.5	650.0	0.0	.19177
6729	288.2	619.5	625.9	632.1	637.9	643.5	650.0	0.0	.19586
6753	288.0	619.5	625.9	632.1	637.9	643.5	650.0	0.0	.20013
6776	287.7	619.4	625.9	632.0	637.9	643.5	650.0	0.0	.20421
6800	287.5	619.4	625.9	632.0	637.9	643.5	650.0	0.0	.20848
6823	287.2	619.4	625.9	632.0	637.9	643.5	650.0	0.0	.21257
6847	287.0	619.4	625.8	632.0	637.9	643.5	650.0	0.0	.21683
6870	286.7	619.4	625.8	632.0	637.9	643.5	650.0	0.0	.22092
6893	286.5	619.3	625.8	632.0	637.9	643.5	650.0	0.0	.22501
6917	286.2	619.3	625.8	632.0	637.9	643.5	650.0	0.0	.22927

Y-12

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT FULL CERTIFICATION **** FULL CERTIFICATION **** 91213 REV 2 12-15-76 05/23/78 14.08.24 PAGE 14
**** **** **** FULL CERTIFICATION **** S01CC52

SLAB TEMPERATURE DISTRIBUTION PROGRAM 91213

PRESSURIZER SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

ITERATION	INSIDE FLUID	2	3	4	5	6	OUTSIDE FLUID 7	8	TIME
6940	286.0	619.3	625.8	632.0	637.9	643.5	650.0	0.0	.23336
6963	285.7	619.3	625.8	631.9	637.8	643.5	650.0	0.0	.23[illegible]
6987	285.5	619.3	625.7	631.9	637.8	643.5	650.0	0.0	.24171
7011	285.2	619.2	625.7	631.9	637.8	643.5	650.0	0.0	.24598
7034	285.0	619.2	625.7	631.9	637.8	643.5	650.0	0.0	.25007
7058	284.7	619.2	625.7	631.9	637.8	643.5	650.0	0.0	.25433
7081	284.5	619.2	625.7	631.9	637.8	643.5	650.0	0.0	.25842
7104	284.3	619.2	625.7	631.9	637.8	643.5	650.0	0.0	.26251
7128	284.0	619.1	625.6	631.9	637.8	643.5	650.0	0.0	.26677
7151	283.7	619.1	625.6	631.8	637.8	643.5	650.0	0.0	.27086
7175	283.5	619.1	625.6	631.8	637.8	643.5	650.0	0.0	.27512
7198	283.2	619.1	625.6	631.8	637.8	643.4	650.0	0.0	.27921
7222	283.0	619.0	625.6	631.8	637.8	643.4	650.0	0.0	.28348
7245	282.7	619.0	625.6	631.8	637.7	643.4	650.0	0.0	.28756
7269	282.5	619.0	625.5	631.8	637.7	643.4	650.0	0.0	.29183
7292	282.2	619.0	625.5	631.8	637.7	643.4	650.0	0.0	.29592
7315	282.0	619.0	625.5	631.8	637.7	643.4	650.0	0.0	.30000
7339	281.7	618.9	625.5	631.7	637.7	643.4	650.0	0.0	.30427
7362	281.5	618.9	625.5	631.7	637.7	643.4	650.0	0.0	.30836
7385	281.2	618.9	625.5	631.7	637.7	643.4	650.0	0.0	.31262
7409	281.0	618.9	625.4	631.7	637.7	643.4	650.0	0.0	.31671
7433	280.7	618.9	625.4	631.7	637.7	643.4	650.0	0.0	.32097
7456	280.5	618.8	625.4	631.7	637.7	643.4	650.0	0.0	.32506
7480	280.2	618.8	625.4	631.7	637.7	643.4	650.0	0.0	.32933
7603	280.0	618.8	625.4	631.7	637.7	643.4	650.0	0.0	.33342

TIME 0540, FIG 1 Pg A-4

PDS-21069-6 (6-78)

CONTRACT NO 595-7072 620-0011	DOCUMENT COMMENT FORM	RELEASED BY [signature] 11/8/78 TASK ENGINEER DATE	
SUPPLIER B&W	PREPARED BY: [signature] 11/8/78 NAME DATE	REL. DATE 11-17-78	PAGE OF
PO. NO.			

PART/TGS	B&W DOC. NO.	DOCUMENT TITLE	CUSTOMER/ SUPPLIER DOC. NO.	STATUS	RRL NUMBER
50-01-001		SMUD COOLDOWN INCIDENT JUSTIFICATION OF PRIMARY PIPING FOR SACRAMENTO MUNICIPAL UTILITY DISTRICT (RANCHO SECO)	620-0011-50 CONTRACT #3075	APPROVED	N/A

33 0279 00

DISTRIBUTION:

J.M. BURNETT (w/ 1 ATTACH)

R.R. SCHAEFER (w/ 1 ATTACH) - MTV

J.J. KELLY (w/ 6 ATTACH)

J.T. Janis (w/o ATTACH)

SMUD COOLDOWN INCIDENT
JUSTIFICATION OF PRIMARY PIPING

FOR

SACRAMENTO MUNICIPAL UTILITY DISTRICT
RANCHO SECO

B&W CONTRACT NO: 620-0011-50

PREPARED BY: John W. Stockhouse / Associate Engr / 6-5-78

CHECKED BY: Fred M. Duffer / associate Eng. / 6-7-78

APPROVED BY: R. R. Schaefer / Senior Engr. / 6-9-78

Mt. Vernon Engineering
The Babcock & Wilcox Company
Mt. Vernon, Indiana

TABLE OF CONTENTS

	PAGE NO.
Introduction	1
Discussion	2
Results	3
Conclusion	4
References	5
Transient Description	A-1 thru A-7
Surge Line Justification	B-1 thru B-1
Surge Nozzle Justification	C-1 thru C-3
36" & 28" Primary Pipe Justification	D-1 thru D-4
Make-Up & HPI Nozzle Justification	E-1 thru E-13
Spray Nozzle Justification	F-1 thru F-5
Decay Heat Nozzle Justification	G-1 thru G-3

APPENDIX

Film Coefficient Calculations	Y-1 thru Y-7
28" Carbon Steel 91232 Output	Y-8 thru Y-13
28" Stainless Steel 91232 Output	Y-14 thru Y-25
36" Carbon Steel 91232 Output	Y-26 thru Y-37
Spray Nozzle 91232 Output	Y-38 thru Y-47
Decay Heat Nozzle 91232 Output	Y-48 thru Y-53

INTRODUCTION:

The following calculation package has been assembled so as to show that the Primary Piping, RCS Piping and Surge Line, is still in accordance with Section III of the ASME Boiler and Pressure Vessel Code, following the accelerated cooldown of SMUD. (Ref. D-1)

This rapid cooldown transient is being analyzed since it was not defined in the Reactor Coolant System Functional Specification, CS(F)-3-92/NSS11, or the Reactor Coolant Piping Functional Specification CS(F)-3-37/NSS-11, and was therefore not analyzed in the Primary Piping Stress Reports, 620-0011-50.

DISCUSSION:

The Primary Piping, which includes the surge line, the 36" hot leg, and the 28" upper and lower cold legs, as well as the various nozzles (HPI, Make-Up, Decay Heat, Spray, and Surge Nozzles), have been analyzed to show that the cumulative usage factor of the pipe, of the nozzle, and of the pipe in the area of the nozzle does not exceed the allowable of 1.0.

Generally speaking, this was done by one of the following two methods:

1. Recalculating the primary plus secondary stresses, primary plus secondary plus peak stresses, and then a new cumulative usage factor.

2. By going into the applicable design analysis and where a more severe or equally severe transient has been analyzed, recalculate a new cumulative usage factor by increasing, by the appropriate number of cycles associated with the accelerated cooldown, the number of design cycles previously analyzed.

RESULTS:

The following is a tabulation of the original and new cumulative usage factors for the various piping locations analyzed:

LOCATION	ORIGINAL C.U.F.	NEW C.U.F.
28" Primary Pipe	.049	.049
Make-Up & HPI Nozzle Branch Connection	.079	.083
HPI Nozzle	.954	.677*
Spray Nozzle Branch Connection	.210	.212
Spray Nozzle	.444	.463
Decay Heat Nozzle Branch Connection	.679	.686
Surge Nozzle Branch Connection	.620	.697
Surge Line	.760	.762

*Note that this new cumulative usage factor was reduced from the original C.U.F., because some of the conservatism was deleted and the entire C.U.F. recalculated.

CONCLUSION:

It has been concluded that the Primary Piping still meets all of the requirements of the ASME Boiler and Pressure Vessel Code, Section III; and that the accelerated cooldown of the system does not reduce any of the number of cycles originally designed for and defined in the Functional Specification, Ref. B-5.

REFERENCES:

A. Drawings

1. B&W Drawing #143491E7 - Piping Coolant List of Material
2. B&W Drawing #143498E10 - Details for 28" Coolant Inlet Pipe
3. B&W Drawing #143499E2 - 28" ID Elbow Forming Drawing
4. B&W Drawing #143495E7 - Details for 36" Coolant Outlet Pipe
5. B&W Drawing #143496E2 - 36" ID Elbow Forming Drawing
6. B&W Drawing #143510E6 - 2-1/2" & 12" Decay Heat Nozzles Ass'y. & Details

B. Codes, Specifications, and Reports

1. USAS B31.7 - 1969.
2. ASME Boiler and Pressure Vessel Code, Section III, 1965 Edition thru Summer 1967 Addenda.
3. B&W Standards Manual 2A3521 and 2A3522, Heat Transfer Calculation.
4. B&W Reactor Coolant Piping Functional Specification, CS(F)3-37/NSS-11.
5. B&W Reactor Coolant System Functional Specification, CS(F)3-92/NSS-11.
6. "Primary Piping Analysis Report No. 2", prepared by Al McKim, dated October 1971.
7. "Decay Heat Nozzle Report No. 3", prepared by Randal R. Schaefer, dated January 1973.
8. "Thermal/Mechanical Analysis of Surge Line Nozzle Report No. 4", prepared by Randal R. Schaefer, dated October 1971.
9. "Thermal/Mechanical Analysis of 2-1/2" SCH 16^{0} Make-Up and High Pressure Injection Nozzle Report No. 5", prepared by H.W. Behnke, dated May 1972.
10. "Stress Evaluation of Reactor Coolant Spray Line Nozzle Report No. 7", prepared by Ralph Skinner, dated November 1971.
11. "Stress Analysis of Surge Line, Report No. 6", prepared by Randal R. Schaefer, dated January 1972, Rev. 1 dated January 5, 1973.

C. Computer Program

1. Program No. 91232 - One-Dimensional Implicit Transient Temperature Distribution.

D. General

1. Letter from J.M. Burnett to Distribution, subject - SMUD Cooldown Incident, 620-0011-50/59, dated 4-4-78.
2. Letter from J.M. Burnett to Distribution, subj-ct - SMUD Cooldown Incident, 620-0011-50/59, dated 4-7-78.
3. Letter from R.W. Moore to J.M. Burnett, subject - Pressurizer Spray Following Rapid SMUD Cooldown of 3-20-78, 620-0011-50/59, dated 5-23-78.
4. Telecopy of "Sequence of Events - SMUD Transient" from J.M. Burnett to Mt. Vernon.
5. Letter from J. M. Burnett to Distribution, Subject: SMUD Cooldown Incident", 620-0011-50/59, dated 4/20/78.

-A-

TRANSIENT DESCRIPTION

The following pages of this section contain a description of the sequence of events of the SMUD Cooldown Incident. Also contained herein is a time-temperature and time-pressure plot of the reactor coolant system which is used in the justification of the cooldown.

SEQUENCE OF EVENTS - 04:25(AM) to 05:34(AM)

TAKEN FROM REF D-2

TIME	EVENT
4:25:35	- Lost NNI power supply cabinets 5,6, & 7 (B&W Channel "Y")
	- This caused a loss of T_H signals to the ICS. BTU limits ran back feedwater, resulting in a loss of feedwater (actual Rx power was 72%).
4:25:46	- Reactor trip on high pressure, turbine trip on interlock.
	- Pressurizer code relief setting was known to be low (≈2225 psig). The electromatic relief was isolated due to previous leakage problems. The data indicates primary pressure went ≈2400 psig =>code relief valve lifted.
4:26:17	- Operator starts HPI pump "B" to maintain pzr. level.
4:28:23	- Operator stops HPI pump "B".
4:30	- OTSG "B" goes dry. Data indicates that "A" OTSG probably also went dry.
4:3[illegible]:23	- RC pressure ≈1900 PSI (low pressure trip set-point.
4:34	- Operator increases speed of a MFP and feeds "A" OTSG. This starts RCS on pressure and temperature decrease.
4:37:16	- SFAS actuation at 1600 psig This starts HPI, LPI and initiates aux. feed. Aux. FW valves are opened to full open position. The system makes no automatic attempt to control steam generator water level.
4:40	- RC pressure at 1475 psig. It starts to recover from this point due to HPI. T_{ave} = 528°F.
4:43:56	- "A" HPI pump secured.
4:46:09	- LPI secured.
[illegible]	- "A" HPI initiated. From this point on, the operator started and stopped HPI pumps as necessary to maintain pressurized level.

TIME	EVENT
4:51:25	- Secured RCP-D (T_{ave} =435°F) This reduced #RCP's to three
4:57:27	- OTSG "A" water level - 599.7"
	Speculate that =2 ft of tubes are not flooded (at top) due to steam line arrangement.
5:00:00	- Hourly computer log printout Steam temp 380°F (OTSG "B") Steam pressure 171 psig (OTSG "B")
	Assuming T_{ave} = T_{sat} => T_{ave} ≈ 380°F
5:13:47	- OTSG "B" level - 599.1"
5:34	- Power restored to NNI cabinets 5,6 & 7
	T_{ave} = 285°F
	RCS Pressure =2000 psig
	Both OTSG full level ranges pegged high
	* Operator begins to reduce RC pressure using Pzr spray.
	Operator stops electric aux FW pump.

* SEE PAGES A-6 AND A-7.

TAKEN FROM REF D-2

SEQUENCE OF EVENTS - SMUD TRANSIENT (REF D-4)

TIME	EVENT
04:25:35	LOST NNI PWR SUPPLY
04:25:45	TURB TRIP RX TRIP (HP)
04:26:17 (1 CYCLE OF "B")	HPI "B" ON (MANUAL)
04:26:23	" " NORMAL (OFF)
04:34:25	RX LOW PRESS TRIP
04:37:56	TRIP "B" SFAS ANALOG
04:37:57	" "A" " "
04:37:58 (1 CYCLE OF "B")	HPI MTR ON @ SFAS — WR PRESS 1543 1591 1535
04:43	1670, 1665, 1662 WR RCS PRESS
04:43:56 (1 CYCLE OF "A")	B HPI SECURED
04:46:09	B LPI SECURED
04:46:39	A " "
04:49:54	A HPI INITIATED (MANUAL)
04:51:25 (1 CYCLE OF "A")	D RCP SECURED
04:51:52	A HPI SECURED
04:55:23 (1 CYCLE OF "A")	A HPI INITIATED
05:05:30	" & B HPI SECURED
05:08:42 (1 CYCLE OF "B")	B HPI INITIATED
05:23:04	B HPI SECURED
05:33:19 (1 CYCLE OF "B")	B HPI INITIATED
05:34:04	B HPI SECURED

AT 04:44:16 - CALCULATED HT UP/C/D RATE 84°/HR

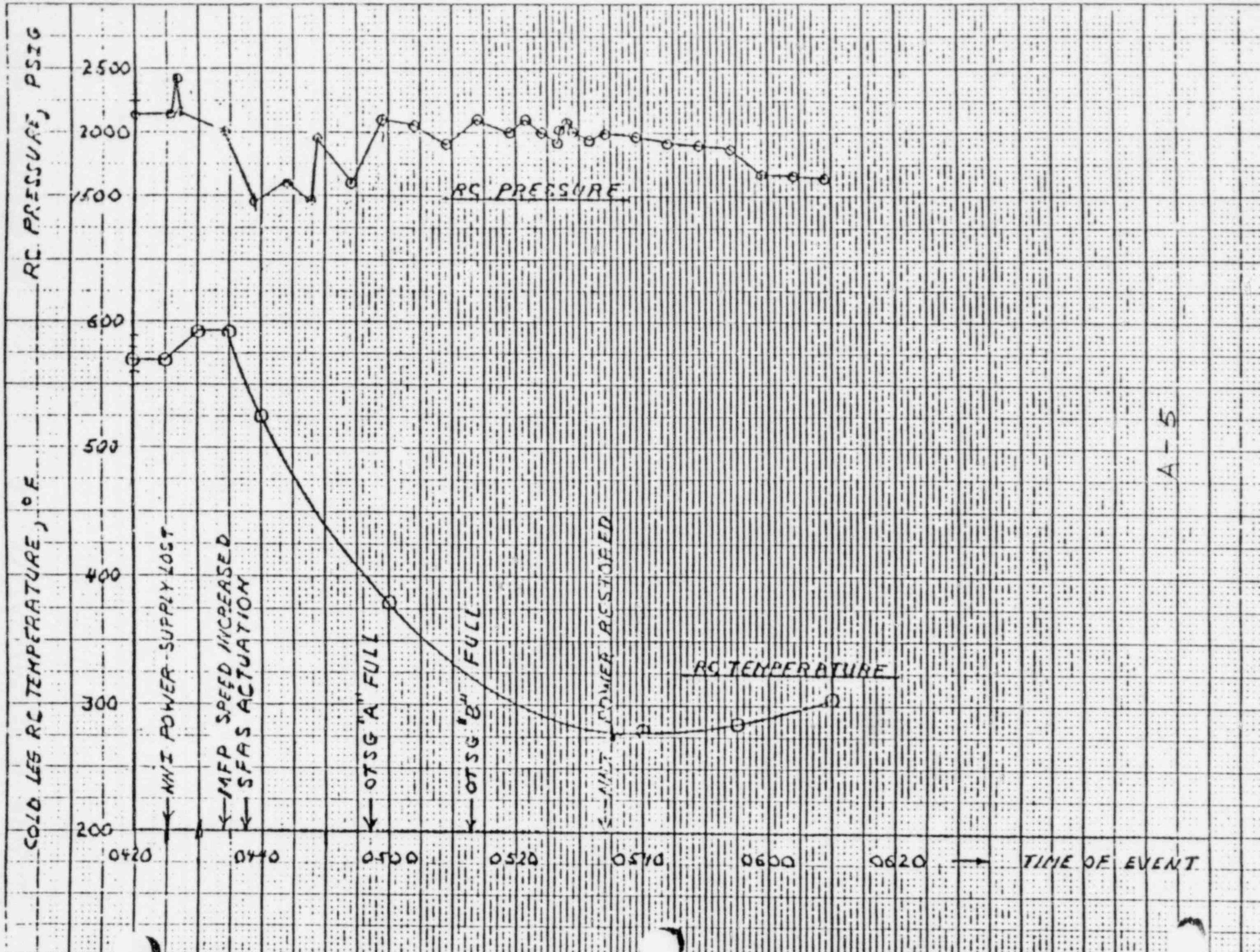
AT 04:45:16 " " " 291.1°/HR

XMITTER SWITCH DURING CALC

05:34. RESTORED NNI X & Y PWR SUPPLIES

AUX FW WITH SFAS

NOTE THAT THE MAX # OF CYCLES WAS 4, EXPERIENCED BY HPI "B". THIS WILL BE USED IN THE FATIGUE ANALYSIS OF THE HPIS. REF PG E-6.



TAKEN FROM REF D-1

THE BABCOCK & WILCOX COMPANY
POWER GENERATION GROUP

To
J.M. Burnett, RCS Components

From
R.W. Moore, Control Analysis (2648)

BDS 663.5

Cust.
SMUD

File No.
or Ref.

Subj.
Pressurizer Spray Following Rapid SMUD Cooldown of 3/20/78

Date
May 23, 1978

This letter to cover one customer and one subject only.

Attached please find a description of spray line variables for the pressurizer spray down following the rapid cooldown at SMUD on 3/20/78. The RCS pressure may be taken to be saturation pressure for the stated pressurizer temperature. The source of spray water was taken from the cold leg (not auxiliary spray).

RWM/lp

TAKEN FROM REF D-3

PRESSURIZER SPRAY FLOW AND TEMP.

FOLLOWING SMUD RCS COOLDOWN TRANSIENT OF 3/20/78

Time Hr:Min	Elapsed Time, Min.	Pressurizer Steam, Temp., F	Spray Nozzle Fluid Temp., F	Spray Rate GPM
5:34	0.	637	280	1.0
5:56	22.0	633	280	1.0
5:56.1	22.1	633	280	150.
5:59.5	25.5	613	280	150.
5:59.6	25.6	613	280	1.0
6:05	31.0	613	280	1.0
6:05.1	31.1	613	280	25.
6:07	33.0	611.5	280	25.
6:07.1	33.1	611.5	280	1.0
6:15	41.0	610	280	1.0
6:15.1	41.1	610	280	20.
6:29	55.0	600	280	20.
6:29.1	55.1	600	280	1.0
7:05	91.0	591	280	1.0

TAKEN FROM REF D-3

-B-

SURGE LINE

SURGE LINE

REFERENCE B-11, "STRESS ANALYSIS OF SURGE LINE", WAS SCANNED AND IT WAS DETERMINED THAT THE BIMETAL WELD, AT THE RCS SURGE NOZZLE TO SURGE LINE JUNC., HAD THE HIGHEST CUMULATIVE USAGE FACTOR IN THE SURGE LINE. PAGES C-17 + D-3 SHOW THAT THE FIRST FATIGUE CASE ANALYZED ASSUMED A ΔP OF 2500 PSI AND A ΔT OF 580°F. SINCE THIS CASE IS WORSE THAN THE ACCELERATED COOLDOWN BEING ANALYZED A NEW USAGE FACTOR WILL BE CALCULATED ASSUMING ONE ADDITIONAL CYCLE WHICH WILL ACCOUNT FOR THE ACCELERATED COOLDOWN. SINCE ORIGINALLY 240 CYCLES WERE ANALYZED, THE NEW USAGE FACTOR WILL BE BASED ON 241 CYCLES.

HENCE: $U_1 = \frac{241}{550} = .438$ (REF Pg D-3 OF REF B-11)

$U_{TOT} = .438 + .016 + .008 + .300 + 0.000 + 0.000$

$U_{TOT} = .762 < 1.0$

- C -

SURGE NOZZLE

PRIMARY PIPE AT THE BASE OF THE SURGE NOZZLE

PRI + SEC, EQ 10

$$S_n = C_1 \frac{PD_o}{2t} + C_{2b} \frac{M_b}{Z_b} + C_{2r} \frac{M_r}{Z_r} + \frac{1}{2(1-\nu)} E\alpha |\Delta T_1| + C_3 E_{ab} |\alpha_a T_a - \alpha_b T_b| \leq 3S_m$$

WHERE: $C_1 \frac{PD_o}{2t} = 1.0 \frac{2500(42.25)}{2(2.8125)} = 18.8$ KSI

$C_{2b} \frac{M_b}{Z_b} = 7.5$ KSI (REF PG B-15-7 OF REF B-8)

$C_{2r} \frac{M_r}{Z_r} = 2.5$ KSI (REF PG B-15-2 OF REF B-8)

$\frac{1}{2(1-\nu)} E\alpha \Delta T_1 = 6.8$ KSI (REF PG Y-36 OF REPORT)

$C_3 E_{ab} |\alpha_a T_a - \alpha_b T_b|$ WILL BE CONSERVATIVELY CALCULATED ASSUMING A MAX ΔT BETWEEN THE AVERAGE TEMP OF THE SURGE NOZZLE AND THE AVERAGE TEMP OF THE RUN PIPE OF 310°F. (310°F COMES FROM THE MAX ΔT OF FLUID TEMP, 590°F @ TIME 0435 MINUS 280°F @ TIME 0540.)

$C_3 E_{ab} |\alpha_a T_a - \alpha_b T_b| = 1.8(29.67\times10^6) |6.12\times10^{-6}(590°) - 6.12\times10^{-6}(280)| = 101.3$ KSI

$S_n = 18.8 + 7.5 + 2.5 + (6.8 + 2.0) + 101.3 = 138.9$ KSI

PREVIOUS R.G. STRESS FROM PRIMARY PIPE REPORT REF Pg 275

BABCOCK & WILCOX

DEPARTMENT | DATE | BY

CHECKED DATE | BY

JOB NO.

REVISION

SHEET C-1 OF

$S_n = 138.9\ KSI > 3S_m = 52.2\ KSI$

PEAK STRESSES, EQ 11

$$S_p = K_1 C_1 \frac{P_o D_o}{2t} + C_{2b} K_{2b} \frac{M_b}{Z_b} + C_{2r} K_{2r} \frac{M_r}{Z_r} + \frac{1}{2(1-\nu)} K_3 E \alpha \Delta T_1 + K_3 C_3 E_{ab} |\alpha_a T_a - \alpha_b T_b|$$

$$+ \frac{1}{1-\nu} E \alpha \Delta T_2$$

WHERE: $K_1 C_1 \frac{P_o D_o}{2t} = 1.7(1.0) \frac{2500\ (42.25)}{2\ (2.8125)} = 31.9\ KSI$

$C_{2b} K_{2b} \frac{M_b}{Z_b} = 14.7\ KSI$ (REF PG B-15-7 OF REF B-8)

$C_{2r} K_{2r} \frac{M_r}{Z_r} = 4.9\ KSI$ (REF PG B-15-2 OF REF B-8)

$\frac{1}{2(1-\nu)} K_3 E \alpha \Delta T_1 = 1.7(6.8) = 11.6\ KSI$ (REF PG Y-36 OF REPORT)

$\frac{1}{(1-\nu)} E \alpha \Delta T_2 = 9.5 - 6.8 = 2.7\ KSI$ (REF PG Y-36 OF REPORT)

$K_3 C_3 E_{ab} |\alpha_a T_a - \alpha_b T_b|$ WILL BE CONSERVATIVELY CALCULATED ASSUMING A MAX ΔT BETWEEN THE AVERAGE TEMP OF THE SURGE NOZZLE AND THE AVERAGE TEMP OF THE RUN PIPE OF 310°F. (310°F COMES FROM THE MAX ΔT OF THE FLUID TEMP, 590°F @ TIME 0455 MINUS 280°F @ TIME 0540.)

$$C_3 K_3 E_{ab} |\alpha_a T_a - \alpha_b T_b| = 1.8(1.7)\, 29.67 \times 10^6 \left| 6.12 \times 10^{-6}(590) - 6.12 \times 10^{-6}(280) \right|$$
$$= 172.2\ KSI$$

BABCOCK & WILCOX

DEPARTMENT

DATE BY

CHECKED DATE BY

JOB NO.

REVISION

SHEET C-2 OF

PREVIOUS R.G. STRESS FROM PRIMARY PIPE REPORT REF PG 275

$S_p = 31.9 + 14.7 + 4.9 + (11.6 + 2.0) + 2.7 + 172.2 = 240.0$ KSI

USING SIMPLIFIED ELASTIC PLASTIC
USAS B31.7 NUCLEAR POWER PIPING

$\frac{S_n}{3S_m} = \frac{138.9}{52.2} = 2.66$; $\therefore A = 1.45$ (FIG D-201)

$S_{ALT} = \frac{1}{2}\left[S_p + A(S_p - S_n)\right]\frac{S_n}{3S_m}$

$= \frac{1}{2}\left[240 + 1.45(240 - 138.9)\right]\frac{138.9}{52.2}$

$= 514.4$ KSI

$N_1 = 13$

$U_1 = \frac{1}{13} = .077$

ADDING U_1 TO THE PREVIOUS USAGE FACTOR OF THE REPORT (REF PG B-16-30 OF REF B-11)

$U_{TOT} = .077 + .620 = .697$

$U_{TOT} = .697 < 1.0$

BABCOCK & WILCOX | REVISION
DEPARTMENT | DATE | BY
CHECKED DATE | BY
JOB NO.
SHEET C-3 OF

-D-

36" & 28"

PRIMARY PIPE

BMS 247-1

PRIMARY PIPE

CARBON STEEL

THE PRIMARY + SECONDARY AND PRIMARY + SECONDARY + PEAK STRESSES HAVE BEEN RECALCULATED USING THE SMUD COOLDOWN INCIDENT TRANSIENT. IN ADDITION A NEW FATIGUE USAGE FACTOR HAS BEEN CALCULATED.

THE RADIAL GRADIENT STRESS HAS BEEN RECALCULATED FOR A 28" STAINLESS STEEL SECTION. THIS INCREASED RADIAL GRADIENT STRESS HAS BEEN ADDED TO THE WORST STRESSED JOINT IN THE HOT OR COLD LEG. THE 28" STAINLESS STEEL RADIAL GRADIENT STRESS WAS CHOSEN TO BE ADDED TO THE HIGHEST STRESSED JOINT IN THE RCS PRIMARY PIPING SINCE THE 28" S.S. SECTION HAD THE HIGHEST RADIAL GRADIENT STRESS OF THE 28" AND 36" PIPING. (SEE THERMAL OUTPUT OF 28" + 36" C.S. SECTIONS AND 28" S.S. SECTIONS, PG Y-8 THRU Y-37.)

THE MAXIMUM PRI + SEC STRESS (AS WELL AS MAX USAGE FACTOR) OCCURS AT JOINT # 47 WHICH IS THE 28" COLD LEG DISCHARGE CARBON STEEL - STAINLESS STEEL PUMP JOINT.

FROM "PRIMARY PIPING ANALYSIS, REPORT # 2, 620-0011-50" THE PRI + SEC STRESS IS

$S_{PRI+SEC} = 71,738$ (REF PG 160)

$\sigma_{R.G.\,(INCIDENT)} = 6848$ PSI (~~CALCULATED USING 1-DIMENSIONAL~~ THERMAL COMPUTER PROGRAM)

ADDING THE ADDITIONAL RADIAL GRADIENT STRESS TO THE PRI + SEC STRESS OF THE REPORT

$S_{PRI+SEC} = 71,738 + 6848 = 78,586$ PSI

$S = 78,586$ PSI $> 3S_m = 57,000$ PSI

PAGE 181 CONTAINS THE COMPUTER OUTPUT OF THE DETAILED ANALYSIS OF JT # 47 WHICH WAS PERFORMED SINCE ORIGINALLY THE $3S_m$ LIMIT WAS EXCEEDED ALSO. THE σ_{RG} WILL BE CONSERVATIVELY ADDED TO THE STRESS INTENSITY TO SHOW COMPLIANCE WITH THE $3S_m$ LIMIT.

$S_{22} = 42,590$ PSI (REF PAGE 181)

$S_{22} + \Delta\sigma_{RG} = 42,590 + 6848 = 49,438$ PSI

$S_{22} = 49,438$ PSI $< 3S_m = 57,000$ PSI

NOTE THAT THERE IS NO CHANGE IN THE DISCONTINUITY STRESS PREVIOUSLY CALCULATED. FROM PREVIOUS THERMAL DISCONTINUITY ANALYSISES IT HAS BEEN DETERMINED THAT THE MAX DISCONT STRESS OCCURS AT THE MAX SYSTEM TEMPERATURE RATHER THAN

MS 247-1

AT A HEATUP OR COOLDOWN OR OTHER THERMAL TRANSIENT CONDITION. THIS IS DUE TO THE FACT THAT THERE ARE VERY SMALL ΔT'S PRESENT BETWEEN THE AVERAGE STAINLESS STEEL SECTION TEMPERATURES AND THE AVERAGE CARBON STEEL TEMPERATURES DURING A TRANSIENT CONDITION.

CALCULATION OF USAGE FACTOR

FROM THE OUTPUT OF THE 1-DIMENSIONAL COMPUTER PROGRAM THE MAX PEAK RADIAL GRADIENT STRESS IS 9468 PSI. (THIS WAS RUN FOR THE THERMAL PARAMETER DEFINED IN THE SMUD COOLDOWN INCIDENT.)

$$\sigma_{R.G.\ \text{COOLDOWN INCIDENT}} = (K_3 \times \text{LINEAR PORTION}) + \text{PEAK PORTION}$$

$$= 1.7\,(6848) + (9468 - 6848)$$

$$= 14262 \text{ PSI}$$

REF PG 162 OF STRESS REPORT

$$\rightarrow S_{PEAK\ REPORT} + \sigma_{R.G.} = 70,737 + 14,262$$
$$= 84,999 \text{ PSI}$$

$$S_{ALT} = \frac{84,999}{2} = 42,499 \text{ PSI}$$

$$N_{ALLOW} = 6,500 \text{ CYCLES}$$

$U_{CYCLE} = .000$

$U_{TOTAL} = .000 + .002 + .047 = .049 < 1.0$

HENCE IT HAS BEEN SHOWN THAT THE SMUD COOLDOWN INCIDENT DOES NOT SIGNIFICANTLY EFFECT THE PRI + SEC STRESSES OR THE CUMULATIVE USAGE FACTOR. HENCE THE PRIMARY PIPING IS IN ACCORDANCE WITH SECTION III FOR THE PREVIOUS DESIGN LIFE.

BABCOCK & WILCOX			REVISION
DEPARTMENT	DATE	BY	
	CHECKED DATE	BY	
	JOB NO.		SHEET D-4 OF

-E-

MAKE-UP & HPI NOZZLE

MAKE-UP + HPI NOZZLE

SINCE THE MAKE-UP + HPI NOZZLES ARE ANALYZED COLLECTIVELY IN ONE STRESS REPORT ("THERMAL MECHANICAL ANALYSIS OF 2½" SCH 160 MAKE-UP AND HPI NOZZLE", DESIGN REPORT # S, 620-0011-50) THEY AGAIN WILL BE ANALYZED TOGETHER FOR THIS COOLDOWN INCIDENT.

BRANCH CONNECTION

OF THE TWO NOZZLES, THE MAKE-UP NOZZLE HAD THE HIGHER STRESS + USAGE FACTOR AT THE BRANCH CONNECTION AND WILL HEREFORE BE USED IN THE JUSTIFICATION CALCULATIONS.

THE MAX STRESS INTENSITY FROM Pg ii of ABOVE REFERENCED POINT IS:

$$S = 52.2 \text{ KSI} < 3S_m = 53.4 \text{ KSI}$$

THE INCREASED RADIAL GRADIENT STRESS IN THE BRANCH CONNECTION WILL BE ADDED TO THE PRI + SEC STRESS OF THE REPORT OF 52.2 KSI.

$\sigma_{R.G.} = 5.2$ KSI (REF 28" COMPUTER OUTPUT, ATTACHED)

$\therefore \quad S = 52.2 + 5.2 = 57.4 \text{ KSI} > 3S_m = 53.4 \text{ KSI}$

USING A SIMPLIFIED ELASTIC PLASTIC OF USAS B31.7 - 1969

$$S_{ALT} = \frac{1}{2}\left[S_P + A(S_P - S_n)\right]\frac{S_n}{3S_m}$$

WHERE $S_n = 57.4$ KSI

$3S_m = 53.4$ KSI

$A = .75$ (FIG D-201 (a))

$$S_{PEAK} = S_{P\,OF\,REPORT}^{(PG\ 3-65)} + \sigma_{R.G.}$$

$$\sigma_{R.G.} = \frac{1}{2(1-\nu)} K_3 E\alpha \Delta T_1 + \frac{1}{1-\nu} E\alpha \Delta T_2$$ (REF 28" COMPUTER OUTPUT, ATTACHED)

$$\sigma_{R.G} = \left[1.7(5.2) + (7.3 - 5.2)\right] = 10.9 \text{ KSI}$$

$$S_{PEAK} = 107.7 + 10.9 = 118.6 \text{ KSI}$$

BABCOCK & WILCOX | REVISION

DEPARTMENT | DATE | BY

CHECKED DATE | BY

JOB NO.

$S_{alt} = \frac{1}{2}\left[118.6 + .75(718.6 - 57.4)\right] \frac{57.4}{53.4}$

$= 88.4 \text{ KSI}$

$N_1 = 900$

ASSUMING THE HPI PUMPS WERE STARTED AND STOPPED 4 TIMES

$U_1 = \frac{4}{900} = .004$

ADDING U_1 TO THE PREVIOUS U OF THE STRESS REPORT (REF PG 3-66 OF STRESS REPORT)

$U_{TOT} = .004 + .079 = .083$

$U_{TOT} = .083 < 1.0$

HPI NOZZLE SAFE END

NO ADDITIONAL THERMAL TRANSIENT ANALYSIS IS REQUIRED ON THE HPI + MAKE-UP NOZZLES SINCE A MORE SEVERE TRANSIENT WAS ANALYZED IN REF B-9 FOR A "RAPID DEPRESSURIZATION" CONDITION, TRANSIENT # 9 OF REF B-4. THEREFORE IN ORDER TO JUSTIFY 4 CYCLES OF THE HPI ACTUATION, THESE 4 CYCLES WILL BE ADDED TO THE 40 CYCLES OF "RAPID DEPRESSURIZATION" ALREADY ANALYZED.

THE HPI NOZZLE HAD THE HIGHER OVER-ALL STRESS + USAGE FACTOR AT THE END OF THE NOZZLE. IN ORDER TO JUSTIFY THIS LOCATION, SOME OF THE CONSERVATISM OF THE CALCULATION OF THE CUMULATIVE USAGE FACTOR WAS DELETED AND HENCE THE CALCULATIONS OF PG 5-28 THRU 5-30, REF B-9, WERE REVISED.

(TAKEN FROM REF B-9)

HPI STRESS CASES

ITERATION	TIME	EXPLANATION
27967	4.95 Hrs.	End of Heat-Up - No flow condition See Page 4-5
41491	7.5 Hrs.	Steady State Temperature at 575 Hottest temperature in vicinity of Bi-metal weld.
42021	7.6 Hrs.	Reversal in Axial gradient from 27967. See Page 4-5
3, 6, 8	0 - 10 Secs.	Maximum radial gradient stress during test transient. See Page 8-6
15	10.7 Sec. from start of test	Maximum axial gradient in upper part of nozzle
30	21.4 Sec. after test	Reversal of radial gradient
1211	14.8 min. after test	Reversal of axial gradient in upper part of nozzle
5060, 5063, 5072	0-10 Secs. after start of rapid depressurization	Maximum radial gradient stress in radid depressurization. See Page 4-7
5124	1.015 Hrs. .9 min. after start of rapid depressurization	One location of possible maximum axial gradient stress. See Page 4-7.
5237	1.0384 Hrs.	Possible maximum axial gradient stress
6059	1.2 hrs.	Possible maximum axial gradient stress.
6307	1.248 hrs.	End of 40°F water injection
6338	1.254 hrs.	Reversal of radial gradient and reversal of axial gradient. See Page 4-8
6850	1.35 hrs.	Reversal of axial gradient.
1	-	Pressure Only, 1000 PSI.

JUNCTURE NO. 8

ITER.	PRIMARY + SECONDARY STRESS INTENSITIES						PEAK STRESS INTENSITIES					
	L - R		R - H		H - I		L - R		R - H		H - I	
	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTS
3	63.7	-58.2	-54.7	50.2	-9.0	2.9	109.0	-50.7	-92.9	22.5	-16.0	28
6	77.5	-70.8	-63.6	59.5	-14.0	11.3	115.0	-67.3	-92.1	31.3	-22.9	36
8	78.8	-71.9	-62.9	59.2	-16.0	12.6	113.3	-70.6	-88.0	32.7	-25.3	37
15	69.3	-63.0	-47.3	48.2	-22.0	14.9	95.0	-75.0	-64.2	38.0	-30.9	37
30	7.7	-6.9	-1.2	1.1	-6.5	5.8	8.7	-9.4	-1.0	1.2	-7.7	8
1211	-.4	.3	.1	-.1	.3	-.2	-.4	.4	.1	-.1	.4	-
1491	.0	-.0	.0	.0	-.0	-.0	.0	-.0	.0	.0	-.0	-
1	2.2	.6	-3.5	-1.6	1.3	1.0	2.5	.9	-3.5	-1.6	1.0	
42021	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
27776	-.7	.6	1.1	-.3	-.5	-.3	-.8	.5	1.2	.0	-.4	-

STRESS OUTPUT ANALYSIS

ITER.	L - R INSIDE	L - R OUTSIDE	R - H INSIDE	R - H OUTSIDE	H - I INSIDE	H - I OUTSIDE	L - R INSIDE	L - R OUTSIDE	R - H INSIDE	R - H OUTSIDE	H - I INSIDE	H - I OUTS
5072	86.0	-78.3	-62.4	60.0	-23.6	18.3	117.3	-80.5	-83.1	34.7	-34.2	95
5060	73.1	-66.8	-61.9	58.3	-11.2	8.4	147.4	-53.3	-128.6	21.9	-18.7	31
5063	97.9	-89.3	-81.4	74.5	-16.4	14.8	143.3	-85.3	-115.7	39.3	-27.6	46
5124	33.0	-29.7	-13.1	15.1	-19.8	14.7	39.9	-36.7	-15.8	11.4	-24.1	25
5237	11.5	-10.4	-3.8	5.5	-7.7	4.9	14.2	-13.4	-5.1	4.8	-9.2	8
6059	.4	-.4	.3	.4	-.7	-.0	.5	-.5	.3	.3	-.8	.
6307	.4	-.4	.2	.3	-.6	.0	.5	-.5	.2	.3	-.7	.2
6338	-7.7	7.0	5.6	-5.1	2.1	-1.9	-9.6	8.7	6.6	-4.3	3.1	-4.4
6850	-3.5	3.1	-1.0	-.5	4.5	-2.6	-1.3	4.1	-3.4	-.4	4.7	-3.7
1	2.2	.6	-3.5	-1.6	1.3	1.0	2.5	.9	-3.5	-1.6	1.0	.7

TAKEN FROM REF B-9

STRESS OUTPUT ANALYSIS

STRESS INTENSITY ON BRANCH DUE TO BRANCH PIPE LOADS

SECTION	CATEGORY	R_i	R_o	M_i FT-KIPS	INTENSITY (KSI) INSIDE, OUTSIDE
1	PRIMARY	$R_m = 1.25$		2.68	17.1
	SECONDARY 2 OBE	1.0625	1.4375	4.54	24.6, 33.3
$\frac{1}{I} = .425$	SECONDARY OBE+THER	↓	↓	3.45	18.7, 25.3
	SECONDARY THERM	↓	↓	1.18	6.4, 8.7
2	PRI	$R_m = 1.28125$		2.76	14.3
	SEC. (2OBE)	1.0625	1.5	4.64	19.9, 28.1
$\frac{1}{I} = .336$	SEC. (OBE+THER)	↓	↓	3.52	15.1, 21.3
	SEC (THER)	↓	↓	1.20	5.1, 7.3
3	PRI	$R_m = 2.1875$		3.89	1.3
	SEC (2OBE)	1.1875	3.1875	5.91	1.1, 2.8
$\frac{1}{I} = .0126$	SEC (OBE+THER)	↓	↓	4.45	.8, 2.1
	SEC (THER)	↓	↓	1.50	.3, .7
4		STRESS INDEX			
	PRI	1.863		3.89	2.86
	SEC (2OBE)	2.489		5.91	5.86
$Z = 30.06\ IN^3$	SEC (OBE+THER)	2.484		4.45	4.91
	SEC (THER)	2.489		1.50	1.49

(TAKEN FROM REF B-9)

PRI + SEC STRESSES

CASE 1

40 CYCLES "RAPID DEPRES"
4 " ACCELERATED COOLDOWN (REF PG A-4)
44 CYCLES

$S_n = [\sigma^{L-R}_{ITER\ 5060} + \sigma_{PRES} + \sigma_{THERM\ EXP}] - [\sigma^{L-R}_{ITER\ 4385} + \sigma_{PRES}]$

$= [73.1 + 2.2(2.2) + 5.1] - [-7.7 + 1.5(2.2)]$

$= 83.04 + 4.40 = 87.44\ KSI > 3S_m = 51.3\ KSI$

SINCE $S = 87.44 > 1.7(3S_m) = 87.21$ $\therefore$ $K_e = 3.33$

CASE 2

40 CYCLES "TEST TRANSIENT"

$S_n = [\sigma^{L-R}_{ITER\ 6}] - [\sigma^{L-R}_{ITER\ 30}]$

$= 77.5 - 7.7 = 69.8\ KSI > 3S_m = 51.3\ KSI$

$K_e = 1.0 + \frac{1-.3}{.3(1.7-1)}\left(\frac{69.8}{51.3} - 1\right) = 2.20$

CASE 3

30 CYCLES "OBE SEISMIC" @ STEADY STATE

$S_n = [\sigma_{PRES} + \sigma_{THERM\ EXP} + \sigma_{OBE}] - [\text{COLD CONDITION}]$

$S_n = 2.2(2.2) + 15.1 = 19.9\ KSI < 3S_m = 51.3\ KSI$

BWS-2421

PRI + SEC STRESSES

CASE 4

240 CYCLES "HEAT-UP + COOLDOWN"

$S_n = \left[\sigma^{L-R}_{ITER\ 279\%} + \sigma_{PRES} + \sigma_{THERM\ EXP}\right]$ - COLD CONDITION

$= \left[-.7 + 2.2(2.2) + 5.1\right] - 0$

$= 9.24$ KSI $< 3S_m = 51.3$ KSI

CASE 5

620 CYCLES "2 OBE"

$S_n = 19.9$ KSI REF PG E-8

$S = 19.9$ KSI $< 3S_m = 51.3$ KSI

BABCOCK & WILCOX

DEPARTMENT DATE BY

CHECKED DATE BY

JOB NO.

REVISION

SHEET E-9 OF

BMS-2421

PEAK STRESSES

CASE 1

$$S_P = \left[\sigma^{L-R}_{ITER\ 8060} + \sigma_{PRESS} + SCF \times \sigma_{THERM\ EXP}\right] - \left[\sigma^{L-R}_{ITER\ 6229} + S.C.F \times \sigma_{PRES}\right]$$

$$= \left[147.4 + (2.2)2.2 + 1.39(5.1)\right] - \left[-9.6 + (1.5)2.2\right]$$

$$= 159.3 + 6.3 = 165.6 \text{ KSI}$$

CASE 2

$$S_P = \left[\sigma^{L-R}_{ITER\ C}\right] - \left[\sigma^{L-R}_{ITER}\right] = 115.0 - 8.7 = 106.3 \text{ KSI}$$

CASE 3

$$S_P = \left[\sigma_{PRESS} + S.C.F(\sigma_{THERM\ EXP} + \sigma_{ABE})\right] - \left[\text{COLD CONDITION}\right]$$

$$= \left[2.2(2.2) + 1.39(15.1)\right] = 25.83 \text{ KSI}$$

BABCOCK & WILCOX			REVISION
DEPARTMENT	DATE	BY	
	CHECKED DATE	BY	
	JOB NO.		SHEET E-10 OF

PEAK STRESSES

CASE 4

$S_P = \left[\sigma^{C-X}_{ITER\ 27926} + \sigma_{PRES} + S.C.F.(\sigma_{THERM\ EXP})\right] - \left[COLD\ CONDITION\right]$

$= \left[-.8 + 2.2(2.2) + 1.39(5.1)\right]$

$= 11.13$ KSI

CASE 5

$S_P = \left[2 \times OBE \times S.C.F.\right]$

$= \left[19.9\ (1.39)\right]$

$= 27.66$ KSI

USAGE FACTOR

CASE 1 $S_{ALT} = K_e \frac{S_P}{2} = 3.33\left(\frac{165.6}{2}\right)$

$= 276.0$ KSI

$n_1 = 44$

$N_1 = 70$

$U_1 = \frac{n_1}{N_1} = \frac{44}{70} = .629$

BABCOCK & WILCOX
DEPARTMENT
DATE BY
CHECKED DATE BY
JOB NO.
REVISION
SHEET E-11 OF

BWS-2421

USAGE FACTOR

CASE 2

$S_{ALT} = K_e \left(\frac{S_p}{2}\right) = 2.2 \left(\frac{106.3}{2}\right) = 116.9$ KSI

$n_2 = 40$

$N_2 = 830$

$U_2 = \frac{40}{830} = .048$

CASE 3

$S_{ALT} = \frac{S_p}{2} = \frac{25.83}{2} = 12.92$ KSI

$n_3 = 30$

$N_3 = \infty$

$U_3 = 0.000$

CAS_ 4

$S_{ALT} = \frac{S_p}{2} = \frac{11.13}{2} = 5.57$ KSI

$n_4 = 240$

$N_4 = \infty$

$U_4 = 0.000$

CASE 5

$S_{ALT} = \frac{S_p}{2} = \frac{27.66}{2} = 13.83$ KSI

$n_5 = 620$

$N_5 = \infty$

$U_5 = 0.000$

BABCOCK & WILCOX

DEPARTMENT

DATE BY

CHECKED DATE BY

JOB NO.

REVISION

SHEET E-12 OF

USAGE FACTOR

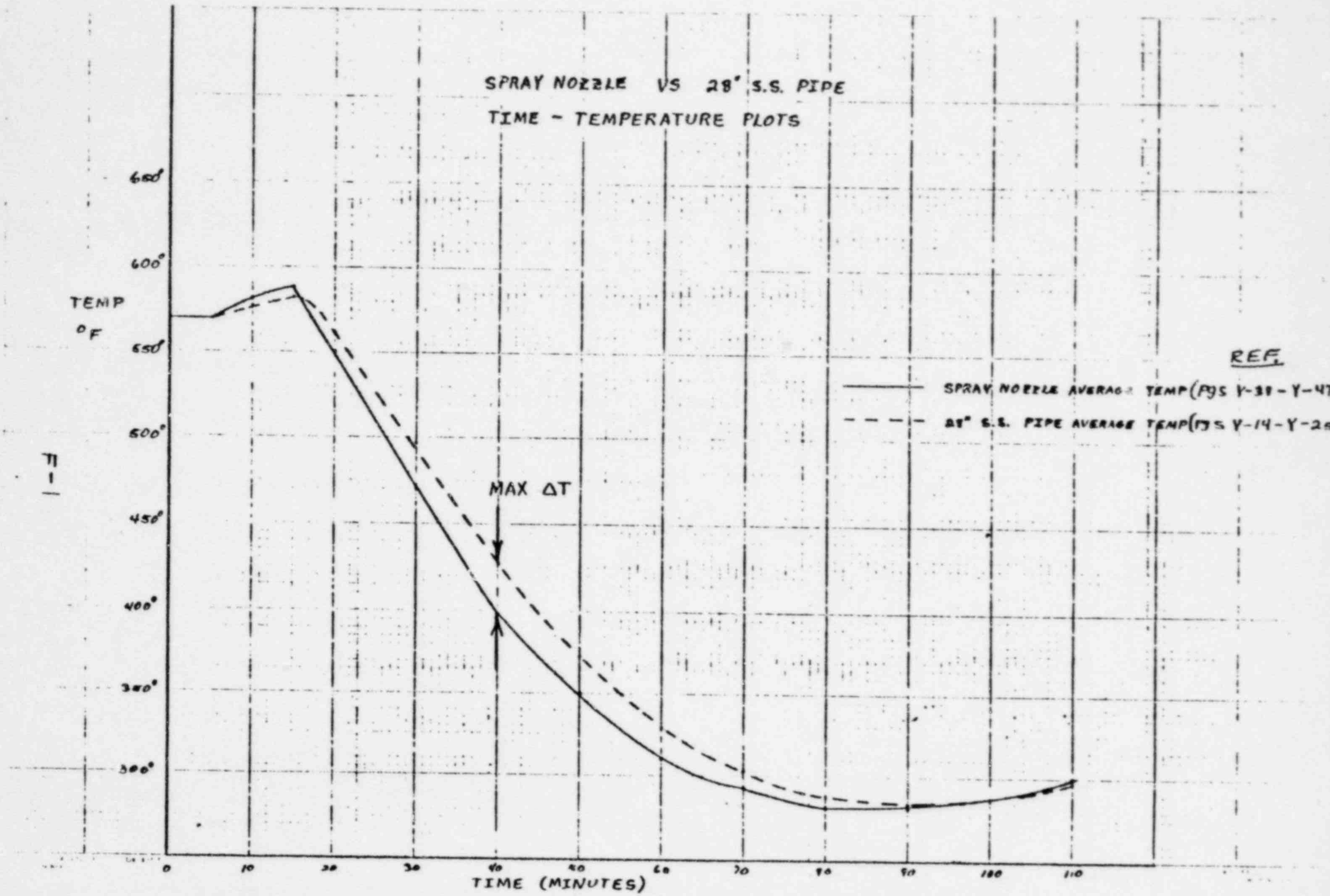
$$U_{TOT} = U_1 + U_2 + U_3 + U_4 + U_5$$

$$= .629 + .048 + 0.000 + 0.000 + 0.000$$

$$= .677 < 1.0$$

- F -

SPRAY NOZZLE



SPRAY NOZZLE VS 28" S.S. PIPE
TIME - TEMPERATURE PLOTS
TEMP
°F
650°
600°
550°
500°
450°
400°
350°
300°
MAX ΔT
REF.
SPRAY NOZZLE AVERAGE TEMP (PGS V-38 - V-47)
28" S.S. PIPE AVERAGE TEMP (PGS V-14 - V-25
0
10
20
30
40
50
60
70
80
90
100
110
TIME (MINUTES)

T1-1

FM 247-1

SPRAY NOZZLE - PRIMARY PIPE
BRANCH CONNECTION

PRI + SEC, EQ 10

$$S = C_1 \frac{PD_o}{2t} + C_{2b}\frac{M_b}{Z_b} + C_{2r}\frac{M_r}{Z_r} + \frac{1}{2(1-\nu)} E\alpha\Delta T + C_3 E_{ab} |\alpha_a T_a \; \alpha_b T_b|$$

FROM THE SPRAY NOZZLE STRESS REPORT, THE PRESSURE AND MOMENT TERMS ARE STILL APPLICABLE.

$\frac{1}{2(1-\nu)} E\alpha\Delta T = 12.3$ KSI (REF 28" S.S. COMPUTER OUTPUT, ATTACHED)

$C_3 E_{ab} |\alpha_a T_a - \alpha_b T_b| = 1.8(28.42 \times 10^6) | 8.70 \times 10^{-6}(427°) - 8.70 \times 10^{-6}(398°)| = 12.9$ KSI

NOTE THAT THE 427°F + 398°F WERE SELECTED FROM THE ATTACHED COMPUTER OUTPUT OF THE 28" S.S. PIPE AND THE SPRAY NOZZLE @ APPROX 40.0 MINUTES WHICH IS WHERE THE MAX ΔT OCCURRED FOR THIS COOLDOWN.

R.G STRESS FROM REPORT

(REF EQ 11 OF STRESS REPORT) $S = 30.5 + 5.5 + 8.6 + (5.0 + 12.3) + 12.9 = 74.8$ KSI

$S = 74.8$ KSI $> 3S_m = 51.3$ KSI

USING SIMPLIFIED ELASTIC PLASTIC OF USAS B 31.7 - 1969

$$S_{ALT} = \frac{1}{2}\left[S_p + A(S_p - S_n)\right]\frac{S_n}{3S_m}$$

WHERE $\frac{S_n}{3S_m} = 1.48 \rightarrow A = .7$ (REF FIG D-201)

BABCOCK & WILCOX

DEPARTMENT | DATE | BY

CHECKED DATE | BY

JOB NO.

REVISION

SHEET F-2 OF

RADIAL GRADIENT STRESS FROM REPORT ↓

(Ref Pg 11a of STRESS REPORT)

$$S_{PEAK} = 51.8 + 5.5 + 25.9 + 8.5 + K_3 C_3 E_{ab} |\alpha_a T_a - \alpha_b T_b| + K_3 \frac{1}{2(1-\nu)} E\alpha\Delta T_1 + \frac{1}{1-\nu} E\alpha\Delta T_2$$

$$= 51.8 + 5.5 + 25.9 + 8.5 + 1.7(12.9) + [1.7(12.3) + (17.0 - 12.3)]$$

$$= 139.2 \text{ KSI}$$

$$S_{ALT} = \tfrac{1}{2}[139.2 + .7(139.2 - 74.8)] \frac{74.8}{51.3} = 134.4$$

$$S_{ALT} = 134.4 \text{ KSI}$$

$$N_1 = 520 \text{ CYCLES}$$

$$U_1 = \frac{3}{520} = .006$$

ADDING U_1 TO THE U OF THE STRESS REPORT, REF PG 13a.

$$U_{TOT} = .006 + .210 = .216$$

$$U_{TOT} = .212 < 1.0$$

BABCOCK & WILCOX			REVISION
DEPARTMENT	DATE	BY	
	CHECKED DATE	BY	
	JOB NO.		SHEET F-3 OF

SPRAY NOZZLE AT START OF TAPER

PRI + SEC, EQ 10

$$S_n = C_1 \frac{PD_o}{2t} + C_2 \frac{D_o M_i}{2I} + \frac{1}{2(1-\nu)} E\alpha\Delta T + C_3 E_{ab} |\alpha_a T_a - \alpha_b T_b|$$

FROM THE SPRAY NOZZLE STRESS REPORT, REF 8-10, THE PRESSURE AND MOMENT TERMS ARE STILL APPLICABLE.

$C_1 \frac{PD_o}{2t} = 13.4$ KSI
$C_2 \frac{D_o M_i}{2I} = 29.2$ KSI
} REF Pg 9 OF 8-10

$\frac{1}{2(1-\nu)} E\alpha\Delta T = 5.8$ KSI (REF SPRAY NOZZLE COMPUTER OUTPUT

$C_3 E_{ab} |\alpha_a T_a - \alpha_b T_b| = 1.0(28.42\times10^6)\,|8.7\times10^{-6}(590°) - 8.7\times10^{-6}(280)| = 76.6$ KSI

$C_3 E_{ab} |\alpha_a T_a - \alpha_b T_b|$ WAS CONSERVATIVELY CALCULATED ASSUMING A MAX ΔT OF 310°F. (310° COMES FROM THE MAX ΔT OF THE FLUID TEMP, 590°F @ TIME 0435 MINUS 280°F @ TIME 0540.)

$S_n = 13.4 + 29.2 + 5.8 + 76.6 = 125.0$ KSI

$S_n = 125.0 > 3S_m = 51.3$ KSI

PEAK STRESSES, EQ 11

$$S_P = K_1C_1\frac{PD_o}{2t} + K_2C_2\frac{D_oM_i}{2I} + \frac{1}{2(1-\nu)}K_3E\alpha\Delta T_1 + \frac{1}{1-\nu}E\alpha\Delta T_2 + K_3C_3E_{ab}\left|\alpha_aT_a - \alpha_bT_b\right|$$

FROM THE SPRAY NOZZLE STRESS REPORT, REF B-10, THE PRESSURE AND MOMENT TERMS ARE STILL APPLICABLE.

$K_1C_1\frac{PD_o}{2t} = 20.1$ KSI } PG 14 OF B-10

$K_2C_2\frac{D_oM_i}{2I} = 52.5$ KSI

$K_3\frac{1}{2(1-\nu)}E\alpha\Delta T_1 = 1.5(5.8) = 8.7$ KSI } REF SPRAY NOZZLE COMPUTER OUTPUT

$\frac{1}{1-\nu}E\alpha\Delta T_2 = 9.3 - 5.8 = 3.5$ KSI

$K_3C_3E_{ab}\left|\alpha_aT_a - \alpha_bT_b\right| = 1.5(76.6) = 114.9$ KSI

$S_P = 20.1 + 52.5 + 8.7 + 3.5 + 114.9 = 199.7$ KSI

$$S_{ALT} = \frac{1}{2}\left[S_P + A(S_P - S_m)\right]\frac{S_m}{3S_m}$$

A = .7 REF FIG D-201 OF B-1

$$S_{ALT} = \frac{1}{2}\left[199.7 + .7(199.7 - 125.0)\right]\frac{125.0}{51.3} = 307.0 \text{ KSI}$$

$N_1 = 52$ CYCLES

$U_1 = \frac{1}{52} = .019$

ADDING U_1 TO U OF REPORT, PG 15,

$U_{TOT} = .444 + .019 = .463 < 1.0$

BABCOCK & WILCOX

DEPARTMENT | DATE | BY

CHECKED DATE | BY

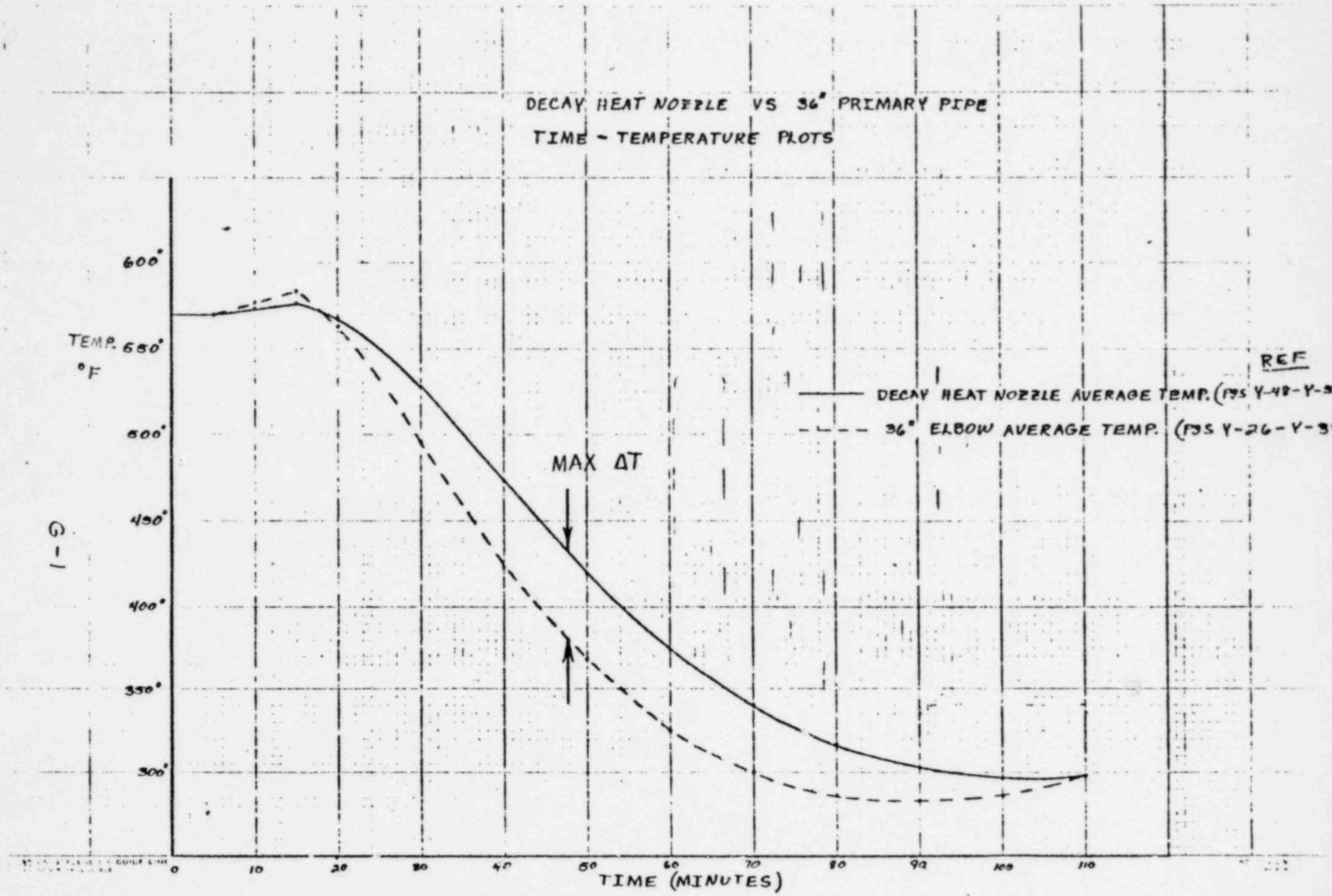
JOB NO.

REVISION

SHEET F-5 OF

- G -

DECAY HEAT NOZZLE


DECAY HEAT NOZZLE VS 36" PRIMARY PIPE
TIME - TEMPERATURE PLOTS
TEMP. °F
600°
550°
500°
450°
400°
350°
300°
MAX ΔT
REF
DECAY HEAT NOZZLE AVERAGE TEMP. (FIGS Y-48-Y-5
36" ELBOW AVERAGE TEMP. (FIGS Y-26-Y-37
0
10
20
30
40
50
60
70
80
90
100
110
TIME (MINUTES)

G-1

DECAY HEAT NOZZLE BRANCH CONNECTION

PRI + SEC, EQ 10

$$S = C_1 \frac{PD_o}{2t} + C_{2R} \frac{M_R}{Z_R} + C_{2B} \frac{M_B}{Z_B} + \frac{1}{2(1-\nu)} E\alpha\Delta T$$

$$+ C_3 E_{ab} \left| \alpha_a T_a - \alpha_b T_b \right|$$

FROM DECAY HEAT NOZZLE STRESS REPORT, THE PRESSURE AND MOMENT TERMS ARE STILL APPLICABLE.

$\frac{1}{2(1-\nu)} E\alpha\Delta T = 6.8$ KSI (Ref 36" ELBOW Computer Output, ATTACHED)

$C_3 E_{ab} \left| \alpha_a T_a - \alpha_b T_b \right| = 1.8(29.67\times10^6) \left| 6.12\times10^{-6}(433°) - 6.12\times10^{-6}(381°) \right| = 17.0$ KSI

THE 433° + 381° IS THE MAX ΔT BETWEEN NOZZLE + BRANCH AND OCCURS @ 47.5 MINUTES. (SEE COMPUTER OUTPUT)

$S = 31.2 + 10.2 + 19.7 + (3.9 + 6.8) + 17.0 = 88.8$ KSI (Ref Pg D-4 STRESS REPORT)

$S = 88.8$ KSI $> 3S_m = 52.2$ KSI for SA-105 Gr 2

- USING SIMPLIFIED ELASTIC PLASTIC

$\frac{S_n}{3S_m} = \frac{88.8}{52.2} = 1.70 \; ; \therefore A = 1.1$ (REF FIG D-201)

$\frac{1}{1-\nu} E\alpha\Delta T_2$

$S_{PEAK} = 53.1 + 20.4 + 19.7 + 6.6 + K_3 C_3 E_{ab} \left| \alpha_a T_a - \alpha_b T_b \right| + K_2 \frac{1}{2(1-\nu)} E\alpha\Delta T_1$

$= 53.1 + 20.4 + 19.7 + 6.6 + 1.7(17.0) + [1.7(6.8) + (9.5 - 6.8)]$

$= 143.0$ KSI

(Ref Pg D-10 STRESS REPORT)

BABCOCK & WILCOX

DEPARTMENT | DATE | BY

CHECKED DATE | BY

JOB NO.

REVISION

SHEET G-2 OF

$$S_{ALT} = \frac{1}{2}\left[S_p + A(S_p - S_n)\right]\frac{S_n}{3S_m}$$

$$S_{ALT} = \frac{1}{2}\left[143.0 + 1.1(143.0 - 88.8)\right]\frac{88.8}{52.2} = 172.3 \text{ KSI}$$

N_1 = 190 CYCLES

$$U_1 = \frac{1}{150} = .007$$

ADDING U_1 TO THE PREVIOUS U OF THE STRESS REPORT, REF P. D-14.

U_{TOT} = .007 + .679

U_{TOT} = .686 < 1.0

BABCOCK & WILCOX

DEPARTMENT

DATE BY

CHECKED DATE BY

JOB NO.

REVISION

APPENDIX

36" HOT LEG

$$R_e = \frac{\rho V D}{\mu}$$

$\rho = 42.3 \text{ lb/ft}^3$ @ 600°F
$D = 3.0$ ft
$\mu = 58 \times 10^{-6}$ lbm/ft-sec @ 600°F

$\dot{M} = 92{,}400$ GPM / PUMP

$$\dot{M} = \frac{2(92{,}400)\ \text{gal}}{\text{min}} \cdot \frac{231\ \text{in}^3}{\text{gal}} \cdot \frac{\text{ft}^3}{1728\ \text{in}^3} \cdot \frac{\text{min}}{60\ \text{sec}}$$
$$= 412\ \text{ft}^3/\text{sec}$$

$$V = \frac{\dot{M}}{A} = \frac{412\ \text{ft}^3/\text{sec}}{\pi (1.5)^2} = 58.3\ \text{ft/sec}$$

$$R_e = \frac{42.3 (58.3)\, 3}{58 \times 10^{-6}} = 1.3 \times 10^{8}$$

$$[Gr_D\, Pr]_m = K_{SD}\, D^3\, \Delta T$$

$D = 3.0$ ft
ΔT = assume this is 10°F
$K_{SD} = 4.4 \times 10^{10}$ from fig NC-23

$$[Gr_D\, Pr]_m = 4.4 \times 10^{10} (3.0)^3\, 10 = 1.2 \times 10^{13}$$

SINCE $[Gr_D\, Pr]_m > 10^9$ AND FROM FIG FC-7, $Re_D = 1.3 \times 10^8 >$ $Re_c = 2.5 \times 10^6$ THIS IS TURBULENT II FLOW.

BABCOCK & WILCOX
DEPARTMENT — DATE — BY
CHECKED DATE — BY
JOB NO.
REVISION
SHEET Y-1 OF

36" HOT LEG FILM COEFFICIENTS

THE HEAT TRANSFER FROM THE FLUID TO THE HOT LEG FALLS IN THE TURBULENT REGION II REGIME.

THE EQUATION FOR THE FILM COEFFICIENT THEREFORE IS:

$$h = K_{104}\left(\frac{\dot{m}^{.8}}{D^{1.8}}\right)$$

WHERE $D = 3.0$ ft

$\dot{m} = 2(92{,}400)$ GPM $= 412\ ft^3/sec$

$$\dot{m}\left(\frac{lb}{Hr}\right) = \frac{412\ ft^3}{sec}\ \frac{3600\ sec}{Hr}\ \frac{\rho\ lb}{ft^3}$$

$= 1{,}483{,}200\ \rho$ @ TEMP

IN ORDER TO TAKE INTO ACCOUNT THE AFFECT OF THE CLADDING, AN EFFECTIVE FILM COEFFICIENT WILL BE CALCULATED USING THE FOLLOWING FORMULA:

$$h_{eff} = \frac{1}{\frac{1}{h} + \frac{\Delta X}{K}}$$

WHERE ΔX = MINIMUM THICKNESS OF S.S. CLADING

K = THERMAL CONDUCTIVETY OF S.S. @ TEMP.

BABCOCK & WILCOX

DEPARTMENT

DATE	BY	REVISION
CHECKED DATE	BY	
JOB NO.		SHEET Y-2 OF

SAMPLE EFFECTIVE FILM COEFFICIENT CALCULATION AT 600 °F

$$h = K_{10V}\left(\frac{\dot{m}^{.8}}{D^{1.8}}\right) = .0295\left[\frac{(141,200\,(42.3))^{.8}}{(3.0)^{1.8}}\right] = 6788$$

$$h_{eff} = \frac{1}{\frac{1}{h} + \frac{\Delta x}{K}} = \frac{1}{\frac{1}{6788} + \frac{.125}{134.2}} = 927$$

36" HOT LEG FILM COEFFICIENTS

TEMP °F	ρ_{H_2O} lb/ft³	K_{SS} BTU/ft²-HR-°F/IN	K_{10V}	h BTU/HR FT² °F	h_{eff} BTU/HR FT² °F
600	42.3	134.2	.0295	6788	927
550	46.0	131.3	.0285	7298	918
500	49.0	128.5	.0275	7407	903
450	51.4	125.6	.0264	7388	885
400	53.7	122.7	.0252	7303	865
350	55.6	119.9	.0239	7122	845
300	57.3	117.0	.0222	6777	822
250	58.8	114.2	.0202	6295	798

FMS 267-1

28" COLD LEG
CARBON STEEL

$$Re = \frac{\rho V D}{\mu}$$

$\rho = 42.3 \ lb/ft^3$ @ 600°

$D = \frac{28}{12} = 2.33 \ ft$

$\mu = 58 \times 10^{-6} \ lb_m/ft\text{-sec}$ @ 600°F

$\dot{M} = 92,400$ GPM/PUMP

$$\dot{M} = \frac{92,400 \ gal}{min} \cdot \frac{231 \ in^3}{gal} \cdot \frac{ft^3}{1728 \ in^3} \cdot \frac{min}{60 \ sec}$$

$= 206 \ ft^3/sec$

$$V = \frac{\dot{M}}{A} = \frac{206}{\pi (1.17)^2} = 47.9 \ ft/sec$$

$$Re = \frac{42.3 (47.9) 2.33}{58 \times 10^{-6}} = 8.2 \times 10^7$$

$[Gr_D \, Pr]_m = K_{5a} D^3 \Delta T$; $D = 2.33 \ ft$

ΔT = assume 10°F

$K_{5a} = 4.4 \times 10^{10}$ from fig NC-23

$$[Gr_D \, Pr]_m = 4.4 \times 10^{10} (2.33)^3 \, 10 = 5.6 \times 10^{12}$$

SINCE $[Gr_D \, Pr] > 10^9$ AND FROM FIG EC-7, $Re_D = 8.2 \times 10^7 > Re_c = 1.8 \times 10^6$ THIS IS TURBULENT II FLOW.

BABCOCK & WILCOX

DEPARTMENT	DATE	BY	REVISION
	CHECKED DATE	BY	
	JOB NO.		SHEET Y-4 OF

28" CARBON STEEL FILMS COEFFICIENTS

THE HEAT TRANSFER FROM THE FLUID TO THE HOT LEG FALLS IN THE TURBULENT REGION II REGIME.

THE EQUATION FOR THE FILM COEFFICIENT THEREFORE IS:

$$h = K_{104}\left(\frac{\dot{m}^{.8}}{D^{1.8}}\right)$$

WHERE $D = 2.33$ ft

$\dot{m} = 92{,}400 = 206\ ft^3/sec$

$$\dot{m}\left(\frac{lb}{Hr}\right) = \frac{206\ ft^3}{sec}\ \frac{3600\ sec}{Hr}\ \frac{\rho\ lb}{ft^3}$$

$$= 741{,}600 \times \rho \text{ @ TEMP}$$

IN ORDER TO TAKE INTO ACCOUNT THE AFFECT OF THE CLADDING, AN EFFECTIVE FILM COEFFICIENT WILL BE CALCULATED USING:

$$h_{eff} = \frac{1}{\frac{1}{h} + \frac{\Delta x}{K}}$$

WHERE Δx = MIN. THICKNESS OF S.S. CLADDING

K = THERMAL CONDUCTIVITY OF S.S. @ TEMP

SAMPLE EFFECTIVE FILM COEF CALCULATION AT 600°F

$$h = K_{10\%}\left(\frac{\dot{m}^{.8}}{D^{1.8}}\right) = .0295\left(\frac{((741,600)(42.3))^{.8}}{(2.33)^{1.8}}\right) = 6394$$

$$h_{eff} = \frac{1}{\frac{1}{h} + \frac{\Delta x}{K}} = \frac{1}{\frac{1}{6394} + \frac{.125}{134.2}} = 919$$

28" CARBON STEEL COLD LEG

TEMP °F	ρ_{H_2O} lb/ft³	$K_{S.S.}$ BTU/ft²-Hr-°F/in	$K_{10\%}$	h BTU/Hr-ft²-°F	h_{eff} BTU/Hr ft² °F
600	42.3	134.2	.0295	6394	919
550	46.0	131.3	.0285	6606	906
500	49.0	128.5	.0275	6705	891
450	51.4	125.6	.0264	6688	874
400	53.7	122.7	.0252	6611	855
350	55.6	119.9	.0239	6447	835
300	57.3	117.0	.0222	6134	812
250	58.8	114.2	.0202	5698	787

BABCOCK & WILCOX

DEPARTMENT DATE BY

CHECKED DATE BY

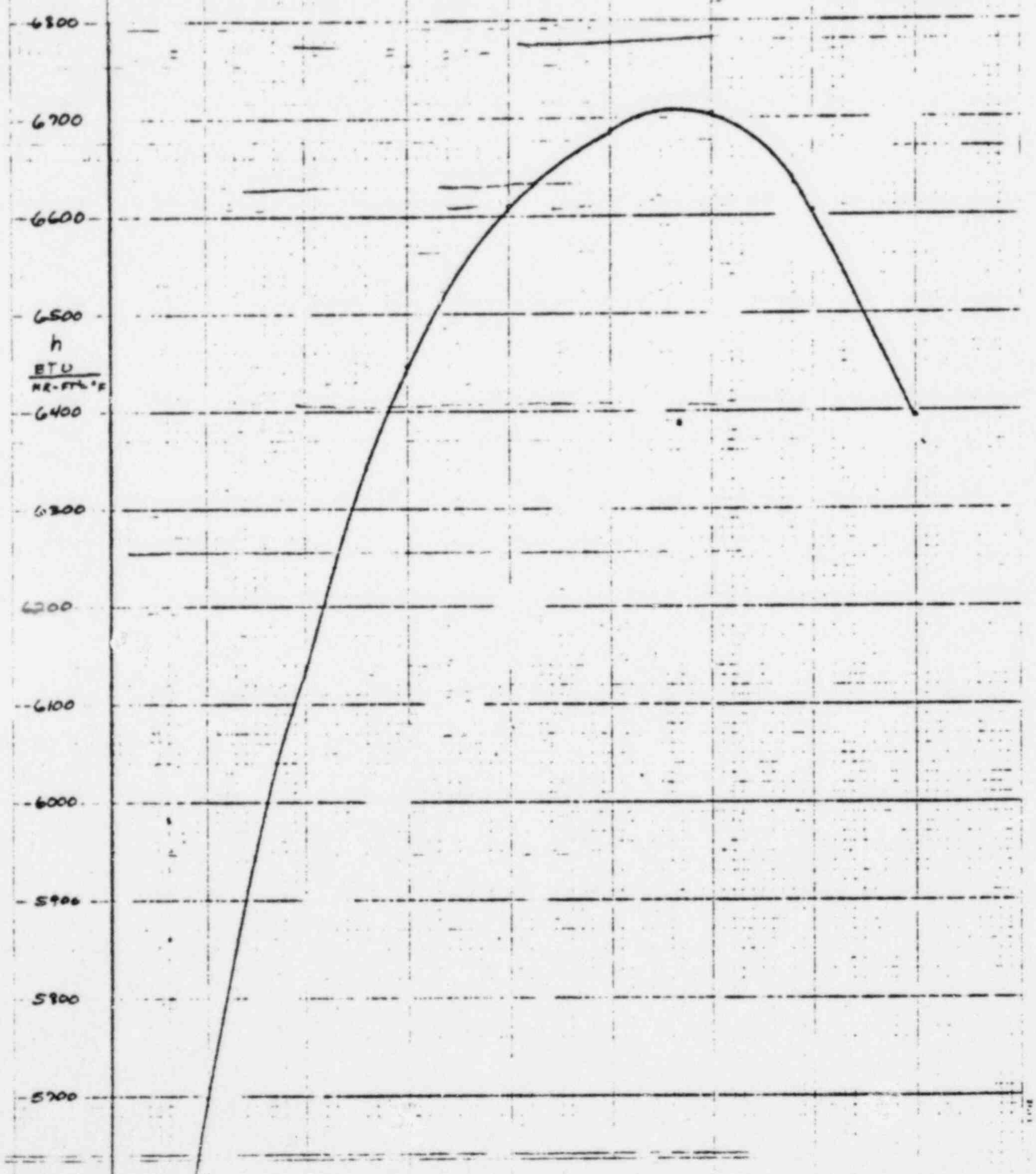
JOB NO.

REVISION

SHEET Y-6 OF

28" STAINLESS STEEL STRAIGHT SECTION FILM COEFFICIENTS

REF PG Y-6



28 INCH C.S. ELBOW, SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/08/78

DIMENSIONS

INSIDE RADIUS = 14.2500 INCHES OUTSIDE RADIUS = 17.3750 INCHES REF A-3

NO. OF NODES = 9 RADIAL INCREMENT = .3906 INCHES

MATERIAL CODE = 1 POISSON S RATIO = .3000

L = 0.0000

INITIAL CONDITIONS

NODE	RADIUS	TEMPERATURE
1	14.2500	570.0
2	14.6406	570.0
3	15.0313	570.0
4	15.4219	570.0
5	15.8125	570.0
6	16.2031	570.0
7	16.5938	570.0
8	16.9844	570.0
9	17.3750	570.0

28 INCH C.S. ELBOW. SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/08/78

TABULATION OF
BOUNDARY CONDITIONS

FLUID TEMP. CURVE APPROXIMATION		FILM COEFF. CURVE APPROXIMATION		PRESSURE CURVE APPROXIMATION	
TIME (MINUTES)	INSIDE FLUID TEMPERATURE	TIME (MINUTES)	INSIDE FILM COEFFICIENT	TIME (MINUTES)	PRESSURE (PSI)
0.0000	570.0	0.0000	911.0	0.0000	0.
5.0000	570.0	5.0000	911.0	0.0000	0.
10.0000	590.0	10.0000	915.0	0.0000	0.
15.0000	540.0	15.0000	916.0	0.0000	0.
20.0000	525.0	20.0000	899.0	0.0000	0.
40.0000	380.0	40.0000	847.0	0.0000	0.
60.0000	300.0	60.0000	812.0	0.0000	0.
80.0000	280.0	80.0000	802.0	0.0000	0.
95.0000	285.0	95.0000	805.0	0.0000	0.
110.0000	305.0	110.0000	814.0	0.0000	0.

REF PG A-5

REF PG Y-6

TEMPERATURE CALCULATION TIMES AND PRINTOUTS

TIME INCREMENT (MINUTES)	TIME LIMIT (MINUTES)	NUMBER OF PRINTOUTS
.2500	110.000	440.

28 INCH C.S. ELBOW. SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/08/78

TIME	EQUIV RAD	LIN. STR.	DELT1	DELT2	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9
.2500		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
.5000		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
.7500		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
1.0000		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
1.2500		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
1.5000		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
1.7500		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
2.0000		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
2.2500		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
2.5000		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
2.7500		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
3.0000		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
3.2500		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
3.5000		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
3.7500		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
4.0000		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
4.2500		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
4.5000		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
4.7500		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
5.0000		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
5.2500		-41.	-.390	-.328	-133.	16.	570.55	570.19	570.06	570.02	570.00	570.00	570.00	570.00	570.00
5.5000		-118.	-.868	-.614	-291.	51.	571.26	570.62	570.28	570.11	570.04	570.02	570.00	570.00	570.00
5.7500		-211.	-1.552	-.850	-449.	100.	572.03	571.14	570.60	570.30	570.14	570.05	570.03	570.01	570.01
6.0000		-311.	-2.284	-1.024	-603.	155.	572.83	571.72	571.00	570.56	570.30	570.15	570.08	570.04	570.03
6.2500		-413.	-3.043	-1.190	-751.	217.	573.64	572.34	571.45	570.87	570.50	570.29	570.16	570.09	570.08
6.5000		-515.	-3.795	-1.315	-894.	280.	574.48	572.97	571.94	571.22	570.75	570.45	570.27	570.18	570.15
6.7500		-615.	-4.534	-1.435	-1031.	343.	575.32	573.65	572.46	571.61	571.04	570.66	570.42	570.30	570.25
7.0000		-713.	-5.253	-1.545	-1162.	404.	576.18	574.36	573.01	572.04	571.36	570.90	570.61	570.46	570.41
7.2500		-807.	-5.946	-1.647	-1287.	465.	577.04	575.07	573.59	572.50	571.72	571.18	570.84	570.65	570.59
7.5000		-898.	-6.614	-1.742	-1407.	523.	577.91	575.80	574.18	572.98	572.10	571.49	571.10	570.87	570.80
7.7500		-985.	-7.254	-1.831	-1521.	579.	578.79	576.54	574.80	573.49	572.52	571.84	571.39	571.13	571.05
8.0000		-1068.	-7.858	-1.916	-1630.	632.	579.67	577.29	575.44	574.02	572.96	572.21	571.71	571.43	571.33
8.2500		-1147.	-8.454	-1.996	-1735.	686.	580.56	578.05	576.09	574.57	573.43	572.61	572.06	571.75	571.65
8.5000		-1223.	-9.015	-2.072	-1834.	733.	581.45	578.83	576.76	575.15	573.93	573.04	572.45	572.11	571.99
8.7500		-1296.	-9.552	-2.144	-1929.	780.	582.35	579.62	577.44	575.74	574.44	573.50	572.86	572.49	572.37
9.0000		-1366.	-10.064	-2.214	-2020.	825.	583.26	580.42	578.14	576.35	574.98	573.98	573.30	572.90	572.77
9.2500		-1432.	-10.553	-2.279	-2107.	869.	584.17	581.23	578.86	576.98	575.54	574.48	573.76	573.34	573.20
9.5000		-1495.	-11.021	-2.342	-2190.	909.	585.08	582.04	579.58	577.63	576.12	575.01	574.25	573.80	573.66
9.7500		-1556.	-11.467	-2.403	-2269.	949.	586.00	582.87	580.32	578.29	576.72	575.56	574.76	574.29	574.14

28 INCH C.S. ELBOW, SMUD COOLDOWN INCIDENT TRANSIENT

DATE 05/08/78

TIME	EQUIV RAD	LIN. STR.	DELT1	DELT2	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9
10.0000		-1614.	-11.893	-2.450	-2344.	985.	586.92	583.7[illegible]	581.07	578.97	577.34	576.12	575.29	574.80	574.63
10.2500		-1624.	-12.000	-2.185	-2286.	1005.	587.29	584.34	581.77	579.65	577.97	576.71	575.84	575.34	575.17
10.5000		-1604.	-11.821	-1.995	-2193.	1006.	587.50	584.77	582.33	580.26	578.58	577.30	576.41	575.89	575.72
10.7500		-1561.	-11.508	-1.895	-2101.	989.	587.67	585.13	582.79	580.79	579.15	577.88	576.94	576.46	576.28
11.0000		-1509.	-11.125	-1.805	-2009.	963.	587.80	585.34	583.18	581.27	579.68	578.44	577.55	577.02	576.85
11.2500		-1453.	-10.708	-1.720	-1920.	931.	587.92	585.61	583.54	581.70	580.17	578.96	578.10	577.58	577.41
11.5000		-1394.	-10.277	-1.639	-1834.	897.	588.03	585.85	583.86	582.11	580.63	579.47	578.63	578.12	577.95
11.7500		-1335.	-9.845	-1.553	-1752.	861.	588.12	586.05	584.15	582.4[illegible]	581.07	579.95	579.14	578.65	578.49
12.0000		-1278.	-9.420	-1.471	-1673.	825.	588.21	586.24	584.43	582.83	581.48	580.41	579.63	579.16	579.00
12.2500		-1222.	-9.005	-1.422	-1597.	790.	588.30	586.4[illegible]	584.69	583.1[illegible]	581.87	580.84	580.10	579.65	579.50
12.5000		-1167.	-8.605	-1.357	-1525.	755.	588.38	586.59	584.94	583.48	582.24	581.25	580.55	580.12	579.97
12.7500		-1115.	-8.229	-1.295	-1455.	722.	588.45	586.7[illegible]	585.17	583.78	582.60	581.66	580.98	580.56	580.43
13.0000		-1065.	-7.850	-1.236	-1389.	690.	588.52	586.87	585.39	584.05	582.94	582.04	581.38	580.99	580.86
13.2500		-1017.	-7.495	-1.140	-1326.	659.	588.59	587.03	585.60	584.33	583.25	582.40	581.79	581.40	581.27
13.5000		-971.	-7.157	-1.126	-1266.	629.	588.65	587.17	585.80	584.59	583.57	582.74	582.15	581.79	581.67
13.7500		-927.	-6.832	-1.075	-1208.	600.	588.72	587.3[illegible]	586.00	584.84	583.86	583.07	582.51	582.16	582.05
14.0000		-885.	-6.523	-1.026	-1153.	573.	588.77	587.42	586.18	585.07	584.14	583.39	582.85	582.52	582.41
14.2500		-845.	-6.227	-.979	-1101.	547.	588.83	587.54	586.35	585.30	584.40	583.69	583.17	582.86	582.75
14.5000		-806.	-5.944	-.935	-1051.	522.	588.88	587.65	586.52	585.51	584.66	583.98	583.48	583.18	583.08
14.7500		-770.	-5.675	-.893	-1003.	499.	588.93	587.75	586.68	585.72	584.90	584.25	583.78	583.49	583.40
15.0000		-735.	-5.417	-.352	-958.	475.	588.98	587.85	586.83	585.91	585.13	584.51	584.06	583.79	583.70
15.2500		-559.	-4.147	-.548	-483.	404.	587.25	587.31	586.78	586.05	585.34	584.76	584.33	584.07	583.98
15.5000		-287.	-2.119	1.351	74.	269.	584.97	586.05	586.22	585.91	585.43	584.95	584.57	584.33	584.25
15.7500		64.	.325	2.119	624.	91.	582.52	584.45	585.30	585.48	585.31	585.01	584.75	584.56	584.49
16.0000		398.	2.931	2.747	1165.	-111.	579.97	582.66	584.14	584.81	585.01	584.96	584.83	584.71	584.67
16.2500		758.	5.588	3.278	1684.	-327.	577.35	580.72	582.80	583.96	584.53	584.75	584.79	584.78	584.76
16.5000		1116.	8.231	3.740	2182.	-547.	574.69	578.67	581.32	582.96	583.90	584.40	584.63	584.73	584.75
16.7500		1468.	10.820	4.134	2658.	-769.	571.94	576.57	579.74	581.83	583.14	583.92	584.35	584.55	584.61
17.0000		1809.	13.334	4.530	3114.	-986.	569.25	574.39	578.05	580.58	582.25	583.31	583.94	584.26	584.35
17.2500		2134.	15.760	4.877	3550.	-1195.	566.49	572.15	576.29	579.23	581.25	582.58	583.40	583.84	583.98
17.5000		2455.	18.092	5.206	3967.	-1399.	563.71	569.85	574.45	577.79	580.14	581.74	582.75	583.30	583.48
17.7500		2758.	20.327	5.504	4364.	-1594.	560.90	567.51	572.54	576.26	578.94	580.78	581.98	582.64	582.85
18.0000		3049.	22.466	5.779	4743.	-1782.	558.07	565.13	570.56	574.65	577.63	579.73	581.10	581.87	582.11
18.2500		3326.	24.510	6.050	5105.	-1962.	555.23	562.71	568.53	572.96	576.24	578.57	580.11	580.98	581.25
18.5000		3592.	26.463	6.317	5450.	-2134.	552.36	560.25	566.44	571.20	574.76	577.31	579.02	579.99	580.30
18.7500		3845.	28.326	6.550	5779.	-2299.	549.48	557.75	564.29	569.37	573.20	575.96	577.82	578.89	579.23
19.0000		4087.	30.103	6.791	6092.	-2455.	546.59	555.22	562.10	567.47	571.56	574.53	576.54	577.69	578.07
19.2500		4317.	31.798	7.010	6391.	-2605.	543.68	552.65	559.85	565.52	569.84	573.01	575.16	576.40	576.81
19.5000		4537.	33.413	7.219	6676.	-2749.	540.75	550.06	557.56	563.50	568.06	571.41	573.70	575.02	575.45
19.7500		4746.	34.953	7.417	6947.	-2884.	537.81	547.41	555.23	561.43	566.21	569.74	572.15	573.56	574.01

Y-11

24 INCH C.S. ELBOW, SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/08/78

TIME	EQUIV RAD	LIN. STR.	DELT1	DELT2	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9
20.0000		4946.	36.419	7.606	7205.	-3014.	534.86	544.74	552.85	559.30	564.29	567.99	570.53	572.01	572.49
20.2500		5078.	37.386	7.320	7263.	-3115.	532.68	542.34	550.52	557.14	562.32	566.17	568.83	570.38	570.88
20.5000		5149.	37.904	7.096	7272.	-3182.	530.72	540.27	548.38	555.05	560.33	564.31	567.06	568.67	569.20
20.7500		5188.	38.193	6.930	7271.	-3224.	528.82	538.29	546.36	553.04	558.38	562.43	565.25	566.91	567.45
21.0000		5216.	38.347	6.827	7265.	-3250.	526.96	536.35	544.40	551.08	556.45	560.54	563.01	565.10	565.66
21.2500		5219.	38.417	6.757	7256.	-3264.	525.11	534.47	542.48	549.16	554.55	558.66	561.56	563.27	563.83
21.5000		5222.	38.435	6.709	7246.	-3271.	523.28	532.60	540.59	547.27	552.65	556.78	559.69	561.41	561.99
21.7500		5221.	38.420	6.674	7235.	-3274.	521.45	530.73	538.72	545.38	550.77	554.90	557.82	559.55	560.12
22.0000		5216.	38.386	6.649	7223.	-3273.	519.63	528.90	536.86	543.51	548.89	553.03	555.95	557.68	558.25
22.2500		5210.	38.339	6.628	7211.	-3270.	517.81	527.06	535.00	541.64	547.02	551.15	554.07	555.80	556.37
22.5000		5203.	38.284	6.611	7200.	-3267.	515.99	525.23	533.15	539.78	545.15	549.28	552.19	553.92	554.49
22.7500		5196.	38.226	6.596	7188.	-3262.	514.17	523.39	531.30	537.92	543.28	547.40	550.32	552.05	552.61
23.0000		5188.	38.164	6.583	7176.	-3259.	512.36	521.55	529.45	536.06	541.41	545.53	548.44	550.17	550.74
23.2500		5179.	38.102	6.571	7165.	-3253.	510.54	519.71	527.61	534.21	539.55	543.66	546.56	548.29	548.86
23.5000		5171.	38.039	6.560	7153.	-3249.	508.73	517.91	525.76	532.35	537.68	541.79	544.69	546.41	546.98
23.7500		5163.	37.976	6.549	7142.	-3242.	506.91	516.07	523.92	530.50	535.82	539.92	542.82	544.53	545.10
24.0000		5155.	37.913	6.539	7130.	-3237.	505.10	514.24	522.08	528.64	533.96	538.05	540.94	542.66	543.22
24.2500		5146.	37.851	6.529	7119.	-3232.	503.29	512.41	520.24	526.79	532.10	536.18	539.07	540.78	541.35
24.5000		5138.	37.789	6.519	7108.	-3227.	501.47	510.58	518.40	524.94	530.24	534.32	537.20	538.91	539.47
24.7500		5130.	37.728	6.509	7097.	-3222.	499.65	508.75	516.56	523.09	528.38	532.45	535.33	537.03	537.60
25.0000		5122.	37.668	6.499	7086.	-3217.	497.84	506.91	514.72	521.24	526.52	530.58	533.45	535.16	535.72
25.2500		5114.	37.608	6.489	7075.	-3212.	496.03	505.11	512.88	519.39	524.66	528.72	531.59	533.29	533.85
25.5000		5107.	37.549	6.480	7065.	-3207.	494.21	503.27	511.04	517.54	522.80	526.86	529.72	531.42	531.98
25.7500		5099.	37.491	6.470	7054.	-3202.	492.40	501.44	509.20	515.69	520.95	524.99	527.85	529.55	530.11
26.0000		5091.	37.433	6.461	7044.	-3197.	490.59	499.62	507.36	513.84	519.09	523.13	525.98	527.68	528.23
26.2500		5084.	37.376	6.452	7033.	-3192.	488.77	497.79	505.52	512.00	517.23	521.27	524.12	525.81	526.36
26.5000		5076.	37.319	6.442	7023.	-3187.	486.96	495.95	503.68	510.15	515.38	519.41	522.25	523.94	524.49
26.7500		5068.	37.263	6.433	7013.	-3183.	485.15	494.16	501.85	508.30	513.52	517.54	520.38	522.07	522.63
27.0000		5061.	37.207	6.424	7003.	-3178.	483.33	492.31	500.01	506.45	511.67	515.68	518.52	520.20	520.76
27.2500		5054.	37.152	6.415	6993.	-3173.	481.52	490.44	498.17	504.61	509.82	513.82	516.65	518.34	518.89
27.5000		5046.	37.098	6.406	6983.	-3169.	479.71	488.65	496.34	502.76	507.96	511.96	514.79	516.47	517.02
27.7500		5039.	37.044	6.398	6973.	-3164.	477.90	486.84	494.50	500.92	506.11	510.10	512.93	514.60	515.16
28.0000		5032.	36.990	6.389	6963.	-3160.	476.09	485.01	492.67	499.07	504.26	508.25	511.07	512.74	513.29
28.2500		5025.	36.937	6.380	6953.	-3155.	474.27	483.19	490.83	497.23	502.40	506.39	509.20	510.87	511.42
28.5000		5018.	36.884	6.372	6944.	-3151.	472.46	481.36	488.99	495.38	500.55	504.53	507.34	509.01	509.56
28.7500		5011.	36.832	6.363	6934.	-3146.	470.65	479.54	487.16	493.54	498.70	502.67	505.48	507.15	507.69
29.0000		5004.	36.780	6.355	6925.	-3142.	468.83	477.71	485.32	491.69	496.85	500.82	503.62	505.28	505.83
29.2500		4997.	36.729	6.346	6915.	-3137.	467.02	475.89	483.49	489.85	495.00	498.96	501.76	503.42	503.97
29.5000		4990.	36.678	6.338	6906.	-3133.	465.21	474.07	481.66	488.01	493.15	497.10	499.90	501.56	502.10
29.7500		4983.	36.627	6.329	6896.	-3129.	463.40	472.25	479.82	486.17	491.30	495.25	498.04	499.70	500.24

28 INCH C.S. ELBOW. SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/08/78

TIME	EQUIV RAD	LIN. STR.	DELT1	DELT2	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9
30.0000		4976.	35.577	6.321	6887.	-3124.	461.59	470.42	477.99	484.32	489.45	493.39	496.18	497.83	493.38
30.2500		4969.	36.527	6.313	6878.	-3120.	459.77	468.59	476.15	482.48	487.60	491.54	494.32	495.97	495.52
30.5000		4963.	35.478	6.305	6868.	-3115.	457.96	466.77	474.32	480.64	485.75	489.69	492.46	494.11	494.66
30.7500		4956.	36.429	6.297	6859.	-3112.	456.15	464.95	472.49	478.80	483.90	487.83	490.51	492.25	492.80
31.0000		4949.	36.380	6.289	6850.	-3107.	454.34	463.12	470.65	476.96	482.05	485.98	488.75	490.39	490.94
31.2500		4943.	36.332	6.280	6841.	-3103.	452.53	461.30	468.82	475.11	480.21	484.12	486.89	488.53	489.04
31.5000		4936.	36.283	6.272	6832.	-3099.	450.72	459.48	466.99	473.27	478.36	482.27	485.03	486.67	487.22
31.7500		4930.	36.236	6.265	6823.	-3095.	448.90	457.66	465.16	471.43	476.51	480.42	483.18	484.82	485.36
32.0000		4923.	36.188	6.257	6814.	-3091.	447.09	455.81	463.32	469.59	474.66	478.57	481.32	482.96	483.50
32.2500		4917.	36.141	6.249	6805.	-3087.	445.28	454.01	461.49	467.75	472.82	476.71	479.47	481.10	481.64
32.5000		4910.	36.094	6.241	6796.	-3083.	443.47	452.19	459.66	465.91	470.97	474.86	477.61	479.24	479.78
32.7500		4904.	35.047	6.233	6787.	-3079.	441.66	450.37	457.83	464.07	469.12	473.01	475.76	477.39	477.92
33.0000		4897.	36.001	6.225	6779.	-3074.	439.85	448.55	456.00	462.23	467.28	471.16	473.90	475.53	476.06
33.2500		4891.	35.954	6.218	6770.	-3070.	438.04	446.72	454.16	460.39	465.43	469.31	472.05	473.67	474.21
33.5000		4884.	35.908	6.210	6761.	-3066.	436.23	444.90	452.33	458.55	463.58	467.46	470.19	471.81	472.35
33.7500		4878.	35.863	6.202	6752.	-3062.	434.41	443.08	450.50	456.71	461.74	465.61	468.34	469.96	470.49
34.0000		4872.	35.817	6.195	6744.	-3058.	432.60	441.25	448.67	454.87	459.89	463.76	466.48	468.10	468.64
34.2500		4865.	35.772	6.187	6735.	-3054.	430.79	439.43	446.84	453.03	458.05	461.91	464.63	466.25	466.78
34.5000		4859.	35.727	6.180	6726.	-3050.	428.98	437.61	445.01	451.20	456.20	460.06	462.78	464.39	464.92
34.7500		4853.	35.682	6.172	6718.	-3046.	427.17	435.79	443.18	449.36	454.35	458.21	460.92	462.54	463.07
35.0000		4847.	35.637	6.165	6709.	-3043.	425.36	433.97	441.35	447.52	452.51	456.36	459.07	460.64	461.21
35.2500		4840.	35.593	6.157	6701.	-3039.	423.55	432.15	439.52	445.68	450.67	454.51	457.22	458.83	459.36
35.5000		4834.	35.549	6.150	6692.	-3035.	421.74	430.33	437.68	443.84	448.83	452.66	455.36	456.97	457.50
35.7500		4828.	35.505	6.142	6684.	-3031.	419.93	428.51	435.85	442.00	446.98	450.81	453.51	455.12	455.65
36.0000		4822.	35.461	6.135	6675.	-3027.	418.12	426.69	434.02	440.17	445.14	448.96	451.66	453.26	453.79
36.2500		4816.	35.417	6.127	6667.	-3023.	416.30	424.86	432.19	438.33	443.29	447.11	449.81	451.41	451.94
36.5000		4810.	35.374	6.120	6658.	-3019.	414.49	423.04	430.36	436.49	441.45	445.26	447.96	449.55	450.08
36.7500		4803.	35.330	6.113	6650.	-3015.	412.68	421.22	428.53	434.65	439.61	443.41	446.10	447.70	448.23
37.0000		4797.	35.287	6.106	6641.	-3011.	410.87	419.41	426.70	432.82	437.76	441.57	444.25	445.85	446.37
37.2500		4791.	35.244	6.098	6633.	-3008.	409.06	417.54	424.87	430.98	435.92	439.72	442.40	443.99	444.52
37.5000		4785.	35.201	6.091	6624.	-3004.	407.25	415.76	423.04	429.14	434.08	437.87	440.55	442.14	442.67
37.7500		4779.	35.159	6.084	6616.	-3000.	405.44	413.94	421.21	427.31	432.23	436.02	438.70	440.29	440.81
38.0000		4773.	35.116	6.077	6608.	-2996.	403.63	412.11	419.39	425.47	430.39	434.18	436.85	438.44	438.96
38.2500		4767.	35.074	6.069	6599.	-2992.	401.82	410.29	417.56	423.63	428.55	432.33	435.00	436.58	437.11
38.5000		4761.	35.032	6.062	6591.	-2988.	400.01	408.47	415.73	421.79	426.70	430.48	433.15	434.73	435.25
38.7500		4755.	34.989	6.055	6583.	-2985.	398.20	406.65	413.90	419.96	424.86	428.63	431.30	432.88	433.40
39.0000		4749.	34.947	6.048	6574.	-2981.	396.39	404.83	412.07	418.12	423.02	426.79	429.45	431.03	431.55
39.2500		4743.	34.906	6.041	6565.	-2977.	394.58	403.01	410.24	416.29	421.18	424.94	427.60	429.17	429.69
39.5000		4737.	34.864	6.034	6558.	-2973.	392.77	401.19	408.41	414.45	419.34	423.09	425.75	427.32	427.84
39.7500		4731.	34.822	6.027	6550.	-2970.	390.96	399.37	406.58	412.61	417.49	421.25	423.90	425.47	425.99

28 INCH S.S. PIPE, SYUD COOLDOWN INCIDENT TRANSIENT DATE 05/08/78

DIMENSIONS

INSIDE RADIUS = 14.0000 INCHES OUTSIDE RADIUS = 16.7500 INCHES REF A-2

NO. OF NODES = 9 RADIAL INCREMENT = .3438 INCHES

MATERIAL CODE = 3 POISSON S RATIO = .3000

L = 0.0000

INITIAL CONDITIONS

NODE	RADIUS	TEMPERATURE
1	14.0000	570.0
2	14.3438	570.0
3	14.6875	570.0
4	15.0313	570.0
5	15.3750	570.0
6	15.7188	570.0
7	16.0625	570.0
8	16.4063	570.0
9	16.7500	570.0

28 INCH S.S. PIPE. SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/08/78

TABULATION OF BOUNDARY CONDITIONS

FLUID TEMP. CURVE APPROXIMATION			FILM COEFF. CURVE APPROXIMATION			PRESSURE CURVE APPROXIMATION	
TIME (MINUTES)	INSIDE FLUID TEMPERATURE		TIME (MINUTES)	INSIDE FILM COEFFICIENT		TIME (MINUTES)	PRESSURE (PSI)
0.0000	570.0	REF PG A-5	0.0000	6520.0	REF PG Y-6	0.0000	0.
5.0000	570.0		5.0000	6520.0		0.0000	0.
10.0000	590.0		10.0000	6435.0		0.0000	0.
15.0000	540.0		15.0000	6435.0		0.0000	0.
20.0000	525.0		20.0000	6675.0		0.0000	0.
40.0000	380.0		40.0000	6555.0		0.0000	0.
60.0000	300.0		60.0000	6134.0		0.0000	0.
80.0000	240.0		90.0000	5995.0		0.0000	0.
95.0000	245.0		95.0000	6035.0		0.0000	0.
110.0000	305.0		110.0000	6170.0		0.0000	0.

TEMPERATURE CALCULATION TIMES AND PRINTOUTS

TIME INCREMENT (MINUTES)	TIME LIMIT (MINUTES)	NUMBER OF PRINTOUTS
.2500	110.000	440.

28 INCH S.S. PIPE, SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/08/78

THERMAL PROPERTIES

TIME	INSIDE FLUID TEMP.	INSIDE FILM COEFF.	AVE. TEMP.	CONDUC-TIVITY	SPECIFIC HEAT	YOUNGS MODULUS	COEFF. OF EXPANS.	DENSITY
30.000	453.	6615.	495.9992	128.2492	.1276	2.61E+07	.95E-05	488.5717
30.250	451.	6614.	494.2989	128.1920	.1276	2.61E+07	.95E-05	488.5969
30.500	449.	6612.	493.5956	128.1346	.1275	2.61E+07	.95E-05	488.6222
30.750	447.	6611.	491.8896	127.9971	.1274	2.61E+07	.95E-05	488.6475
31.000	445.	6609.	490.1408	127.8996	.1274	2.61E+07	.95E-05	488.6729
31.250	443.	6608.	488.4695	127.8015	.1273	2.61E+07	.95E-05	488.6983
31.500	442.	6606.	486.7555	127.7015	.1273	2.61E+07	.95E-05	488.7238
31.750	440.	6605.	485.0391	127.6054	.1272	2.61E+07	.95E-05	488.7492
32.000	438.	6603.	483.3203	127.5071	.1272	2.61E+07	.95E-05	488.7748
32.250	436.	6602.	481.5991	127.4087	.1271	2.62E+07	.95E-05	488.8003
32.500	434.	6600.	479.8757	127.3102	.1270	2.62E+07	.95E-05	488.8259
32.750	433.	6599.	478.1501	127.2115	.1270	2.62E+07	.95E-05	488.8515
33.000	431.	6597.	476.4223	127.1127	.1269	2.62E+07	.95E-05	488.8772
33.250	429.	6596.	474.6925	127.0139	.1269	2.62E+07	.95E-05	488.9029
33.500	427.	6594.	472.9606	126.9148	.1268	2.62E+07	.95E-05	488.9286
33.750	425.	6593.	471.2268	126.8157	.1267	2.62E+07	.95E-05	488.9543
34.000	424.	6591.	469.4912	126.7166	.1267	2.62E+07	.95E-05	488.9801
34.250	422.	6590.	467.7536	126.6171	.1266	2.62E+07	.95E-05	489.0059
34.500	420.	6588.	466.0143	126.5176	.1266	2.62E+07	.95E-05	489.0317
34.750	418.	6587.	464.2733	126.4181	.1265	2.63E+07	.95E-05	489.0576
35.000	416.	6585.	462.5305	126.3184	.1264	2.63E+07	.95E-05	489.0835
35.250	414.	6584.	460.7862	126.2187	.1264	2.63E+07	.95E-05	489.1094
35.500	413.	6582.	459.0402	126.1189	.1263	2.63E+07	.95E-05	489.1353
35.750	411.	6581.	457.2927	126.0190	.1262	2.63E+07	.95E-05	489.1613
36.000	409.	6579.	455.5437	125.9190	.1262	2.63E+07	.95E-05	489.1872
36.250	407.	6578.	453.7932	125.8189	.1261	2.63E+07	.95E-05	489.2132
36.500	405.	6576.	452.0413	125.7187	.1260	2.63E+07	.95E-05	489.2392
36.750	404.	6575.	450.2881	125.6183	.1260	2.63E+07	.95E-05	489.2653
37.000	402.	6573.	448.5335	125.5181	.1259	2.63E+07	.95E-05	489.2913
37.250	400.	6572.	446.7776	125.4177	.1258	2.64E+07	.94E-05	489.3174
37.500	398.	6570.	445.0204	125.3173	.1258	2.64E+07	.94E-05	489.3435
37.750	396.	6569.	443.2620	125.2167	.1257	2.64E+07	.94E-05	489.3696
38.000	395.	6567.	441.5024	125.1161	.1256	2.64E+07	.94E-05	489.3957
38.250	393.	6566.	439.7416	125.0155	.1255	2.64E+07	.94E-05	489.4219
38.500	391.	6564.	437.9797	124.9147	.1255	2.64E+07	.94E-05	489.4480
38.750	389.	6563.	436.2167	124.8139	.1254	2.64E+07	.94E-05	489.4742
39.000	387.	6561.	434.4526	124.7130	.1253	2.64E+07	.94E-05	489.5004
39.250	385.	6560.	432.6875	124.6121	.1253	2.64E+07	.94E-05	489.5266
39.500	384.	6558.	430.9213	124.5111	.1252	2.64E+07	.94E-05	489.5528
39.750	382.	6557.	429.1542	124.4101	.1251	2.64E+07	.94E-05	489.5791

28 INCH S.S. PIPE, SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/08/78

THERMAL PROPERTIES

TIME	INSIDE FLUID TEMP.	INSIDE FILM COEFF.	AVE. TEMP.	CONDUC-TIVITY	SPECIFIC HEAT	YOUNGS MODULUS	COEFF. OF EXPANS.	DENSITY
40.000	380.	6555.	427.3961	24.3099	.1250	2.65E+07	.94E-05	489.6053
40.250	379.	6550.	425.7003	24.2125	.1250	2.65E+07	.94E-05	489.6304
40.500	378.	6544.	424.0617	24.1189	.1249	2.65E+07	.94E-05	489.6547
40.750	377.	6539.	422.4572	24.0272	.1248	2.65E+07	.94E-05	489.6785
41.000	376.	6534.	420.8806	23.9371	.1248	2.65E+07	.94E-05	489.7019
41.250	375.	6529.	419.3282	23.8483	.1247	2.65E+07	.94E-05	489.7250
41.500	374.	6523.	417.7972	23.7608	.1246	2.65E+07	.94E-05	489.7477
41.750	373.	6518.	416.2859	23.6743	.1246	2.65E+07	.94E-05	489.7702
42.000	372.	6513.	414.7727	23.5890	.1245	2.65E+07	.94E-05	489.7923
42.250	371.	6508.	413.3164	23.5045	.1244	2.65E+07	.94E-05	489.8143
42.500	370.	6502.	411.8560	23.4211	.1244	2.65E+07	.94E-05	489.8359
42.750	369.	6497.	410.4106	23.3385	.1243	2.65E+07	.94E-05	489.8574
43.000	368.	6492.	408.9796	23.2565	.1242	2.66E+07	.94E-05	489.8787
43.250	367.	6487.	407.5623	23.1756	.1242	2.66E+07	.94E-05	489.8997
43.500	366.	6481.	406.1542	23.0953	.1241	2.66E+07	.94E-05	489.9206
43.750	365.	6476.	404.7666	23.0157	.1240	2.66E+07	.94E-05	489.9412
44.000	364.	6471.	403.3873	22.9369	.1240	2.66E+07	.94E-05	489.9617
44.250	363.	6466.	402.0196	22.8587	.1239	2.66E+07	.94E-05	489.9820
44.500	362.	6460.	400.6633	22.7811	.1238	2.66E+07	.94E-05	490.0021
44.750	361.	6455.	399.3174	22.7042	.1238	2.66E+07	.94E-05	490.0221
45.000	360.	6450.	397.9830	22.6279	.1237	2.66E+07	.94E-05	490.0419
45.250	359.	6444.	396.6595	22.5521	.1237	2.66E+07	.94E-05	490.0616
45.500	358.	6439.	395.3438	22.4770	.1236	2.66E+07	.94E-05	490.0811
45.750	357.	6434.	394.0387	22.4023	.1235	2.66E+07	.94E-05	490.1005
46.000	356.	6429.	392.7429	22.3283	.1235	2.66E+07	.94E-05	490.1198
46.250	355.	6423.	391.4561	22.2547	.1234	2.67E+07	.94E-05	490.1389
46.500	354.	6418.	390.1780	22.1815	.1234	2.67E+07	.94E-05	490.1578
46.750	353.	6413.	388.9084	22.1090	.1233	2.67E+07	.94E-05	490.1767
47.000	352.	6408.	387.6469	22.0369	.1232	2.67E+07	.94E-05	490.1954
47.250	351.	6402.	386.3934	21.9652	.1232	2.67E+07	.94E-05	490.2140
47.500	350.	6397.	385.1475	21.8940	.1231	2.67E+07	.94E-05	490.2325
47.750	349.	6392.	383.9091	21.8232	.1231	2.67E+07	.94E-05	490.2509
48.000	348.	6387.	382.6782	21.7529	.1230	2.67E+07	.94E-05	490.2692
48.250	347.	6381.	381.4541	21.6829	.1229	2.67E+07	.94E-05	490.2874
48.500	346.	6376.	380.2368	21.6132	.1229	2.67E+07	.94E-05	490.3055
48.750	345.	6371.	379.0261	21.5440	.1228	2.67E+07	.93E-05	490.3234
49.000	344.	6366.	377.8219	21.4751	.1228	2.67E+07	.93E-05	490.3413
49.250	343.	6360.	376.6238	21.4066	.1227	2.67E+07	.93E-05	490.3591
49.500	342.	6355.	375.4317	21.3385	.1226	2.67E+07	.93E-05	490.3768
49.750	341.	6350.	374.2456	21.2706	.1226	2.67E+07	.93E-05	490.3944

28 INCH S.S. PIPE, SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/08/78

THERMAL PROPERTIES

TIME	INSIDE FLUID TEMP.	INSIDE FILM COEFF.	AVE. TEMP.	CONDUC-TIVITY	SPECIFIC HEAT	YOUNGS MODULUS	COEFF. OF EXPANS.	DENSITY
50.000	340.	6345.	373.0648	121.2031	.1225	2.68E+07	.93E-05	490.4120
50.250	339.	6339.	371.8497	121.1160	.1225	2.68E+07	.93E-05	490.4294
50.500	338.	6334.	370.7199	121.0491	.1224	2.68E+07	.93E-05	490.4468
50.750	337.	6329.	369.5552	121.0025	.1223	2.68E+07	.93E-05	490.4641
51.000	336.	6323.	368.3956	120.9362	.1223	2.68E+07	.93E-05	490.4813
51.250	335.	6318.	367.2404	120.8701	.1222	2.68E+07	.93E-05	490.4984
51.500	334.	6313.	366.0907	120.8044	.1222	2.68E+07	.93E-05	490.5153
51.750	333.	6308.	364.9451	120.7389	.1221	2.68E+07	.93E-05	490.5325
52.000	332.	6302.	363.8040	120.6735	.1220	2.68E+07	.93E-05	490.5495
52.250	331.	6297.	362.6671	120.6085	.1220	2.68E+07	.93E-05	490.5664
52.500	330.	6292.	361.5344	120.5439	.1219	2.68E+07	.93E-05	490.5832
52.750	329.	6287.	360.4058	120.4793	.1219	2.68E+07	.93E-05	490.5999
53.000	328.	6281.	359.2810	120.4150	.1218	2.69E+07	.93E-05	490.6166
53.250	327.	6276.	358.1600	120.3509	.1218	2.69E+07	.93E-05	490.6333
53.500	326.	6271.	357.0427	120.2871	.1217	2.69E+07	.93E-05	490.6499
53.750	325.	6266.	355.9290	120.2234	.1216	2.69E+07	.93E-05	490.6664
54.000	324.	6260.	354.8187	120.1597	.1216	2.69E+07	.93E-05	490.6829
54.250	323.	6255.	353.7114	120.0966	.1215	2.69E+07	.93E-05	490.6993
54.500	322.	6250.	352.6081	120.0335	.1215	2.69E+07	.93E-05	490.7157
54.750	321.	6245.	351.5076	119.9706	.1214	2.69E+07	.93E-05	490.7321
55.000	320.	6239.	350.4101	119.9078	.1213	2.69E+07	.93E-05	490.7484
55.250	319.	6234.	349.3156	119.8453	.1213	2.69E+07	.93E-05	490.7646
55.500	318.	6229.	348.2240	119.7828	.1212	2.69E+07	.93E-05	490.7808
55.750	317.	6223.	347.1352	119.7206	.1212	2.69E+07	.93E-05	490.7970
56.000	316.	6218.	346.0490	119.6585	.1211	2.69E+07	.93E-05	490.8131
56.250	315.	6213.	344.9655	119.5965	.1210	2.69E+07	.93E-05	490.8292
56.500	314.	6208.	343.8845	119.5347	.1210	2.69E+07	.93E-05	490.8453
56.750	313.	6202.	342.8060	119.4731	.1209	2.69E+07	.93E-05	490.8613
57.000	312.	6197.	341.7299	119.4115	.1209	2.69E+07	.93E-05	490.8772
57.250	311.	6192.	340.6551	119.3501	.1208	2.69E+07	.93E-05	490.8932
57.500	310.	6187.	339.5845	119.2889	.1208	2.69E+07	.93E-05	490.9091
57.750	309.	6181.	338.5151	119.2277	.1207	2.69E+07	.93E-05	490.9250
58.000	308.	6176.	337.4478	119.1667	.1206	2.70E+07	.93E-05	490.9408
58.250	307.	6171.	336.3826	119.1058	.1206	2.70E+07	.93E-05	490.9567
58.500	306.	6166.	335.3196	119.0450	.1205	2.70E+07	.93E-05	490.9724
58.750	305.	6160.	334.2581	118.9843	.1205	2.70E+07	.93E-05	490.9882
59.000	304.	6155.	333.1986	118.9238	.1204	2.70E+07	.93E-05	491.0039
59.250	303.	6150.	332.1410	118.8633	.1203	2.70E+07	.93E-05	491.0196
59.500	302.	6145.	331.0851	118.8029	.1203	2.70E+07	.93E-05	491.0353
59.750	301.	6139.	330.0310	118.7425	.1202	2.70E+07	.93E-05	491.0510

28 INCH S.S. PIPE. SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/08/78

THERMAL PROPERTIES

TIME	INSIDE FLUID TEMP.	INSIDE FILM COEFF.	AVE. TEMP.	CONDUC-TIVITY	SPECIFIC HEAT	YOUNGS MODULUS	COEFF. OF EXPANS.	DENSITY
60.000	300.	6134.	328.3786	118.5925	.1202	2.70E+07	.91E-05	491.0666
60.250	300.	6132.	328.0060	118.6267	.1201	2.70E+07	.91E-05	491.0811
60.500	300.	6131.	327.0752	118.5736	.1201	2.70E+07	.91E-05	491.0949
60.750	299.	6129.	326.1408	118.5225	.1200	2.70E+07	.91E-05	491.1081
61.000	299.	6127.	325.3128	118.4729	.1200	2.70E+07	.91E-05	491.1210
61.250	299.	6125.	324.6649	118.4247	.1199	2.70E+07	.91E-05	491.1335
61.500	299.	6124.	323.8490	118.3777	.1199	2.70E+07	.91E-05	491.1457
61.750	298.	6122.	322.8481	118.3319	.1198	2.70E+07	.91E-05	491.1576
62.000	298.	6120.	322.0659	118.2872	.1198	2.70E+07	.91E-05	491.1692
62.250	298.	6118.	321.3012	118.2435	.1197	2.70E+07	.91E-05	491.1806
62.500	298.	6117.	320.5531	118.2007	.1197	2.70E+07	.91E-05	491.1917
62.750	297.	6115.	319.8206	118.1589	.1196	2.70E+07	.92E-05	491.2026
63.000	297.	6113.	319.1032	118.1178	.1196	2.71E+07	.92E-05	491.2132
63.250	297.	6111.	318.4002	118.0776	.1196	2.71E+07	.92E-05	491.2237
63.500	297.	6110.	317.7110	118.0382	.1195	2.71E+07	.92E-05	491.2339
63.750	296.	6108.	317.0351	117.9996	.1195	2.71E+07	.92E-05	491.2439
64.000	296.	6106.	316.3720	117.9617	.1194	2.71E+07	.92E-05	491.2538
64.250	296.	6104.	315.7213	117.9245	.1194	2.71E+07	.92E-05	491.2635
64.500	296.	6103.	315.0826	117.8879	.1194	2.71E+07	.92E-05	491.2729
64.750	295.	6101.	314.4555	117.8521	.1193	2.71E+07	.92E-05	491.2822
65.000	295.	6099.	313.8396	117.8169	.1193	2.71E+07	.92E-05	491.2914
65.250	295.	6098.	313.2346	117.7823	.1193	2.71E+07	.92E-05	491.3004
65.500	295.	6096.	312.6401	117.7483	.1192	2.71E+07	.92E-05	491.3092
65.750	294.	6094.	312.0558	117.7149	.1192	2.71E+07	.92E-05	491.3179
66.000	294.	6092.	311.4814	117.6820	.1191	2.71E+07	.92E-05	491.3264
66.250	294.	6091.	310.9167	117.6498	.1191	2.71E+07	.92E-05	491.3348
66.500	294.	6089.	310.3612	117.6180	.1191	2.71E+07	.92E-05	491.3430
66.750	293.	6087.	309.8148	117.5868	.1190	2.71E+07	.92E-05	491.3512
67.000	293.	6085.	309.2771	117.5560	.1190	2.71E+07	.92E-05	491.3591
67.250	293.	6084.	308.7480	117.5258	.1190	2.71E+07	.92E-05	491.3670
67.500	293.	6082.	308.2271	117.4960	.1190	2.71E+07	.92E-05	491.3747
67.750	292.	6080.	307.7142	117.4668	.1189	2.71E+07	.92E-05	491.3823
68.000	292.	6078.	307.2090	117.4379	.1189	2.71E+07	.92E-05	491.3899
68.250	292.	6077.	306.7114	117.4093	.1189	2.71E+07	.92E-05	491.3972
68.500	292.	6075.	306.2211	117.3813	.1188	2.71E+07	.92E-05	491.4045
68.750	291.	6073.	305.7379	117.3537	.1188	2.71E+07	.92E-05	491.4117
69.000	291.	6071.	305.2616	117.3266	.1188	2.71E+07	.92E-05	491.4188
69.250	291.	6070.	304.7920	117.2996	.1187	2.71E+07	.92E-05	491.4257
69.500	291.	6068.	304.3289	117.2731	.1187	2.71E+07	.92E-05	491.4326
69.750	290.	6066.	303.8720	117.2470	.1187	2.71E+07	.92E-05	491.4394

28 INCH S.S. PIPE. SHUD COOLDOWN INCIDENT TRANSIENT DATE 05/08/78

TIME	EQUIV RAD	LIN. STR.	DELT1	DELT2	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9
.2500		-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
.5000		-0.	-.000	-.000	-0.	0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
.7500		-0.	-.000	-.000	-0.	0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
1.0000		-0.	-.000	-.000	-0.	0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
1.2500		-0.	-.000	.000	-0.	0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
1.5000		-0.	-.000	.000	-0.	0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
1.7500		-0.	-.000	.000	-0.	0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
2.0000		-0.	-.000	.000	-0.	0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
2.2500		-0.	-.000	.000	-0.	0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
2.5000		-0.	-.000	.000	-0.	0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
2.7500		-0.	-.000	.000	-0.	0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
3.0000		-0.	-.000	.000	-0.	0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
3.2500		-0.	-.000	.000	-0.	0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
3.5000		-0.	-.000	.000	-0.	0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
3.7500		-0.	-.000	.000	-0.	0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
4.0000		-0.	-.000	.000	-0.	0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
4.2500		-0.	-.000	.000	-0.	0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
4.5000		-0.	-.000	.000	-0.	0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
4.7500		-0.	-.000	.000	-0.	0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
5.0000		-0.	-.000	.000	-0.	0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
5.2500		-81.	-.461	-.662	-313.	30.	570.93	570.27	570.06	570.01	570.00	570.00	570.00	570.00	570.00
5.5000		-203.	-1.156	-1.102	-603.	82.	571.95	570.78	570.27	570.04	570.02	570.01	570.00	570.00	570.00
5.7500		-366.	-1.967	-1.468	-890.	149.	572.92	571.33	570.59	570.23	570.08	570.03	570.01	570.00	570.00
6.0000		-500.	-2.841	-1.758	-1145.	227.	573.91	572.05	571.00	570.45	570.19	570.07	570.03	570.01	570.01
6.2500		-660.	-3.751	-2.021	-1400.	314.	574.85	572.75	571.45	570.72	570.33	570.15	570.06	570.03	570.02
6.5000		-823.	-4.679	-2.239	-1645.	407.	575.87	573.47	571.95	571.04	570.52	570.25	570.11	570.05	570.04
6.7500		-987.	-5.610	-2.430	-1883.	503.	576.86	574.22	572.48	571.39	570.75	570.38	570.19	570.10	570.08
7.0000		-1150.	-6.537	-2.601	-2111.	602.	577.84	574.99	573.04	571.78	571.00	570.54	570.29	570.17	570.13
7.2500		-1311.	-7.453	-2.755	-2332.	702.	578.83	575.75	573.62	572.20	571.29	570.73	570.41	570.25	570.21
7.5000		-1469.	-8.355	-2.897	-2545.	801.	579.82	576.55	574.23	572.64	571.60	570.95	570.56	570.36	570.30
7.7500		-1625.	-9.239	-3.028	-2753.	900.	580.81	577.36	574.85	573.11	571.94	571.19	570.73	570.50	570.42
8.0000		-1777.	-10.103	-3.151	-2953.	997.	581.80	578.15	575.48	573.60	572.30	571.45	570.93	570.65	570.55
8.2500		-1925.	-10.946	-3.257	-3147.	1093.	582.78	578.95	576.13	574.10	572.69	571.74	571.15	570.83	570.73
8.5000		-2069.	-11.767	-3.375	-3335.	1186.	583.77	579.78	576.80	574.62	573.09	572.05	571.39	571.03	570.92
8.7500		-2209.	-12.556	-3.491	-3517.	1277.	584.76	580.61	577.47	575.16	573.51	572.38	571.66	571.26	571.13
9.0000		-2345.	-13.347	-3.590	-3693.	1365.	585.75	581.44	578.16	575.72	573.96	572.74	571.95	571.51	571.37
9.2500		-2478.	-14.096	-3.676	-3863.	1452.	586.74	582.28	578.85	576.28	574.42	573.11	572.26	571.78	571.63
9.5000		-2607.	-14.828	-3.768	-4028.	1537.	587.73	583.12	579.56	576.87	574.89	573.50	572.59	572.07	571.91
9.7500		-2732.	-15.539	-3.856	-4188.	1618.	588.73	583.97	580.27	577.46	575.39	573.91	572.94	572.39	572.21

28 INCH S.S. PIPE. SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/08/78

TIME	EQUIV LIN. RAD STR.	DELT1	DELT2	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9
10.0000	-2853.	-16.228	-3.941	-4343.	1699.	589.72	584.83	581.00	578.07	575.90	574.34	573.31	572.72	572.53
10.2500	-2889.	-16.436	-3.394	-4181.	1745.	589.74	585.42	581.68	578.68	576.42	574.79	573.70	573.08	572.88
10.5000	-2890.	-16.389	-3.003	-4037.	1769.	589.76	585.77	582.21	579.24	576.94	575.25	574.11	573.45	573.24
10.7500	-2949.	-16.207	-2.777	-3902.	1773.	589.77	586.03	582.63	579.74	577.43	575.71	574.53	573.85	573.63
11.0000	-2902.	-15.942	-2.674	-3774.	1765.	589.78	586.24	582.90	580.18	577.90	576.16	574.95	574.25	574.02
11.2500	-2745.	-15.622	-2.573	-3652.	1745.	589.79	586.41	583.30	580.57	578.33	576.59	575.38	574.67	574.43
11.5000	-2583.	-15.267	-2.479	-3535.	1720.	589.80	586.57	583.57	580.93	578.73	577.02	575.81	575.09	574.85
11.7500	-2617.	-14.891	-2.370	-3423.	1547.	589.81	586.71	583.82	581.26	579.11	577.43	576.22	575.51	575.27
12.0000	-2549.	-14.502	-2.307	-3315.	1650.	589.82	586.83	584.05	581.57	579.48	577.82	576.63	575.92	575.69
12.2500	-2479.	-14.107	-2.229	-3211.	1611.	589.83	586.94	584.26	581.86	579.82	578.20	577.04	576.33	576.10
12.5000	-2409.	-13.711	-2.154	-3111.	1570.	589.83	587.05	584.45	582.13	580.15	578.57	577.43	576.74	576.51
12.7500	-2340.	-13.317	-2.084	-3014.	1528.	589.84	587.15	584.64	582.39	580.46	578.93	577.81	577.13	576.91
13.0000	-2271.	-12.928	-2.016	-2920.	1485.	589.84	587.25	584.82	582.63	580.77	579.27	578.18	577.52	577.30
13.2500	-2204.	-12.545	-1.952	-2830.	1443.	589.85	587.34	584.98	582.87	581.05	579.60	578.54	577.90	577.69
13.5000	-2138.	-12.171	-1.889	-2742.	1401.	589.85	587.42	585.15	583.09	581.34	579.92	578.89	578.27	578.05
13.7500	-2074.	-11.804	-1.830	-2657.	1360.	589.86	587.51	585.30	583.31	581.61	580.23	579.23	578.63	578.42
14.0000	-2011.	-11.447	-1.773	-2575.	1319.	589.86	587.58	585.45	583.52	581.87	580.54	579.56	578.97	578.78
14.2500	-1950.	-11.099	-1.718	-2495.	1280.	589.87	587.65	585.59	583.72	582.12	580.83	579.88	579.31	579.12
14.5000	-1899.	-10.760	-1.664	-2418.	1241.	589.87	587.73	585.73	583.92	582.37	581.11	580.20	579.64	579.45
14.7500	-1832.	-10.431	-1.612	-2343.	1203.	589.87	587.80	585.86	584.11	582.60	581.39	580.50	579.95	579.78
15.0000	-1776.	-10.111	-1.562	-2271.	1167.	589.88	587.87	585.99	584.29	582.83	581.65	580.79	580.27	580.09
15.2500	-1458.	-8.302	-1.100	-1186.	1034.	588.72	587.07	585.92	584.43	583.05	581.91	581.07	580.57	580.40
15.5000	-1008.	-5.738	2.416	-177.	831.	583.56	585.47	585.35	584.37	583.20	582.14	581.35	580.86	580.69
15.7500	-494.	-2.811	3.037	786.	590.	580.39	583.56	584.41	584.05	583.21	582.32	581.59	581.13	580.98
16.0000	55.	.316	4.665	1711.	292.	577.20	581.45	583.22	583.51	583.07	582.40	581.79	581.38	581.24
16.2500	624.	3.549	5.302	2601.	-22.	574.01	579.25	581.85	582.77	582.78	582.39	581.93	581.59	581.47
16.5000	1200.	6.829	6.244	3458.	-356.	570.81	576.94	580.33	581.89	582.36	582.27	581.99	581.75	581.65
16.7500	1777.	10.114	6.879	4297.	-694.	567.61	574.57	578.70	580.88	581.81	582.05	581.99	581.85	581.79
17.0000	2351.	13.376	7.446	5087.	-1049.	564.41	572.11	576.99	579.75	581.15	581.73	581.88	581.89	581.80
17.2500	2917.	16.596	8.021	5861.	-1399.	561.20	569.64	575.19	578.53	580.39	581.31	581.70	581.83	581.85
17.5000	3474.	19.759	8.513	6611.	-1750.	557.99	567.17	573.32	577.22	579.54	580.80	581.43	581.69	581.77
17.7500	4019.	22.858	8.972	7336.	-2095.	554.78	564.63	571.40	575.84	578.60	580.21	581.07	581.48	581.60
18.0000	4552.	25.884	9.402	8039.	-2438.	551.56	562.06	569.42	574.38	577.58	579.53	580.64	581.19	581.35
18.2500	5071.	28.835	9.809	8720.	-2773.	548.35	559.45	567.39	572.86	576.48	578.77	580.11	580.81	581.02
18.5000	5574.	31.704	10.195	9380.	-3100.	545.13	556.83	565.32	571.29	575.32	577.93	579.51	580.35	580.60
18.7500	6071.	34.504	10.554	10020.	-3420.	541.91	554.17	563.21	569.65	574.09	577.02	578.93	579.80	580.11
19.0000	6550.	37.221	10.914	10641.	-3732.	538.69	551.53	561.06	567.96	572.79	576.03	578.07	579.18	579.53
19.2500	7015.	39.861	11.257	11243.	-4035.	535.47	548.84	558.88	565.22	571.43	574.98	577.24	578.49	578.87
19.5000	7468.	42.423	11.594	11826.	-4331.	532.24	546.14	556.66	564.43	570.01	573.96	576.33	577.70	578.14
19.7500	7907.	44.910	11.900	12392.	-4619.	529.02	543.41	554.40	562.60	568.54	572.67	575.35	576.85	577.33

28 INCH S.S. PIPE, SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/08/78

TIME	EQUIV RAD	LIN. STR.	DELT1	DELT2	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9
20.0000		8333.	47.324	12.204	12942.	-4897.	525.80	540.67	552.12	560.72	567.01	571.42	574.31	575.93	575.45
20.2500		8630.	49.001	11.572	13021.	-5125.	523.98	538.30	549.89	558.82	565.43	570.11	573.19	574.93	575.49
20.5000		8856.	50.272	11.190	13119.	-5313.	522.15	536.27	547.84	556.96	563.82	568.74	572.01	573.87	574.47
20.7500		9049.	51.311	10.938	13220.	-5472.	520.33	534.35	545.94	555.17	562.22	567.34	570.78	572.74	573.38
21.0000		9197.	52.190	10.770	13322.	-5607.	518.52	532.51	544.11	553.44	560.64	565.93	569.50	571.56	572.23
21.2500		9333.	52.953	10.661	13425.	-5723.	516.71	530.70	542.34	551.75	559.07	564.49	568.19	570.33	571.03
21.5000		9453.	53.630	10.595	13526.	-5822.	514.89	528.91	540.61	550.09	557.52	563.05	566.85	569.06	569.78
21.7500		9562.	54.239	10.559	13627.	-5910.	513.08	527.15	538.89	548.46	555.98	561.60	565.49	567.75	568.49
22.0000		9662.	54.796	10.546	13726.	-5987.	511.27	525.39	537.20	546.83	554.44	560.15	564.10	566.41	567.17
22.2500		9755.	55.311	10.548	13822.	-6055.	509.46	523.64	535.51	545.22	552.90	558.68	562.70	565.05	565.82
22.5000		9841.	55.792	10.563	13917.	-6120.	507.65	521.90	533.83	543.61	551.36	557.21	561.28	563.67	564.45
22.7500		9922.	56.244	10.585	14010.	-6178.	505.85	520.15	532.16	542.00	549.82	555.73	559.85	562.27	563.06
23.0000		10000.	56.673	10.613	14100.	-6233.	504.04	518.41	530.48	540.39	548.27	554.24	558.40	560.85	561.65
23.2500		10073.	57.081	10.646	14188.	-6284.	502.23	516.67	528.81	538.78	546.72	552.74	556.94	559.42	560.23
23.5000		10144.	57.472	10.681	14274.	-6332.	500.42	514.93	527.14	537.17	545.16	551.23	555.47	557.97	558.79
23.7500		10212.	57.848	10.717	14358.	-6378.	498.61	513.19	525.46	535.55	543.60	549.72	553.99	556.51	557.34
24.0000		10277.	58.209	10.755	14440.	-6422.	496.80	511.45	523.78	533.94	542.04	548.19	552.50	555.04	555.88
24.2500		10341.	58.558	10.793	14519.	-6464.	494.99	509.71	522.10	532.31	540.46	546.66	551.00	553.56	554.40
24.5000		10402.	58.895	10.831	14597.	-6505.	493.18	507.96	520.42	530.68	538.88	545.12	549.49	552.07	552.92
24.7500		10461.	59.221	10.869	14672.	-6544.	491.37	506.22	518.73	529.05	537.30	543.57	547.97	550.57	551.43
25.0000		10518.	59.537	10.907	14745.	-6582.	489.56	504.47	517.04	527.42	535.71	542.02	546.45	549.06	549.92
25.2500		10574.	59.843	10.944	14817.	-6619.	487.75	502.72	515.35	525.77	534.11	540.46	544.91	547.54	548.41
25.5000		10628.	60.140	10.981	14886.	-6654.	485.94	500.97	513.65	524.13	532.51	538.89	543.37	546.02	546.89
25.7500		10681.	60.428	11.016	14954.	-6689.	484.13	499.22	511.96	522.48	530.90	537.32	541.82	544.48	545.36
26.0000		10732.	60.708	11.051	15020.	-6722.	482.32	497.46	510.26	520.82	529.28	535.74	540.26	542.94	543.82
26.2500		10782.	60.981	11.085	15084.	-6755.	480.51	495.71	508.55	519.17	527.67	534.15	538.70	541.39	542.27
26.5000		10830.	61.245	11.119	15146.	-6787.	478.70	493.95	506.84	517.50	526.04	532.55	537.13	539.83	540.72
26.7500		10877.	61.502	11.151	15207.	-6818.	476.89	492.19	505.13	515.84	524.41	530.95	535.55	538.26	539.16
27.0000		10923.	61.752	11.183	15266.	-6848.	475.08	490.43	503.42	514.17	522.78	529.35	533.96	536.69	537.59
27.2500		10968.	61.995	11.214	15324.	-6877.	473.27	488.67	501.71	512.49	521.14	527.74	532.37	535.11	536.02
27.5000		11011.	62.231	11.244	15380.	-6905.	471.46	486.91	499.99	510.81	519.49	526.12	530.78	533.53	534.44
27.7500		11054.	62.461	11.273	15435.	-6933.	469.65	485.15	498.27	509.13	517.84	524.50	529.17	531.94	532.85
28.0000		11095.	62.685	11.302	15489.	-6960.	467.84	483.38	496.54	507.45	516.19	522.87	527.57	530.34	531.25
28.2500		11135.	62.903	11.330	15541.	-6986.	466.03	481.62	494.82	505.76	514.53	521.24	525.95	528.74	529.66
28.5000		11174.	63.115	11.357	15591.	-7012.	464.22	479.85	493.09	504.07	512.87	519.60	524.33	527.13	528.05
28.7500		11213.	63.321	11.384	15641.	-7037.	462.41	478.08	491.36	502.37	511.21	517.96	522.71	525.52	526.44
29.0000		11250.	63.522	11.409	15689.	-7061.	460.60	476.31	489.63	500.67	509.54	516.31	521.08	523.90	524.83
29.2500		11286.	63.717	11.435	15736.	-7084.	458.79	474.54	487.90	498.97	507.87	514.66	519.45	522.27	523.21
29.5000		11321.	63.907	11.459	15782.	-7108.	456.98	472.77	486.16	497.27	506.19	513.01	517.81	520.65	521.58
29.7500		11356.	64.093	11.483	15827.	-7130.	455.17	470.99	484.42	495.56	504.51	511.35	516.16	519.01	519.95

28 INCH S.S. PIPE, SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/08/78

TIME	EQUIV RAD	LIN. STR.	DELT1	DELT2	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9
30.0000		11390.	64.273	11.507	15870.	-7152.	453.36	469.22	482.68	493.85	502.83	509.69	514.52	517.37	518.32
30.2500		11422.	64.449	11.529	15913.	-7173.	451.54	467.44	480.94	492.14	501.14	508.02	512.86	515.73	516.68
30.5000		11454.	64.621	11.551	15954.	-7194.	449.73	465.67	479.20	490.43	499.45	506.35	511.21	514.08	515.03
30.7500		11486.	64.787	11.573	15995.	-7215.	447.92	463.89	477.45	488.71	497.76	504.68	509.55	512.43	513.38
31.0000		11516.	64.950	11.594	16034.	-7236.	446.11	462.11	475.70	486.99	496.06	503.00	507.88	510.78	511.73
31.2500		11546.	65.109	11.615	16073.	-7254.	444.30	460.33	473.96	485.27	494.36	501.32	506.22	509.12	510.07
31.5000		11575.	65.263	11.635	16111.	-7273.	442.49	458.55	472.21	483.54	492.66	499.63	504.55	507.45	508.41
31.7500		11603.	65.414	11.655	16147.	-7291.	440.68	456.77	470.45	481.82	490.95	497.95	502.87	505.79	506.75
32.0000		11631.	65.561	11.674	16183.	-7309.	438.87	454.99	468.70	480.09	489.25	496.26	501.19	504.12	505.08
32.2500		11658.	65.704	11.692	16218.	-7327.	437.05	453.21	466.94	478.36	487.54	494.56	499.51	502.44	503.41
32.5000		11684.	65.843	11.711	16253.	-7344.	435.24	451.43	465.19	476.62	485.82	492.87	497.83	500.76	501.73
32.7500		11710.	65.980	11.728	16285.	-7360.	433.43	449.64	463.43	474.89	484.11	491.17	496.14	499.08	500.05
33.0000		11735.	66.112	11.746	16317.	-7377.	431.62	447.86	461.67	473.15	482.39	489.46	494.45	497.40	498.37
33.2500		11759.	66.242	11.763	16351.	-7393.	429.81	446.08	459.91	471.41	480.67	487.75	492.75	495.71	496.69
33.5000		11783.	66.368	11.779	16382.	-7408.	428.00	444.29	458.15	469.67	478.95	486.05	491.06	494.02	495.00
33.7500		11807.	66.492	11.795	16413.	-7424.	426.19	442.50	456.39	467.93	477.22	484.34	489.36	492.33	493.30
34.0000		11830.	66.612	11.811	16442.	-7439.	424.37	440.72	454.62	466.19	475.50	482.63	487.65	490.63	491.61
34.2500		11852.	66.730	11.827	16471.	-7453.	422.56	438.93	452.86	464.44	473.77	480.91	485.95	488.93	489.91
34.5000		11874.	66.844	11.842	16500.	-7467.	420.75	437.14	451.09	462.70	472.04	479.20	484.24	487.23	488.21
34.7500		11895.	66.956	11.856	16528.	-7481.	418.94	435.35	449.32	460.95	470.31	477.48	482.53	485.52	486.51
35.0000		11916.	67.066	11.871	16555.	-7495.	417.13	433.56	447.55	459.20	468.57	475.76	480.82	483.82	484.81
35.2500		11936.	67.173	11.885	16582.	-7508.	415.31	431.77	445.79	457.45	466.84	474.03	479.10	482.11	483.10
35.5000		11956.	67.277	11.899	16608.	-7521.	413.50	429.98	444.02	455.69	465.10	472.31	477.39	480.40	481.39
35.7500		11976.	67.379	11.912	16633.	-7534.	411.69	428.19	442.24	453.94	463.36	470.58	475.67	478.68	479.68
36.0000		11995.	67.478	11.925	16659.	-7546.	409.88	426.40	440.47	452.18	461.62	468.85	473.94	476.96	477.96
36.2500		12014.	67.576	11.938	16683.	-7558.	408.07	424.61	438.70	450.43	459.87	467.12	472.22	475.25	476.24
36.5000		12032.	67.671	11.951	16706.	-7570.	406.26	422.82	436.92	448.67	458.13	465.39	470.50	473.53	474.52
36.7500		12050.	67.764	11.963	16730.	-7582.	404.44	421.02	435.15	446.91	456.38	463.65	468.77	471.80	472.80
37.0000		12067.	67.855	11.975	16753.	-7593.	402.63	419.23	433.37	445.15	454.64	461.91	467.04	470.08	471.08
37.2500		12085.	67.943	11.987	16777.	-7604.	400.82	417.44	431.60	443.39	452.89	460.17	465.31	468.35	469.35
37.5000		12101.	68.030	11.998	16797.	-7615.	399.01	415.64	429.82	441.62	451.14	458.43	463.57	466.62	467.63
37.7500		12118.	68.115	12.010	16819.	-7625.	397.19	413.85	428.04	439.86	449.38	456.69	461.84	464.89	465.90
38.0000		12134.	68.198	12.021	16840.	-7636.	395.38	412.05	426.26	438.09	447.63	454.95	460.10	463.16	464.17
38.2500		12150.	68.279	12.031	16860.	-7647.	393.57	410.26	424.48	436.33	445.88	453.20	458.36	461.42	462.43
38.5000		12165.	68.359	12.042	16880.	-7657.	391.76	408.46	422.70	434.56	444.12	451.45	456.62	459.69	460.70
38.7500		12180.	68.436	12.052	16900.	-7666.	389.95	406.67	420.92	432.79	442.36	449.71	454.88	457.95	458.96
39.0000		12195.	68.512	12.062	16919.	-7676.	388.13	404.87	419.14	431.02	440.61	447.96	453.14	456.21	457.22
39.2500		12209.	68.587	12.072	16938.	-7685.	386.32	403.07	417.35	429.25	438.85	446.21	451.39	454.47	455.48
39.5000		12224.	68.660	12.082	16957.	-7695.	384.51	401.28	415.57	427.48	437.09	444.45	449.65	452.73	453.74
39.7500		12238.	68.731	12.092	16975.	-7704.	382.70	399.48	413.79	425.71	435.32	442.70	447.90	450.98	452.00

2" INCH S.S. PIPE. SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/08/78

TIME	EQUIV LIN. RAD STR.	DELT1	DELT2	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9
40.0000	12251.	68.801	12.101	16901.	-7713.	380.88	397.64	412.00	423.94	433.56	440.95	446.15	449.24	450.26
40.2500	12198.	68.496	11.583	16751.	-7597.	379.87	396.10	410.26	422.17	431.80	439.19	444.40	447.49	448.51
40.5000	12111.	68.002	11.300	16528.	-7663.	378.85	394.71	408.65	420.45	430.05	437.44	442.65	445.74	446.76
40.7500	12007.	67.413	11.149	16315.	-7617.	377.83	393.40	407.12	418.79	428.33	435.69	440.90	444.00	445.02
41.0000	11894.	66.770	10.997	16111.	-7561.	376.82	392.14	405.65	417.19	426.64	433.97	439.16	442.25	443.27
41.2500	11774.	66.095	10.850	15915.	-7499.	375.81	390.90	404.23	415.63	424.99	432.26	437.43	440.51	441.53
41.5000	11652.	65.403	10.709	15727.	-7431.	374.80	389.69	402.84	414.10	423.37	430.58	435.72	438.78	439.79
41.7500	11527.	64.705	10.575	15545.	-7359.	373.79	388.47	401.48	412.61	421.78	428.92	434.02	437.06	438.06
42.0000	11405.	64.008	10.447	15370.	-7295.	372.78	387.31	400.14	411.14	420.21	427.29	432.34	435.35	436.35
42.2500	11283.	63.317	10.325	15206.	-7210.	371.77	386.14	398.82	409.69	418.67	425.67	430.67	433.66	434.65
42.5000	11162.	62.636	10.208	15035.	-7135.	370.76	384.99	397.52	408.27	417.14	424.07	429.02	431.99	432.97
42.7500	11044.	61.967	10.096	14877.	-7061.	369.75	383.82	396.23	406.86	415.64	422.49	427.40	430.33	431.30
43.0000	10928.	61.312	9.984	14723.	-6987.	368.75	382.67	394.95	405.47	414.15	420.93	425.78	428.69	429.65
43.2500	10815.	60.672	9.884	14573.	-6914.	367.74	381.53	393.68	404.09	412.68	419.39	424.19	427.06	428.01
43.5000	10704.	60.047	9.784	14427.	-6843.	366.73	380.34	392.42	402.72	411.22	417.87	422.62	425.46	426.40
43.7500	10595.	59.440	9.693	14289.	-6773.	365.73	379.2[illegible]	391.17	401.37	409.78	416.36	421.06	423.87	424.80
44.0000	10492.	58.848	9.594	14153.	-6705.	364.72	378.14	389.93	400.03	408.36	414.85	419.51	422.30	423.22
44.2500	10390.	58.273	9.504	14022.	-6639.	363.71	377.01	388.70	398.70	406.95	413.38	417.99	420.74	421.66
44.5000	10291.	57.714	9.416	13894.	-6574.	362.71	375.89	387.48	397.38	405.55	411.92	416.48	419.20	420.10
44.7500	10194.	57.171	9.332	13770.	-6511.	361.70	374.79	386.26	396.07	404.16	410.47	414.98	417.68	418.57
45.0000	10101.	56.645	9.250	13651.	-6450.	360.70	373.67	385.05	394.78	402.78	409.04	413.50	416.17	417.06
45.2500	10010.	56.133	9.170	13534.	-6391.	359.69	372.5[illegible]	383.85	393.49	401.42	407.61	412.04	414.68	415.55
45.5000	9923.	55.637	9.093	13422.	-6333.	358.69	371.46	382.65	392.21	400.07	406.20	410.58	413.20	414.07
45.7500	9837.	55.155	9.019	13313.	-6277.	357.68	370.36	381.46	390.93	398.73	404.81	409.15	411.74	412.60
46.0000	9754.	54.688	8.946	13207.	-6223.	356.68	369.26	380.28	389.67	397.40	403.42	407.72	410.29	411.14
46.2500	9674.	54.235	8.876	13104.	-6170.	355.67	368.16	379.10	388.42	396.08	402.05	406.31	408.85	409.70
46.5000	9596.	53.796	8.808	13004.	-6119.	354.67	367.07	377.92	387.17	394.77	400.69	404.91	407.43	408.27
46.7500	9521.	53.370	8.742	12908.	-6069.	353.66	365.98	376.76	385.93	393.46	399.33	403.52	406.02	406.8[illegible]
47.0000	9447.	52.956	8.678	12814.	-6021.	352.66	364.90	375.59	384.70	392.17	397.99	402.15	404.63	405.45
47.2500	9376.	52.555	8.617	12723.	-5974.	351.65	363.81	374.43	383.47	390.89	396.66	400.78	403.24	404.05
47.5000	9307.	52.167	8.556	12635.	-5929.	350.65	362.73	373.28	382.25	389.61	395.34	399.43	401.87	402.67
47.7500	9241.	51.789	8.498	12550.	-5885.	349.65	361.65	372.13	381.04	388.35	394.03	398.09	400.51	401.31
48.0000	9176.	51.424	8.442	12467.	-5842.	348.64	360.58	370.99	379.83	387.09	392.73	396.75	399.15	399.95
48.2500	9113.	51.069	8.387	12387.	-5801.	347.64	359.50	369.85	378.64	385.84	391.44	395.43	397.81	398.60
48.5000	9052.	50.725	8.334	12309.	-5761.	346.63	358.43	368.71	377.44	384.60	390.16	394.12	396.48	397.27
48.7500	8993.	50.392	8.283	12234.	-5722.	345.63	357.35	367.58	376.25	383.36	388.89	392.82	395.15	395.94
49.0000	8935.	50.069	8.233	12160.	-5684.	344.63	356.30	366.45	375.07	382.13	387.62	391.52	393.85	394.62
49.2500	8880.	49.755	8.184	12089.	-5649.	343.62	355.23	365.33	373.90	380.91	386.36	390.24	392.55	393.32
49.5000	8826.	49.451	8.137	12021.	-5612.	342.62	354.17	364.21	372.73	379.70	385.11	388.96	391.26	392.02
49.7500	8774.	49.156	8.092	11954.	-5578.	341.62	353.11	363.10	371.56	378.49	383.87	387.69	389.98	390.73

28 INCH S.S. PIPE, SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/08/78

TIME	EQUIV LIN. RAD STR.	DELT1	DELT2	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9
50.0000	8723.	48.870	8.048	11889.	-5545.	340.62	352.05	361.98	370.40	377.29	382.63	386.43	388.70	389.45
50.2500	8674.	48.593	8.005	11826.	-5512.	339.61	350.99	360.87	369.24	376.09	381.40	385.18	387.44	388.18
50.5000	8625.	48.324	7.964	11765.	-5481.	338.61	349.93	359.77	368.09	374.90	380.18	383.94	386.18	386.92
50.7500	8580.	48.064	7.923	11706.	-5451.	337.61	348.88	358.67	366.95	373.72	378.97	382.70	384.93	385.65
51.0000	8535.	47.811	7.885	11649.	-5421.	336.60	347.83	357.57	365.81	372.54	377.76	381.47	383.69	384.42
51.2500	8492.	47.566	7.855	11594.	-5393.	335.60	346.78	356.47	364.67	371.37	376.56	380.25	382.45	383.18
51.5000	8447.	47.324	7.827	11540.	-5365.	334.60	345.73	355.38	363.53	370.20	375.36	379.03	381.22	381.94
51.7500	8409.	47.093	7.799	11488.	-5339.	333.60	344.68	354.29	362.41	369.03	374.17	377.82	380.00	380.72
52.0000	8369.	46.874	7.771	11437.	-5312.	332.60	343.63	353.20	361.28	367.88	372.99	376.62	378.79	379.50
52.2500	8331.	46.657	7.745	11388.	-5287.	331.59	342.59	352.11	360.16	366.72	371.81	375.42	377.58	378.29
52.5000	8293.	46.447	7.720	11341.	-5262.	330.59	341.54	351.03	359.04	365.58	370.64	374.23	376.38	377.08
52.7500	8257.	46.243	7.695	11294.	-5239.	329.59	340.51	349.95	357.93	364.43	369.47	373.05	375.18	375.88
53.0000	8222.	46.046	7.671	11250.	-5215.	328.59	339.46	348.87	356.82	363.29	368.31	371.87	373.99	374.69
53.2500	8188.	45.854	7.647	11206.	-5193.	327.59	338.42	347.80	355.71	362.15	367.15	370.70	372.81	373.50
53.5000	8155.	45.668	7.625	11164.	-5171.	326.58	337.38	346.72	354.60	361.03	366.00	369.53	371.63	372.32
53.7500	8123.	45.488	7.603	11124.	-5150.	325.58	336.35	345.65	353.50	359.90	364.85	368.36	370.46	371.15
54.0000	8092.	45.313	7.582	11084.	-5130.	324.58	335.31	344.58	352.40	358.78	363.71	367.20	369.29	369.98
54.2500	8062.	45.144	7.561	11046.	-5110.	323.58	334.27	343.52	351.31	357.66	362.57	366.05	368.13	368.81
54.5000	8033.	44.980	7.541	11009.	-5091.	322.58	333.24	342.45	350.22	356.54	361.43	364.90	366.97	367.65
54.7500	8005.	44.820	7.522	10972.	-5072.	321.58	332.21	341.39	349.13	355.43	360.30	363.75	365.81	366.49
55.0000	7977.	44.666	7.503	10938.	-5054.	320.57	331.19	340.33	348.04	354.32	359.17	362.62	364.67	365.34
55.2500	7951.	44.516	7.485	10904.	-5037.	319.57	330.16	339.27	346.96	353.21	358.05	361.48	363.52	364.20
55.5000	7925.	44.371	7.467	10871.	-5020.	318.57	329.13	338.21	345.88	352.11	356.93	360.35	362.38	363.06
55.7500	7900.	44.230	7.450	10839.	-5004.	317.57	328.10	337.16	344.80	351.01	355.82	359.22	361.25	361.92
56.0000	7876.	44.093	7.434	10808.	-4989.	316.57	327.06	336.10	343.72	349.92	354.70	358.10	360.12	360.78
56.2500	7852.	43.961	7.418	10778.	-4972.	315.57	326.03	335.05	342.65	348.82	353.59	356.98	358.99	359.66
56.5000	7830.	43.833	7.402	10749.	-4957.	314.57	325.00	334.00	341.57	347.73	352.49	355.86	357.87	358.53
56.7500	7809.	43.708	7.387	10721.	-4943.	313.57	323.98	332.95	340.50	346.64	351.39	354.75	356.75	357.41
57.0000	7786.	43.587	7.372	10693.	-4929.	312.56	322.95	331.91	339.44	345.56	350.29	353.64	355.63	356.29
57.2500	7765.	43.470	7.358	10667.	-4915.	311.56	321.93	330.86	338.37	344.48	349.19	352.53	354.52	355.18
57.5000	7745.	43.357	7.344	10641.	-4902.	310.56	320.91	329.82	337.31	343.40	348.10	351.43	353.41	354.07
57.7500	7726.	43.247	7.331	10615.	-4889.	309.56	319.88	328.77	336.25	342.32	347.01	350.33	352.31	352.96
58.0000	7707.	43.140	7.318	10592.	-4876.	308.56	318.86	327.73	335.19	341.24	345.92	349.23	351.20	351.85
58.2500	7689.	43.037	7.305	10569.	-4864.	307.56	317.84	326.69	334.13	340.17	344.83	348.14	350.10	350.75
58.5000	7671.	42.936	7.293	10546.	-4853.	306.56	316.82	325.65	333.07	339.10	343.75	347.05	349.01	349.66
58.7500	7653.	42.839	7.281	10524.	-4841.	305.56	315.80	324.61	332.02	338.03	342.67	345.96	347.91	348.56
59.0000	7637.	42.745	7.270	10503.	-4830.	304.56	314.78	323.58	330.96	336.97	341.60	344.87	346.82	347.47
59.2500	7621.	42.653	7.259	10482.	-4820.	303.56	313.76	322.54	329.91	335.90	340.52	343.79	345.74	346.38
59.5000	7605.	42.565	7.248	10462.	-4809.	302.55	312.74	321.50	328.86	334.84	339.45	342.71	344.65	345.29
59.7500	7590.	42.479	7.238	10443.	-4799.	301.55	311.73	320.47	327.82	333.78	338.38	341.63	343.57	344.21

36 INCH ELBOW, SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/02/78

DIMENSIONS

INSIDE RADIUS = 18.2500 INCHES OUTSIDE RADIUS = 22.0000 INCHES REF A-5

NO. OF NODES = 9 RADIAL INCREMENT = .4688 INCHES

MATERIAL CODE = 1 POISSON S RATIO = .3000

L = 0.0000

INITIAL CONDITIONS

NODE	RADIUS	TEMPERATURE
1	18.2500	570.0
2	18.7188	570.0
3	19.1875	570.0
4	19.6563	570.0
5	20.1250	570.0
6	20.5938	570.0
7	21.0625	570.0
8	21.5313	570.0
9	22.0000	570.0

36 INCH ELBOW. SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/02/78

TABULATION OF
BOUNDARY CONDITIONS

FLUID TEMP. CURVE APPROXIMATION TIME (MINUTES)	INSIDE FLUID TEMPERATURE	FILM COEFF. CURVE APPROXIMATION TIME (MINUTES)	INSIDE FILM COEFFICIENT	PRESSURE CURVE APPROXIMATION TIME (MINUTES)	PRESSURE (PSI)
0.0000	570.0	0.0000	925.0	0.0000	0.
5.0000	570.0	5.0000	925.0	0.0000	0.
10.0000	590.0	10.0000	930.0	0.0000	0.
15.0000	590.0	15.0000	930.0	0.0000	0.
20.0000	525.0	20.0000	911.0	0.0000	0.
40.0000	380.0	40.0000	955.0	0.0000	0.
60.0000	300.0	60.0000	822.0	0.0000	0.
80.0000	280.0	80.0000	910.0	0.0000	0.
95.0000	285.0	95.0000	815.0	0.0000	0.
110.0000	305.0	110.0000	922.0	0.0000	0.

REF PG A-5

REF PG Y-3

TEMPERATURE CALCULATION TIMES AND PRINTOUTS

TIME INCREMENT (MINUTES)	TIME LIMIT (MINUTES)	NUMBER OF PRINTOUTS
.2500	145.000	580.

36 INCH EL30#. SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/02/78

THERMAL PROPERTIES

TIME	INSIDE FLUID TEMP.	INSIDE FILM COEFF.	AVE. TEMP.	CONDUC-TIVITY	SPECIFIC HEAT	YOUNGS MODULUS	COEFF. OF EXPANS.	DENSITY
30.000	453.	893.	496.4371	326.4083	.1281	2.70E+07	.71E-05	485.4122
30.250	451.	887.	494.6750	326.6145	.1280	2.70E+07	.70E-05	485.4349
30.500	449.	882.	492.9099	326.8212	.1280	2.70E+07	.70E-05	485.4576
30.750	447.	881.	491.1421	327.0282	.1279	2.70E+07	.70E-05	485.4804
31.000	445.	880.	489.3715	327.2355	.1278	2.71E+07	.70E-05	485.5031
31.250	443.	880.	487.5985	327.4430	.1278	2.71E+07	.70E-05	485.5260
31.500	442.	879.	485.8228	327.6507	.1277	2.71E+07	.70E-05	485.5488
31.750	440.	878.	484.0447	327.8590	.1276	2.71E+07	.70E-05	485.5717
32.000	438.	877.	482.2641	328.0675	.1276	2.71E+07	.70E-05	485.5946
32.250	436.	877.	480.4815	328.2762	.1275	2.71E+07	.70E-05	485.6176
32.500	434.	876.	478.6966	328.4851	.1274	2.72E+07	.70E-05	485.6405
32.750	433.	875.	476.9095	328.6943	.1274	2.72E+07	.70E-05	485.6635
33.000	431.	875.	475.1204	328.9038	.1273	2.72E+07	.70E-05	485.6866
33.250	429.	874.	473.3293	329.1134	.1272	2.72E+07	.70E-05	485.7096
33.500	427.	873.	471.5362	329.3233	.1272	2.72E+07	.70E-05	485.7327
33.750	425.	873.	469.7411	329.5334	.1271	2.72E+07	.70E-05	485.7558
34.000	424.	872.	467.9446	329.7434	.1270	2.72E+07	.70E-05	485.7789
34.250	422.	871.	466.1451	329.9543	.1270	2.73E+07	.70E-05	485.8021
34.500	420.	870.	464.3460	330.1650	.1269	2.73E+07	.70E-05	485.8252
34.750	418.	870.	462.5447	330.3760	.1268	2.73E+07	.70E-05	485.8484
35.000	416.	869.	460.7410	330.5871	.1268	2.73E+07	.70E-05	485.8716
35.250	414.	869.	458.9361	330.7983	.1267	2.73E+07	.70E-05	485.8949
35.500	413.	868.	457.1298	331.0099	.1266	2.73E+07	.70E-05	485.9181
35.750	411.	867.	455.3221	331.2216	.1266	2.73E+07	.70E-05	485.9414
36.000	409.	866.	453.5131	331.4332	.1265	2.74E+07	.70E-05	485.9647
36.250	407.	866.	451.7027	331.6451	.1264	2.74E+07	.70E-05	485.9880
36.500	405.	865.	449.8911	331.8572	.1264	2.74E+07	.70E-05	486.0113
36.750	404.	864.	448.0782	332.0694	.1263	2.74E+07	.69E-05	486.0346
37.000	402.	863.	446.2641	332.2819	.1262	2.74E+07	.69E-05	486.0579
37.250	400.	863.	444.4489	332.4943	.1262	2.74E+07	.69E-05	486.0813
37.500	398.	862.	442.6326	332.7069	.1261	2.74E+07	.69E-05	486.1047
37.750	396.	861.	440.8152	332.9196	.1260	2.75E+07	.69E-05	486.1281
38.000	395.	861.	438.9964	333.1325	.1260	2.75E+07	.69E-05	486.1515
38.250	393.	860.	437.1773	333.3455	.1259	2.75E+07	.69E-05	486.1749
38.500	391.	859.	435.3570	333.5585	.1258	2.75E+07	.69E-05	486.1983
38.750	389.	859.	433.5357	333.7714	.1258	2.75E+07	.69E-05	486.2218
39.000	387.	858.	431.7135	333.9851	.1257	2.75E+07	.69E-05	486.2452
39.250	385.	857.	429.8904	334.1985	.1256	2.76E+07	.69E-05	486.2687
39.500	384.	856.	428.0665	334.4121	.1256	2.76E+07	.69E-05	486.2922
39.750	382.	856.	426.2418	334.6257	.1255	2.76E+07	.69E-05	486.3156

36 INCH ELBOW, SNUD COOLDOWN INCIDENT TRANSIENT DATE 05/02/78

THERMAL PROPERTIES

TIME	INSIDE FLUID TEMP.	INSIDE FILM COEFF.	AVE. TEMP.	CONDUC-TIVITY	SPECIFIC HEAT	YOUNGS MODULUS	COEFF. OF EXPANS.	DENSITY
40.000	380.	855.	424.4153	334.8394	.1254	2.75E+07	.69E-05	486.3391
40.250	379.	855.	422.5376	335.0475	.1254	2.75E+07	.69E-05	486.3620
40.500	378.	854.	420.9114	335.2497	.1253	2.76E+07	.69E-05	486.3842
40.750	377.	854.	419.2229	335.4471	.1252	2.76E+07	.69E-05	486.4060
41.000	376.	853.	417.5554	335.6413	.1252	2.76E+07	.69E-05	486.4273
41.250	375.	853.	415.9365	335.8320	.1251	2.77E+07	.69E-05	486.4483
41.500	374.	853.	414.3321	336.0194	.1251	2.77E+07	.69E-05	486.4689
41.750	373.	852.	412.7587	336.2050	.1250	2.77E+07	.69E-05	486.4893
42.000	372.	852.	411.1306	336.3876	.1250	2.77E+07	.69E-05	486.5093
42.250	371.	851.	409.6506	336.5579	.1249	2.77E+07	.69E-05	486.5292
42.500	370.	851.	408.1297	336.7459	.1248	2.77E+07	.69E-05	486.5487
42.750	369.	850.	406.6204	336.9219	.1248	2.77E+07	.69E-05	486.5681
43.000	368.	850.	405.1414	337.0957	.1247	2.77E+07	.69E-05	486.5872
43.250	367.	850.	403.6727	337.2677	.1247	2.78E+07	.68E-05	486.6061
43.500	366.	849.	402.2199	337.4378	.1246	2.78E+07	.68E-05	486.6248
43.750	365.	849.	400.7825	337.6060	.1245	2.78E+07	.68E-05	486.6433
44.000	364.	848.	399.3549	337.7726	.1245	2.78E+07	.68E-05	486.6616
44.250	363.	848.	397.9515	337.9376	.1245	2.78E+07	.68E-05	486.6797
44.500	362.	848.	396.5572	338.1005	.1244	2.78E+07	.68E-05	486.6977
44.750	361.	847.	395.1761	338.2623	.1244	2.78E+07	.68E-05	486.7155
45.000	360.	847.	393.8078	338.4225	.1243	2.78E+07	.68E-05	486.7331
45.250	359.	846.	392.4520	338.5812	.1243	2.78E+07	.68E-05	486.7505
45.500	358.	846.	391.1041	338.7385	.1242	2.78E+07	.68E-05	486.7678
45.750	357.	846.	389.7759	338.8945	.1242	2.78E+07	.68E-05	486.7850
46.000	356.	845.	388.4543	339.0491	.1241	2.79E+07	.68E-05	486.8020
46.250	355.	845.	387.1446	339.2025	.1241	2.79E+07	.68E-05	486.8188
46.500	354.	844.	385.8446	339.3547	.1240	2.79E+07	.68E-05	486.8355
46.750	353.	844.	384.5551	339.5057	.1240	2.79E+07	.68E-05	486.8521
47.000	352.	843.	383.2752	339.6555	.1239	2.79E+07	.68E-05	486.8686
47.250	351.	843.	382.0046	339.8042	.1239	2.79E+07	.68E-05	486.8850
~~47.500~~	350.	[illegible]	~~380.7432~~	339.9519	.1238	2.79E+07	.68E-05	486.9012
47.750	349.	[illegible]	[illegible]	340.0985	.1238	2.79E+07	.68E-05	486.9173
48.000	348.	[illegible]	378.2456	340.2442	.1237	2.79E+07	.68E-05	486.9333
48.250	347.	841.	377.0104	340.3889	.1237	2.80E+07	.68E-05	486.9492
48.500	346.	841.	375.7824	340.5325	.1236	2.80E+07	.68E-05	486.9651
48.750	345.	841.	374.5619	340.6755	.1236	2.80E+07	.68E-05	486.9808
49.000	344.	840.	373.3469	340.8173	.1235	2.80E+07	.68E-05	486.9964
49.250	343.	840.	372.1430	340.9587	.1235	2.80E+07	.68E-05	487.0119
49.500	342.	839.	370.9439	341.0990	.1234	2.80E+07	.68E-05	487.0273
49.750	341.	839.	369.7515	341.2396	.1234	2.80E+07	.68E-05	487.0427

36 INCH EL304. SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/02/78

THERMAL PROPERTIES

TIME	INSIDE FLUID TEMP.	INSIDE FILM COEFF.	AVE. TEMP.	CONDUC-TIVITY	SPECIFIC HEAT	YOUNGS MODULUS	COEFF. OF EXPANS.	DENSITY
50.000	340.	839.	368.5655	361.3775	.1234	2.80E+07	.66E-05	487.0579
50.250	339.	838.	367.3458	361.5155	.1233	2.80E+07	.66E-05	487.0731
50.500	338.	838.	366.2119	361.5530	.1233	2.80E+07	.66E-05	487.0882
50.750	337.	837.	365.0430	361.7807	.1232	2.80E+07	.66E-05	487.1033
51.000	336.	837.	363.9414	361.9254	.1232	2.80E+07	.66E-05	487.1182
51.250	335.	836.	362.7243	362.0512	.1231	2.81E+07	.66E-05	487.1331
51.500	334.	836.	361.5724	362.1961	.1231	2.81E+07	.66E-05	487.1479
51.750	333.	836.	360.4255	362.3304	.1230	2.81E+07	.66E-05	487.1627
52.000	332.	835.	359.2834	362.4641	.1230	2.81E+07	.66E-05	487.1774
52.250	331.	835.	358.1461	362.5972	.1229	2.81E+07	.66E-05	487.1920
52.500	330.	834.	357.0132	362.7294	.1229	2.81E+07	.67E-05	487.2066
52.750	329.	834.	355.8846	362.8614	.1229	2.81E+07	.67E-05	487.2211
53.000	328.	834.	354.7603	362.9915	.1228	2.81E+07	.67E-05	487.2356
53.250	327.	833.	353.6400	363.1247	.1228	2.81E+07	.67E-05	487.2500
53.500	326.	833.	352.5236	363.2556	.1227	2.81E+07	.67E-05	487.2644
53.750	325.	832.	351.4110	363.3855	.1227	2.81E+07	.67E-05	487.2787
54.000	324.	832.	350.3020	363.5155	.1226	2.81E+07	.67E-05	487.2930
54.250	323.	831.	349.1965	363.6443	.1226	2.81E+07	.67E-05	487.3072
54.500	322.	831.	348.0944	363.7739	.1225	2.82E+07	.67E-05	487.3214
54.750	321.	831.	346.9956	363.9025	.1225	2.82E+07	.67E-05	487.3355
55.000	320.	830.	345.9000	364.0309	.1225	2.82E+07	.67E-05	487.3496
55.250	319.	830.	344.8073	364.1587	.1224	2.82E+07	.67E-05	487.3637
55.500	318.	829.	343.7177	364.2862	.1224	2.82E+07	.67E-05	487.3777
55.750	317.	829.	342.6308	364.4135	.1223	2.82E+07	.67E-05	487.3917
56.000	316.	827.	341.5467	364.5404	.1223	2.82E+07	.67E-05	487.4057
56.250	315.	828.	340.4652	364.6670	.1222	2.82E+07	.67E-05	487.4196
56.500	314.	828.	339.3861	364.7933	.1222	2.82E+07	.67E-05	487.4335
56.750	313.	827.	338.3094	364.9193	.1221	2.82E+07	.67E-05	487.4473
57.000	312.	827.	337.2356	365.0450	.1221	2.82E+07	.67E-05	487.4612
57.250	311.	827.	336.1638	365.1705	.1221	2.82E+07	.67E-05	487.4749
57.500	310.	826.	335.0941	365.2957	.1220	2.82E+07	.67E-05	487.4887
57.750	309.	826.	334.0266	365.4207	.1220	2.83E+07	.67E-05	487.5025
58.000	308.	825.	332.9611	365.5456	.1219	2.83E+07	.67E-05	487.5162
58.250	307.	825.	331.8976	365.6690	.1219	2.83E+07	.67E-05	487.5299
58.500	306.	824.	330.8360	365.7942	.1218	2.83E+07	.67E-05	487.5435
58.750	305.	824.	329.7763	365.9183	.1218	2.83E+07	.67E-05	487.5572
59.000	304.	824.	328.7183	366.0421	.1217	2.83E+07	.67E-05	487.5708
59.250	303.	823.	327.6620	366.1659	.1217	2.83E+07	.67E-05	487.5844
59.500	302.	823.	326.6073	366.2892	.1217	2.83E+07	.67E-05	487.5979
59.750	301.	822.	325.5543	366.4125	.1216	2.83E+07	.67E-05	487.6115

36 INCH FL304. SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/02/78

THERMAL PROPERTIES

TIME	INSIDE FLUID TEMP.	INSIDE FILM COEFF.	AVE. TEMP.	CONDUC-TIVITY	SPECIFIC HEAT	YOUNGS MODULUS	COEFF. OF EXPANS.	DENSITY
60.000	300.	822.	324.5024	346.5355	.1216	2.83E+07	.67E-05	487.6260
60.250	300.	822.	323.4967	346.6536	.1215	2.83E+07	.67E-05	487.6380
60.500	300.	822.	322.5423	346.7651	.1215	2.83E+07	.67E-05	487.6503
60.750	299.	822.	321.5256	346.8724	.1214	2.83E+07	.67E-05	487.6621
61.000	299.	821.	320.7404	346.9760	.1214	2.83E+07	.67E-05	487.6734
61.250	299.	821.	319.9942	347.0763	.1214	2.83E+07	.67E-05	487.6843
61.500	299.	821.	319.0531	347.1735	.1213	2.83E+07	.67E-05	487.6952
61.750	298.	821.	318.2456	347.2681	.1213	2.84E+07	.67E-05	487.7056
62.000	298.	821.	317.4461	347.3501	.1213	2.84E+07	.67E-05	487.7157
62.250	298.	821.	316.6952	347.4496	.1212	2.84E+07	.67E-05	487.7255
62.500	298.	821.	315.9500	347.5368	.1212	2.84E+07	.67E-05	487.7351
62.750	297.	820.	315.2235	347.6219	.1212	2.84E+07	.67E-05	487.7444
63.000	297.	820.	314.5150	347.7048	.1211	2.84E+07	.67E-05	487.7536
63.250	297.	820.	313.8235	347.7854	.1211	2.84E+07	.67E-05	487.7625
63.500	297.	820.	313.1484	347.8648	.1211	2.84E+07	.67E-05	487.7712
63.750	296.	820.	312.4892	347.9420	.1210	2.84E+07	.67E-05	487.7796
64.000	296.	820.	311.9451	348.0174	.1210	2.84E+07	.66E-05	487.7879
64.250	296.	819.	311.2156	348.0910	.1210	2.84E+07	.66E-05	487.7960
64.500	296.	819.	310.6002	348.1611	.1210	2.84E+07	.66E-05	487.8040
64.750	295.	819.	309.9983	348.2316	.1209	2.84E+07	.6[illegible]05	487.8117
65.000	295.	819.	309.4094	348.3025	.1209	2.84E+07	[illegible]E-05	487.8193
65.250	295.	819.	308.9331	348.3700	.1209	2.84E+07	.66E-05	487.8267
65.500	295.	819.	308.2589	348.4360	.1209	2.84E+07	.66E-05	487.8340
65.750	294.	819.	307.7164	348.5007	.1208	2.84E+07	.66E-05	487.8411
66.000	294.	818.	307.1750	348.5641	.1208	2.84E+07	.66E-05	487.8480
66.250	294.	818.	306.5445	348.6262	.1208	2.84E+07	.66E-05	487.8549
66.500	294.	818.	306.1243	348.6871	.1208	2.84E+07	.66E-05	487.8616
66.750	293.	818.	305.6142	348.7468	.1207	2.84E+07	.66E-05	487.8681
67.000	293.	818.	305.1118	348.8054	.1207	2.84E+07	.66E-05	487.8746
67.250	293.	818.	304.6227	348.8629	.1207	2.84E+07	.66E-05	487.8809
67.500	293.	818.	304.1405	348.9193	.1207	2.85E+07	.66E-05	487.8871
67.750	292.	817.	303.6659	348.9747	.1206	2.85E+07	.66E-05	487.8932
68.000	292.	817.	303.2017	349.0292	.1206	2.85E+07	.66E-05	487.8992
68.250	292.	817.	302.7445	349.0827	.1206	2.85E+07	.66E-05	487.9051
68.500	292.	817.	302.2450	349.1353	.1206	2.85E+07	.66E-05	487.9108
68.750	291.	817.	301.4529	349.1871	.1206	2.85E+07	.66E-05	487.9165
69.000	291.	817.	301.4180	349.2380	.1205	2.85E+07	.66E-05	487.9221
69.250	291.	816.	300.9900	349.2881	.1205	2.85E+07	.66E-05	487.9276
69.500	291.	816.	300.5686	349.3374	.1205	2.85E+07	.66E-05	487.9331
69.750	290.	816.	300.1536	349.3860	.1205	2.85E+07	.66E-05	487.9384

36 INCH EL30#. SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/02/78

THERMAL PROPERTIES

TIME	INSIDE FLUID TEM .	INSIDE FILM COEFF.	AVE. TEMP.	CONDUC-TIVITY	SPECIFIC HEAT	YOUNGS MODULUS	COEFF. OF EXPANS.	DENSITY
70.000	300.	816.	299.7447	349.4339	.1205	2.85E+07	.66E-05	487.9437
70.250	300.	816.	299.3418	349.4910	.1204	2.85E+07	.66E-05	487.9488
70.500	299.	816.	298.9446	349.5275	.1204	2.85E+07	.66E-05	487.9540
70.750	299.	816.	298.5528	349.5734	.1204	2.85E+07	.66E-05	487.9590
71.000	299.	815.	298.1664	349.6185	.1204	2.85E+07	.66E-05	487.9640
71.250	299.	815.	297.7450	349.6633	.1204	2.85E+07	.66E-05	487.9689
71.500	299.	815.	297.4086	349.7074	.1204	2.85E+07	.66E-05	487.9737
71.750	298.	815.	297.0368	349.7509	.1203	2.85E+07	.66E-05	487.9785
72.000	298.	815.	296.6697	349.7939	.1203	2.85E+07	.66E-05	487.9832
72.250	298.	815.	296.3069	349.8363	.1203	2.85E+07	.66E-05	487.9879
72.500	298.	815.	295.9443	349.8783	.1203	2.85E+07	.66E-05	487.9925
72.750	297.	814.	295.5937	349.9198	.1203	2.85E+07	.66E-05	487.9971
73.000	297.	814.	295.2431	349.9609	.1203	2.85E+07	.66E-05	488.0016
73.250	297.	814.	294.8962	350.0015	.1202	2.85E+07	.66E-05	488.0061
73.500	297.	814.	294.5529	350.0416	.1202	2.85E+07	.66E-05	488.0105
73.750	296.	814.	294.2132	350.0814	.1202	2.85E+07	.66E-05	488.0149
74.000	296.	814.	293.8764	350.1204	.1202	2.85E+07	.66E-05	488.0192
74.250	296.	813.	293.5435	350.1594	.1202	2.85E+07	.66E-05	488.0235
74.500	295.	813.	293.2135	350.1985	.1202	2.85E+07	.66E-05	488.0277
74.750	295.	813.	292.8864	350.2367	.1201	2.85E+07	.66E-05	488.0319
75.000	295.	813.	292.5622	350.2747	.1201	2.85E+07	.66E-05	488.0361
75.250	295.	813.	292.2407	350.3123	.1201	2.85E+07	.66E-05	488.0402
75.500	295.	813.	291.9220	350.3495	.1201	2.85E+07	.66E-05	488.0443
75.750	294.	813.	291.6058	350.3867	.1201	2.85E+07	.66E-05	488.0484
76.000	294.	812.	291.2920	350.4234	.1201	2.85E+07	.66E-05	488.0524
76.250	294.	812.	290.9807	350.4599	.1201	2.85E+07	.66E-05	488.0565
76.500	294.	812.	290.6716	350.4960	.1200	2.85E+07	.66E-05	488.0604
76.750	293.	812.	290.3647	350.5319	.1200	2.85E+07	.66E-05	488.0644
77.000	293.	812.	290.0600	350.5675	.1200	2.85E+07	.66E-05	488.0683
77.250	293.	812.	289.7573	350.6030	.1200	2.85E+07	.66E-05	488.0722
77.500	293.	812.	289.4566	350.6382	.1200	2.85E+07	.65E-05	488.0761
77.750	292.	811.	289.1577	350.6732	.1200	2.85E+07	.66E-05	488.0799
78.000	292.	811.	288.8607	350.7080	.1200	2.85E+07	.66E-05	488.0837
78.250	292.	811.	288.5654	350.7426	.1199	2.85E+07	.66E-05	488.0875
78.500	292.	811.	288.2719	350.7769	.1199	2.86E+07	.66E-05	488.0913
78.750	291.	811.	287.9799	350.8111	.1199	2.86E+07	.66E-05	488.0951
79.000	291.	811.	287.6895	350.8451	.1199	2.86E+07	.66E-05	488.0988
79.250	291.	810.	287.4006	350.8789	.1199	2.86E+07	.66E-05	488.1025
79.500	291.	810.	287.1132	350.9126	.1199	2.86E+07	.66E-05	488.1062
79.750	290.	810.	286.8271	350.9461	.1199	2.86E+07	.66E-05	488.1099

36 INCH ELBOW. SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/02/78

TIME	EQUIV RAD LIN. STR.	DELT1	DELT2	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9
.2500	-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
.5000	-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
.7500	-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
1.0000	-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
1.2500	-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
1.5000	-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
1.7500	-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
2.0000	-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
2.2500	-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
2.5000	-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
2.7500	-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
3.0000	-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
3.2500	-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
3.5000	-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
3.7500	-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
4.0000	-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
4.2500	-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
4.5000	-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
4.7500	-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
5.0000	-0.	-.000	-.000	-0.	-0.	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00	570.00
5.2500	-36.	-.253	-.352	-134.	17.	570.54	570.17	570.04	570.01	570.00	570.00	570.00	570.00	570.00
5.5000	-106.	-.730	-.671	-300.	[illegible]	571.26	570.53	570.20	570.07	570.02	570.01	570.00	570.00	570.00
5.7500	-193.	-1.423	-.973	-467.	35.	572.04	571.01	570.47	570.20	570.04	570.03	570.01	570.00	570.00
6.0000	-290.	-2.139	-1.209	-632.	135.	572.84	571.56	570.91	570.39	570.14	570.08	570.03	570.01	570.01
6.2500	-393.	-2.897	-1.412	-794.	193.	573.66	572.15	571.20	570.64	570.32	570.15	570.07	570.03	570.02
6.5000	-497.	-3.675	-1.598	-951.	255.	574.50	572.77	571.64	570.93	570.50	570.26	570.13	570.07	570.06
6.7500	-605.	-4.450	-1.745	-1104.	319.	575.35	573.42	572.11	571.25	570.72	570.40	570.22	570.13	570.11
7.0000	-712.	-5.242	-1.856	-1253.	384.	576.20	574.09	572.61	571.61	570.97	570.5?	570.33	570.21	570.18
7.2500	-816.	-6.015	-2.015	-1395.	449.	577.07	574.77	573.13	572.00	571.25	570.75	570.47	570.32	570.27
7.5000	-920.	-6.775	-2.135	-1536.	514.	577.94	575.47	573.68	572.42	571.55	570.99	570.64	570.45	570.39
7.7500	-1020.	-7.518	-2.248	-1671.	578.	578.82	576.19	574.25	572.85	571.88	571.23	570.83	570.61	570.54
8.0000	-1119.	-8.243	-2.354	-1801.	641.	579.71	576.91	574.83	573.31	572.24	571.51	571.04	570.79	570.71
8.2500	-1214.	-8.948	-2.454	-1928.	703.	580.59	577.65	575.43	573.79	572.62	571.81	571.28	570.99	570.90
8.5000	-1307.	-9.633	-2.550	-2050.	763.	581.49	578.40	576.04	574.29	573.02	572.13	571.55	571.23	571.12
8.7500	-1398.	-10.298	-2.641	-2164.	821.	582.38	579.16	576.67	574.80	573.44	572.47	571.84	571.48	571.37
9.0000	-1485.	-10.943	-2.729	-2263.	878.	583.28	579.92	577.32	575.34	573.88	572.84	572.15	571.77	571.64
9.2500	-1570.	-11.568	-2.814	-2393.	933.	584.19	580.70	577.97	575.88	574.33	573.23	572.49	572.07	571.93
9.5000	-1652.	-12.172	-2.895	-2500.	946.	585.10	581.48	578.64	575.45	574.81	573.63	572.85	572.40	572.25
9.7500	-1731.	-12.758	-2.973	-2604.	1037.	586.01	582.27	579.31	577.03	575.30	574.06	573.23	572.75	572.59

36 INCH ELBOW, SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/02/78

TIME	EQUIV LIN. RAD STR.	DELT1	DELT2	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9
10.0000	-1898.	-13.325	-3.449	-2704.	1097.	586.92	583.06	580.00	577.62	575.82	574.51	573.52	573.12	572.95
10.2500	-1867.	-13.510	-2.759	-2666.	1122.	587.30	583.71	580.66	578.22	576.34	574.97	574.04	573.51	573.33
10.5000	-1868.	-13.623	-2.497	-2593.	1139.	587.49	584.15	581.21	578.78	576.87	575.45	574.48	573.92	573.74
10.7500	-1831.	-13.493	-2.291	-2516.	1142.	587.64	584.48	581.66	579.28	577.37	575.93	574.93	574.35	574.16
11.0000	-1801.	-13.273	-2.213	-2438.	1135.	587.76	584.76	582.05	579.73	577.84	576.39	575.38	574.79	574.59
11.2500	-1763.	-12.995	-2.135	-2361.	1121.	587.46	585.00	582.40	580.14	578.29	576.85	575.83	575.23	575.04
11.5000	-1720.	-12.640	-2.059	-2289.	1100.	587.96	585.21	582.71	580.52	578.70	577.29	576.28	575.68	575.49
11.7500	-1675.	-12.343	-1.986	-2211.	1076.	588.04	585.41	582.99	580.87	579.10	577.71	576.72	576.12	575.93
12.0000	-1627.	-11.994	-1.917	-2139.	1049.	588.11	585.59	583.25	581.20	579.48	578.12	577.15	576.55	576.37
12.2500	-1579.	-11.640	-1.851	-2064.	1021.	588.19	585.74	583.50	581.51	579.84	578.52	577.56	576.99	576.80
12.5000	-1531.	-11.286	-1.789	-2000.	991.	588.25	585.89	583.73	581.81	580.19	578.90	577.97	577.41	577.22
12.7500	-1483.	-10.934	-1.727	-1934.	962.	588.31	586.04	583.95	582.09	580.52	579.27	578.36	577.82	577.64
13.0000	-1436.	-10.598	-1.659	-1870.	933.	588.37	586.18	584.15	582.36	580.84	579.63	578.75	578.22	578.04
13.2500	-1390.	-10.249	-1.613	-1809.	903.	588.43	586.31	584.35	582.62	581.15	579.97	579.12	578.60	578.43
13.5000	-1345.	-9.918	-1.559	-1749.	875.	588.48	586.43	584.55	582.87	581.44	580.30	579.48	578.98	578.81
13.7500	-1302.	-9.596	-1.507	-1691.	847.	588.53	586.55	584.73	583.11	581.73	580.62	579.82	579.34	579.18
14.0000	-1257.	-9.292	-1.457	-1635.	819.	588.58	586.67	584.91	583.34	582.00	580.94	580.15	579.69	579.54
14.2500	-1218.	-8.978	-1.408	-1581.	793.	588.63	586.78	585.08	583.56	582.27	581.24	580.49	580.03	579.88
14.5000	-1178.	-8.683	-1.361	-1528.	767.	588.68	586.89	585.24	583.77	582.53	581.53	580.80	580.36	580.22
14.7500	-1139.	-8.397	-1.316	-1475.	742.	588.72	586.99	585.40	583.98	582.77	581.81	581.11	580.68	580.54
15.0000	-1101.	-8.121	-1.273	-1429.	717.	588.76	587.09	585.55	584.18	583.01	582.08	581.40	580.99	580.85
15.2500	-949.	-6.999	-.995	-945.	651.	587.04	586.69	585.58	584.35	583.24	582.34	581.68	581.29	581.15
15.5000	-687.	-5.063	1.255	-360.	530.	586.73	585.55	585.20	584.35	583.40	582.53	581.96	581.57	581.45
15.7500	-369.	-2.724	2.217	224.	373.	582.26	584.04	584.48	584.11	583.44	582.75	582.20	581.84	581.72
16.0000	-21.	-.156	3.014	808.	187.	579.59	582.43	583.51	583.66	583.32	582.84	582.39	582.08	581.98
16.2500	344.	2.538	3.737	1374.	-19.	577.06	580.54	582.36	583.03	583.07	582.82	582.51	582.27	582.19
16.5000	718.	5.293	4.399	1924.	-239.	574.38	578.64	581.07	582.26	582.68	582.69	582.55	582.40	582.35
16.7500	1094.	8.062	4.842	2459.	-465.	571.66	575.62	579.56	581.35	582.16	582.45	582.50	582.46	582.44
17.0000	1467.	10.816	5.325	2977.	-695.	568.91	574.53	578.15	580.34	581.56	582.13	582.36	582.44	582.45
17.2500	1836.	13.533	5.757	3479.	-927.	565.14	572.38	576.56	579.23	580.82	581.70	582.14	582.33	582.38
17.5000	2198.	16.199	6.175	3965.	-1156.	563.35	570.17	574.90	578.03	580.00	581.17	581.82	582.13	582.22
17.7500	2552.	18.805	6.557	4435.	-1341.	560.54	567.93	573.17	576.75	579.09	580.55	581.41	581.84	581.97
18.0000	2896.	21.344	6.916	4889.	-1603.	557.71	565.64	571.37	575.39	578.10	579.85	580.91	581.46	581.63
18.2500	3232.	23.813	7.256	5329.	-1819.	555.87	563.31	569.53	573.97	577.03	579.06	580.32	580.99	581.20
18.5000	3557.	26.209	7.590	5754.	-2029.	552.01	560.95	567.63	572.48	575.89	578.19	579.64	580.43	580.68
18.7500	3873.	28.533	7.898	6165.	-2234.	549.14	558.56	565.68	570.92	574.67	577.24	578.88	579.79	580.03
19.0000	4179.	30.783	8.193	6561.	-2433.	546.29	556.14	563.69	569.31	573.38	576.21	578.04	579.06	579.39
19.2500	4475.	32.961	8.455	6943.	-2625.	543.37	553.64	561.65	567.65	572.03	575.11	577.12	578.25	578.61
19.5000	4761.	35.069	8.736	7315.	-2812.	540.46	551.22	559.54	565.93	570.61	573.93	576.12	577.36	577.76
19.7500	5038.	37.106	8.996	7673.	-2993.	537.55	548.7[illegible]	557.46	564.15	569.13	572.69	575.05	576.39	575.82

36 INCH ELBOW. SMUD COOLDOWN INCIDENT TRANSIENT

DATE 05/02/78

TIME	EQUIV RAD	LIN. STR.	DELT1	DELT2	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9
20.0000		5306.	39.075	9.247	8019.	-3167.	534.62	545.11	555.30	562.33	567.59	571.37	573.90	575.34	575.81
20.2500		5514.	40.602	8.997	8162.	-3317.	532.46	543.86	553.16	560.47	566.00	570.00	572.68	574.22	574.72
20.5000		5653.	41.701	8.741	8248.	-3438.	530.54	541.83	551.17	558.63	564.37	568.55	571.40	573.03	573.55
20.7500		5780.	42.557	8.558	8322.	-3535.	528.68	539.92	549.29	556.86	562.74	567.07	570.06	571.78	572.33
21.0000		5874.	43.248	8.452	8387.	-3615.	526.85	538.04	547.48	555.13	561.13	565.60	568.58	570.46	571.04
21.2500		5953.	43.822	8.377	8448.	-3690.	525.05	536.20	545.72	553.43	559.51	564.10	567.26	569.10	569.70
21.5000		6019.	44.309	8.331	8504.	-3734.	523.27	534.51	543.99	551.76	557.93	562.58	565.81	567.70	568.32
21.7500		6077.	44.731	8.307	8557.	-3780.	521.49	532.75	542.27	550.10	556.33	561.05	564.33	566.20	566.90
22.0000		6128.	45.104	8.297	8608.	-3819.	519.72	531.02	540.57	548.45	554.74	559.51	562.84	564.80	565.45
22.2500		6174.	45.438	8.278	8655.	-3853.	517.94	529.27	538.83	546.81	553.14	557.95	561.33	563.32	563.97
22.5000		6215.	45.743	8.306	8701.	-3886.	516.17	527.55	537.10	545.16	551.54	556.40	559.81	561.82	562.47
22.7500		6254.	46.023	8.319	8744.	-3911.	514.41	525.82	535.50	543.52	549.94	554.84	558.27	560.30	560.97
23.0000		6290.	46.282	8.335	8785.	-3935.	512.64	524.07	533.81	541.87	548.33	553.26	556.72	558.77	559.44
23.2500		6321.	46.525	8.353	8825.	-3959.	510.87	522.31	532.12	540.22	546.71	551.64	555.16	557.22	557.90
23.5000		6355.	46.753	8.372	8863.	-3981.	509.10	520.61	530.43	538.56	545.09	550.09	553.59	555.66	556.35
23.7500		6384.	46.969	8.392	8899.	-4001.	507.33	518.90	528.74	536.90	543.46	548.49	552.01	554.09	554.78
24.0000		6412.	47.173	8.412	8936.	-4020.	505.56	517.17	527.04	535.24	541.83	546.87	550.41	552.51	553.20
24.2500		6439.	47.366	8.431	8967.	-4039.	503.79	515.43	525.34	533.57	540.18	545.25	548.81	550.92	551.62
24.5000		6464.	47.550	8.451	8998.	-4056.	502.01	513.69	523.63	531.89	538.53	543.62	547.20	549.32	550.02
24.7500		6488.	47.725	8.469	9028.	-4070.	500.24	511.95	521.92	530.21	536.88	541.99	545.58	547.71	548.41
25.0000		6511.	47.891	8.487	9057.	-4085.	498.46	510.21	520.21	528.52	535.22	540.34	543.96	546.09	546.80
25.2500		6533.	48.050	8.504	9084.	-4100.	496.69	508.47	518.49	526.83	533.55	538.70	542.32	544.47	545.17
25.5000		6554.	48.201	8.520	9110.	-4114.	494.91	506.71	516.77	525.14	531.87	537.04	540.68	542.83	543.54
25.7500		6574.	48.345	8.536	9135.	-4127.	493.14	504.96	515.04	523.43	530.19	535.39	539.03	541.19	541.90
26.0000		6593.	48.482	8.551	9159.	-4140.	491.36	503.21	513.31	521.73	528.51	533.71	537.37	539.54	540.26
26.2500		6611.	48.612	8.565	9182.	-4152.	489.58	501.45	511.58	520.02	526.82	532.03	535.71	537.88	538.60
26.5000		6628.	48.736	8.578	9203.	-4163.	487.80	499.70	509.85	518.30	525.12	530.35	534.04	536.22	536.94
26.7500		6644.	48.854	8.591	9223.	-4174.	486.02	497.94	508.11	516.59	523.42	528.66	532.36	534.55	535.27
27.0000		6659.	48.965	8.603	9243.	-4184.	484.23	496.18	506.37	514.86	521.71	526.97	530.67	532.87	533.59
27.2500		6674.	49.071	8.614	9261.	-4194.	482.45	494.41	504.62	513.14	520.00	525.27	528.99	531.19	531.91
27.5000		6688.	49.172	8.624	9278.	-4203.	480.67	492.65	502.88	511.40	518.29	523.57	527.29	529.50	530.23
27.7500		6701.	49.267	8.634	9295.	-4212.	478.88	490.88	501.12	509.67	516.56	521.86	525.59	527.80	528.53
28.0000		6714.	49.357	8.643	9310.	-4220.	477.10	489.11	499.37	507.93	514.84	520.14	523.88	526.10	526.83
28.2500		6725.	49.442	8.652	9324.	-4229.	475.31	487.34	497.62	506.19	513.11	518.42	522.17	524.39	525.13
28.5000		6736.	49.522	8.660	9338.	-4235.	473.52	485.57	495.86	504.44	511.38	516.70	520.45	522.68	523.42
28.7500		6747.	49.598	8.667	9351.	-4242.	471.74	483.79	494.10	502.70	509.64	514.97	518.73	520.96	521.70
29.0000		6757.	49.669	8.674	9363.	-4249.	469.95	482.02	492.33	500.94	507.90	513.24	517.01	519.24	519.98
29.2500		6766.	49.735	8.680	9374.	-4255.	468.16	480.24	490.57	499.19	506.15	511.50	515.28	517.51	518.25
29.5000		6774.	49.797	8.685	9385.	-4261.	466.37	478.46	488.80	497.43	504.40	509.75	513.54	515.78	516.52
29.7500		6782.	49.856	8.690	9394.	-4266.	464.58	476.68	487.03	495.67	502.65	508.01	511.80	514.05	514.79

36 INCH ELBOW. SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/02/78

TIME	EQUIV RAD	LIN. STR.	DELTI	DELTP	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9
30.0000		6790.	49.910	8.695	9403.	-4271.	462.79	474.90	485.25	493.91	500.90	506.27	510.06	512.30	513.05
30.2500		6797.	49.951	8.699	9412.	-4276.	461.00	473.11	483.48	492.14	499.14	504.51	508.31	510.55	511.30
30.5000		6803.	50.007	8.703	9419.	-4280.	459.20	471.33	481.70	490.37	497.37	502.75	506.56	508.81	509.55
30.7500		6809.	50.051	8.706	9426.	-4284.	457.41	469.54	479.92	488.60	495.61	501.00	504.80	507.06	507.80
31.0000		6815.	50.090	8.709	9433.	-4289.	455.62	467.76	478.14	486.82	493.84	499.23	503.04	505.30	505.04
31.2500		6820.	50.127	8.711	9439.	-4291.	453.82	465.97	476.36	485.05	492.07	497.47	501.28	503.54	504.28
31.5000		6824.	50.160	8.713	9444.	-4295.	452.03	464.18	474.58	483.27	490.30	495.70	499.51	501.77	502.52
31.7500		6828.	50.199	8.714	9448.	-4297.	450.24	462.39	472.79	481.49	488.52	493.93	497.74	500.01	500.75
32.0000		6832.	50.217	8.715	9453.	-4300.	448.44	460.60	471.00	479.71	486.74	492.15	495.97	498.24	498.98
32.2500		6835.	50.242	8.715	9455.	-4302.	446.64	458.80	469.22	477.92	484.96	490.37	494.19	496.46	497.21
32.5000		6838.	50.263	8.716	9459.	-4304.	444.85	457.01	467.42	476.13	483.18	488.59	492.41	494.68	495.43
32.7500		6841.	50.282	8.716	9462.	-4306.	443.05	455.22	465.63	474.34	481.39	486.81	490.63	492.90	493.65
33.0000		6843.	50.298	8.716	9464.	-4308.	441.26	453.42	463.84	472.55	479.60	485.02	488.85	491.12	491.87
33.2500		6844.	50.311	8.715	9465.	-4309.	439.46	451.62	462.04	470.76	477.81	483.23	487.06	489.33	490.08
33.5000		6845.	50.322	8.714	9467.	-4310.	437.66	449.83	460.25	468.96	476.02	481.44	485.27	487.55	488.29
33.7500		6847.	50.331	8.713	9467.	-4311.	435.86	448.03	458.45	467.17	474.22	479.65	483.48	485.75	485.50
34.0000		6848.	50.338	8.712	9468.	-4312.	434.06	446.23	456.65	465.37	472.42	477.85	481.68	483.96	484.71
34.2500		6848.	50.342	8.710	9468.	-4312.	432.27	444.43	454.85	463.57	470.63	476.05	479.89	482.16	482.91
34.5000		6848.	50.344	8.708	9467.	-4312.	430.47	442.63	453.05	461.77	468.83	474.25	478.09	480.36	481.11
34.7500		6848.	50.344	8.705	9465.	-4312.	428.67	440.83	451.25	459.97	467.02	472.45	476.29	478.56	479.31
35.0000		6848.	50.342	8.703	9465.	-4312.	426.87	439.02	449.44	458.16	465.22	470.65	474.49	476.76	477.51
35.2500		6847.	50.338	8.700	9463.	-4312.	425.07	437.22	447.64	456.36	463.41	468.84	472.69	474.95	475.70
35.5000		6846.	50.332	8.697	9461.	-4312.	423.27	435.42	445.83	454.55	461.61	467.03	470.87	473.15	473.90
35.7500		6845.	50.325	8.693	9459.	-4311.	421.47	433.61	444.03	452.74	459.80	465.22	469.06	471.34	472.09
36.0000		6843.	50.316	8.690	9457.	-4310.	419.67	431.81	442.22	450.93	457.99	463.41	467.25	469.52	470.28
36.2500		6842.	50.305	8.686	9454.	-4309.	417.86	430.00	440.41	449.12	455.17	461.60	465.43	467.71	468.46
36.5000		6840.	50.292	8.682	9451.	-4308.	416.06	428.20	438.60	447.31	454.36	459.79	463.62	465.90	466.65
36.7500		6838.	50.278	8.678	9447.	-4307.	414.26	426.39	436.79	445.50	452.55	457.97	461.80	464.08	464.83
37.0000		6835.	50.263	8.674	9443.	-4305.	412.46	424.59	434.98	443.68	450.73	456.15	459.99	462.26	463.01
37.2500		6833.	50.246	8.669	9439.	-4304.	410.66	422.78	433.17	441.87	448.91	454.33	458.17	460.44	461.19
37.5000		6830.	50.227	8.664	9435.	-4302.	408.85	420.97	431.36	440.05	447.09	452.51	456.34	458.62	459.37
37.7500		6827.	50.208	8.659	9430.	-4301.	407.05	419.16	429.54	438.24	445.28	450.69	454.52	456.79	457.54
38.0000		6824.	50.187	8.654	9426.	-4299.	405.25	417.35	427.73	436.42	443.45	448.87	452.70	454.97	455.72
38.2500		6820.	50.164	8.649	9421.	-4297.	403.45	415.54	425.91	434.60	441.63	447.05	450.87	453.14	453.89
38.5000		6817.	50.141	8.644	9415.	-4295.	401.64	413.73	424.10	432.78	439.81	445.22	449.05	451.32	452.06
38.7500		6813.	50.116	8.639	9410.	-4292.	399.84	411.92	422.28	430.96	437.99	443.39	447.22	449.49	450.24
39.0000		6809.	50.090	8.632	9404.	-4290.	398.04	410.11	420.47	429.14	436.16	441.57	445.39	447.66	448.41
39.2500		6805.	50.064	8.627	9398.	-4287.	396.23	408.30	418.65	427.32	434.34	439.74	443.56	445.83	445.57
39.5000		6801.	50.035	8.621	9392.	-4285.	394.43	406.49	416.83	425.49	432.51	437.91	441.73	443.99	444.74
39.7500		6797.	50.007	8.615	9386.	-4282.	392.62	404.67	415.01	423.67	430.68	436.08	439.89	442.16	442.91

36 INCH ELBOW. SMUD COOLDOWN INCIDENT TRANSIENT DATE 05/02/78

TIME	EQUIV RAD	LIN. STR.	DELT1	DELT2	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9
40.0000		6792.	49.977	8.609	9379.	-4279.	390.82	402.86	413.19	421.85	428.85	434.25	438.06	440.32	441.07
40.2500		6759.	49.735	8.334	9269.	-4266.	389.44	401.18	411.41	420.03	427.02	432.41	436.23	438.49	439.24
40.5000		6697.	49.287	8.157	9134.	-4239.	388.20	399.67	409.72	418.26	425.21	430.59	434.39	435.65	437.40
40.7500		6622.	48.737	8.030	8997.	-4201.	387.00	398.24	408.13	416.54	423.43	428.77	432.56	434.82	435.56
41.0000		6540.	48.131	7.902	8861.	-4156.	385.83	396.87	406.54	414.88	421.69	426.98	430.75	432.99	433.73
41.2500		6453.	47.494	7.779	8729.	-4105.	384.67	395.51	405.09	413.26	419.99	425.22	428.95	431.17	431.91
41.5000		6364.	46.843	7.657	8599.	-4054.	383.53	394.21	403.53	411.68	418.31	423.48	427.17	429.37	430.10
41.7500		6275.	46.190	7.542	8474.	-3999.	382.39	392.92	402.14	410.12	416.65	421.77	425.41	427.59	428.30
42.0000		6186.	45.541	7.431	8352.	-3944.	381.27	391.64	400.78	408.50	415.04	420.08	423.67	425.82	426.53
42.2500		6099.	44.902	7.324	8234.	-3889.	380.15	390.38	399.38	407.09	413.45	418.41	421.96	424.08	424.78
42.5000		6013.	44.276	7.221	8120.	-3835.	379.04	389.13	398.01	405.61	411.87	416.77	420.26	422.35	423.05
42.7500		5930.	43.655	7.122	8009.	-3781.	377.93	387.8[illegible]	396.65	404.14	410.32	415.14	418.59	420.65	421.34
43.0000		5844.	43.070	7.027	7902.	-3729.	376.82	386.64	395.30	402.69	408.78	413.54	416.94	418.98	419.65
43.2500		5770.	42.492	6.935	7798.	-3678.	375.72	385.41	393.97	401.26	407.27	411.90	415.32	417.32	417.98
43.5000		5693.	41.932	6.846	7696.	-3629.	374.63	384.22	392.64	399.84	405.77	410.40	413.71	415.69	416.34
43.7500		5619.	41.389	6.759	7601.	-3581.	373.54	383.02	391.33	398.44	404.29	408.86	412.12	414.07	414.72
44.0000		5548.	40.863	6.677	7508.	-3534.	372.45	381.82	390.03	397.05	402.83	407.34	410.55	412.48	413.11
44.2500		5478.	40.354	6.597	7417.	-3489.	371.36	380.63	388.75	395.68	401.38	405.83	409.01	410.90	411.53
44.5000		5411.	39.862	6.519	7330.	-3446.	370.28	379.44	387.47	394.31	399.95	404.34	407.48	409.35	409.97
44.7500		5346.	39.385	6.445	7245.	-3403.	369.20	378.26	386.20	392.95	398.53	402.87	405.96	407.81	408.42
45.0000		5283.	38.926	6.372	7163.	-3362.	368.12	377.09	384.94	391.63	397.13	401.41	404.47	406.29	406.90
45.2500		5222.	38.481	6.302	7084.	-3323.	367.05	375.92	383.69	390.30	395.74	399.97	402.99	404.79	405.39
45.5000		5164.	38.051	6.235	7008.	-3285.	365.98	374.76	382.44	388.99	394.36	398.54	401.53	403.31	403.90
45.7500		5107.	37.635	6.170	6934.	-3248.	364.91	373.61	381.21	387.68	392.99	397.13	400.09	401.84	402.42
46.0000		5052.	37.234	6.107	6863.	-3212.	363.84	372.46	379.98	386.39	391.64	395.73	398.65	400.39	400.97
46.2500		4999.	36.845	6.046	6793.	-3178.	362.77	371.31	378.76	385.10	390.30	394.35	397.23	398.95	399.52
46.5000		4949.	36.470	5.987	6727.	-3144.	361.71	370.17	377.55	383.83	388.97	392.98	395.83	397.53	398.09
46.7500		4898.	36.107	5.930	6662.	-3112.	360.65	369.03	376.35	382.56	387.65	391.62	394.44	396.12	395.64
47.0000		4850.	35.756	5.875	6600.	-3081.	359.59	367.91	375.15	381.30	386.35	[illegible]	393.06	394.73	395.28
47.2500		4804.	35.417	5.821	6540.	-3051.	358.54	366.7[illegible]	373.96	380.06	385.05	388.93	391.70	393.35	393.87
47.5000		4759.	35.090	5.770	6481.	-3021.	357.49	365.66	372.78	378.82	383.76	387.61	390.35	391.98	392.52
47.7500		4716.	34.773	5.720	6425.	-2993.	356.43	364.54	371.60	377.58	382.49	386.29	389.01	390.62	391.16
48.0000		4674.	34.467	5.672	6370.	-2966.	355.38	363.43	370.42	376.36	381.22	384.99	387.69	389.28	389.81
48.2500		4633.	3[illegible].171	5.626	6318.	-2940.	354.33	362.32	369.26	375.14	379.96	383.70	386.36	387.95	388.47
48.5000		4594.	33.885	5.581	6267.	-2914.	353.29	361.[illegible]1	368.10	373.93	378.71	382.42	385.05	386.62	387.14
48.7500		4556.	33.608	5.537	6217.	-2890.	352.24	360.11	366.96	372.73	377.47	381.14	383.75	385.31	385.83
49.0000		4520.	33.341	5.495	6170.	-2866.	351.29	359.01	365.79	371.54	376.23	379.88	382.47	384.01	384.52
49.2500		4484.	33.082	5.454	6123.	-2843.	350.10	357.91	364.65	370.35	375.01	378.62	381.19	382.72	383.23
49.5000		4450.	32.832	5.415	6079.	-2821.	349.11	355.82	363.51	369.17	373.79	377.3[illegible]	379.92	381.44	381.94
49.7500		4417.	32.590	5.391	6036.	-2799.	349.08	355.73	362.37	367.99	372.58	376.1[illegible]	378.66	380.17	380.[illegible]7

SPRAY NOZZLE, SMUD COOLDOWN INCIDENT DATE 05/15/78

DIMENSIONS

INSIDE RADIUS = 1.0652 INCHES OUTSIDE RADIUS = 2.5000 INCHES REF. A-6

NO. OF NODES = 9 RADIAL INCREMENT = .1794 INCHES

MATERIAL CODE = 3 POISSON S RATIO = .3000

L = .1771

INITIAL CONDITIONS

NODE	RADIUS	TEMPERATURE
1	1.0652	570.0
2	1.2446	570.0
3	1.4239	570.0
4	1.6033	570.0
5	1.7826	570.0
6	1.9620	570.0
7	2.1413	570.0
8	2.3207	570.0
9	2.5000	570.0

SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

DATE 05/15/78

TABULATION OF BOUNDARY CONDITIONS

FLUID TEMP. CURVE APPROXIMATION TIME (MINUTES)	INSIDE FLUID TEMPERATURE		FLUID FLOW CURVE APPROXIMATION TIME (MINUTES)	INSIDE FLOW GPM		PRESSURE CURVE APPROXIMATION TIME (MINUTES)	PRESSURE (PSI)
0.0000	570.0		0.0000	180.0	REF PG A-7 *	0.0000	0.
5.0000	570.0		110.0000	180.0		0.0000	0.
10.0000	590.0		0.0000	0.0		0.0000	0.
15.0000	590.0	REF PG A-5	0.0000	0.0		0.0000	0.
20.0000	575.0		0.0000	0.0		0.0000	0.
40.0000	369.0		0.0000	0.0		0.0000	0.
60.0000	300.0		0.0000	0.0		0.0000	0.
80.0000	280.0		0.0000	0.0		0.0000	0.
95.0000	285.0		0.0000	0.0		0.0000	0.
110.0000	305.0		0.0000	0.0		0.0000	0.

TEMPERATURE CALCULATION TIMES AND PRINTOUTS

TIME INCREMENT (MINUTES)	TIME LIMIT (MINUTES)	NUMBER OF PRINTOUTS
.2500	110.000	440.

*NOTE THAT A 180 GPM FLOW RATE WILL PRODUCE A CONSERVATIVE FILM COEFFICIENT SINCE THE LARGEST FLOW RATE LISTED ON PAGE A-7 IS 150 GPM.

SPRAY NOZZLE, SMUD COOLDOWN INCIDENT DATE 05/15/78

THERMAL PROPERTIES

TIME	INSIDE FLUID TEMP.	INSIDE FILM COEFF.	AVE. TEMP.	CONDUC-TIVITY	SPECIFIC HEAT	YOUNGS MODULUS	COEFF. OF EXPANS.	DENSITY
30.000	453.	4685.	470.7748	26.7898	.1267	2.62E+07	.95E-05	488.9611
30.250	451.	4684.	468.9466	26.6953	.1267	2.62E+07	.95E-05	488.9882
30.500	449.	4684.	467.1201	26.5808	.1266	2.62E+07	.95E-05	489.0153
30.750	447.	4683.	465.2951	26.4765	.1265	2.62E+07	.95E-05	489.0424
31.000	445.	4683.	463.4716	26.3722	.1265	2.63E+07	.95E-05	489.0695
31.250	443.	4682.	461.6494	26.2681	.1264	2.63E+07	.95E-05	489.0966
31.500	442.	4681.	459.8284	26.1639	.1263	2.63E+07	.95E-05	489.1236
31.750	440.	4680.	458.0085	26.0599	.1263	2.63E+07	.95E-05	489.1506
32.000	438.	4680.	456.1897	25.9559	.1262	2.63E+07	.95E-05	489.1776
32.250	436.	4679.	454.3719	25.8519	.1261	2.63E+07	.95E-05	489.2046
32.500	434.	4677.	452.5547	25.7481	.1260	2.63E+07	.95E-05	489.2316
32.750	433.	4674.	450.7385	25.6442	.1260	2.63E+07	.95E-05	489.2586
33.000	431.	4671.	448.9231	25.5404	.1259	2.63E+07	.95E-05	489.2855
33.250	429.	4668.	447.1083	25.4367	.1258	2.63E+07	.95E-05	489.3125
33.500	427.	4665.	445.2942	25.3329	.1258	2.64E+07	.94E-05	489.3394
33.750	425.	4662.	443.4806	25.2292	.1257	2.64E+07	.94E-05	489.3664
34.000	424.	4659.	441.6676	25.1256	.1256	2.64E+07	.94E-05	489.3933
34.250	422.	4656.	439.8551	25.0217	.1255	2.64E+07	.94E-05	489.4202
34.500	420.	4652.	438.0429	24.9183	.1255	2.64E+07	.94E-05	489.4471
34.750	418.	4649.	436.2312	24.8147	.1254	2.64E+07	.94E-05	489.4740
35.000	416.	4646.	434.4198	24.7112	.1253	2.64E+07	.94E-05	489.5009
35.250	414.	4643.	432.6088	24.6076	.1252	2.64E+07	.94E-05	489.5278
35.500	413.	4639.	430.7980	24.5041	.1252	2.64E+07	.94E-05	489.5547
35.750	411.	4636.	428.9875	24.4006	.1251	2.64E+07	.94E-05	489.5816
36.000	409.	4633.	427.1773	24.2971	.1250	2.65E+07	.94E-05	489.6084
36.250	407.	4629.	425.3673	24.1936	.1249	2.65E+07	.94E-05	489.6353
36.500	405.	4626.	423.5574	24.0901	.1249	2.65E+07	.94E-05	489.6622
36.750	404.	4623.	421.7478	23.9866	.1248	2.65E+07	.94E-05	489.6891
37.000	402.	4619.	419.9383	23.8832	.1247	2.65E+07	.94E-05	489.7159
37.250	400.	4616.	418.1289	23.7797	.1246	2.65E+07	.94E-05	489.7428
37.500	398.	4612.	416.3197	23.6763	.1246	2.65E+07	.94E-05	489.7697
37.750	396.	4609.	414.5106	23.5728	.1245	2.65E+07	.94E-05	489.7965
38.000	395.	4605.	412.7015	23.4694	.1244	2.65E+07	.94E-05	489.8234
38.250	393.	4601.	410.8926	23.3660	.1243	2.65E+07	.94E-05	489.8503
38.500	391.	4598.	409.0438	23.2626	.1242	2.66E+07	.94E-05	489.8771
38.750	389.	4594.	407.2750	23.1591	.1241	2.66E+07	.94E-05	489.9040
39.000	387.	4590.	405.4662	23.0557	.1241	2.66E+07	.94E-05	489.9308
39.250	385.	4586.	403.6576	22.9523	.1240	2.66E+07	.94E-05	489.9577
39.500	384.	4582.	401.8489	22.8489	.1239	2.66E+07	.94E-05	489.9845
39.750	382.	4578.	400.0403	22.7455	.1238	2.66E+07	.94E-05	490.0114

SPRAY NOZZLE, SMUD COOLDOWN INCIDENT DATE 05/15/78

THERMAL PROPERTIES

TIME	INSIDE FLUID TEMP.	INSIDE FILM COEFF.	AVE. TEMP.	CONDUC-TIVITY	SPECIFIC HEAT	YOUNGS MODULUS	COEFF. OF EXPANS.	DENSITY
40.000	380.	4574.	399.2317	122.6421	.1237	2.66E+07	.94E-05	490.0383
40.250	379.	4572.	395.5491	122.5459	.1237	2.66E+07	.94E-05	490.0632
40.500	378.	4569.	394.9525	122.4546	.1236	2.66E+07	.94E-05	490.0869
40.750	377.	4567.	393.4123	122.3665	.1235	2.66E+07	.94E-05	490.1098
41.000	376.	4565.	391.9179	122.2811	.1234	2.67E+07	.94E-05	490.1320
41.250	375.	4562.	390.4635	122.1979	.1234	2.67E+07	.94E-05	490.1536
41.500	374.	4560.	389.0452	122.1164	.1233	2.67E+07	.94E-05	490.1747
41.750	373.	4558.	387.5599	122.0376	.1232	2.67E+07	.94E-05	490.1952
42.000	372.	4555.	386.3048	121.9602	.1232	2.67E+07	.94E-05	490.2154
42.250	371.	4553.	384.9776	121.8843	.1231	2.67E+07	.94E-05	490.2351
42.500	370.	4550.	383.6759	121.8099	.1230	2.67E+07	.94E-05	490.2544
42.750	369.	4548.	382.3981	121.7368	.1230	2.67E+07	.94E-05	490.2734
43.000	368.	4545.	381.1419	121.6550	.1229	2.67E+07	.94E-05	490.2920
43.250	367.	4542.	379.9958	121.5943	.1229	2.67E+07	.94E-05	490.3104
43.500	366.	4549.	378.6883	121.5247	.1228	2.67E+07	.93E-05	490.3285
43.750	365.	4537.	377.4977	121.4560	.1227	2.67E+07	.93E-05	490.3463
44.000	364.	4535.	376.3030	121.3883	.1227	2.67E+07	.93E-05	490.3639
44.250	363.	4532.	375.1326	121.3216	.1226	2.67E+07	.93E-05	490.3813
44.500	362.	4529.	373.9757	121.2557	.1226	2.67E+07	.93E-05	490.3984
44.750	361.	4526.	372.8311	121.1[illegible]	.1225	2.68E+07	.93E-05	490.4155
45.000	360.	4523.	371.6978	121.1250	.1224	2.68E+07	.93E-05	490.4323
45.250	359.	4521.	370.5750	121.0609	.1224	2.69E+07	.93E-05	490.4489
45.500	358.	4518.	369.4619	120.9971	.1223	2.69E+07	.93E-05	490.4655
45.750	357.	4515.	368.3576	120.9340	.1223	2.69E+07	.93E-05	490.4819
46.000	356.	4512.	367.2615	120.8713	.1222	2.69E+07	.93E-05	490.4981
46.250	355.	4509.	366.1730	120.8091	.1222	2.69E+07	.93E-05	490.5143
46.500	354.	4506.	365.0915	120.7473	.1221	2.68E+07	.93E-05	490.5304
46.750	353.	4503.	364.0164	120.6858	.1221	2.68E+07	.93E-05	490.5463
47.000	352.	4500.	362.9472	120.6247	.1220	2.68E+07	.93E-05	490.5622
47.250	351.	4497.	361.8835	120.5638	.1219	2.68E+07	.93E-05	490.5780
47.500	350.	4494.	360.8248	120.5033	.1219	2.69E+07	.93E-05	490.5937
47.750	349.	4490.	359.7707	120.4430	.1218	2.68E+07	.93E-05	490.6094
48.000	348.	4487.	358.7210	120.3830	.1218	2.68E+07	.93E-05	490.6249
48.250	347.	4484.	357.6752	120.3232	.1217	2.68E+07	.93E-05	490.6405
48.500	346.	4481.	356.6330	120.2635	.1217	2.68E+07	.93E-05	490.6560
48.750	345.	4477.	355.5942	120.2042	.1216	2.69E+07	.93E-05	490.6714
49.000	344.	4474.	354.5584	120.1450	.1216	2.69E+07	.93E-05	490.6868
49.250	343.	4470.	353.5255	120.0860	.1215	2.69E+07	.93E-05	490.7021
49.500	342.	4467.	352.4953	120.0271	.1215	2.69E+07	.93E-05	490.7174
49.750	341.	4463.	351.4675	119.9583	.1214	2.69E+07	.93E-05	490.7327

SPRAY NOZZLE, SMUD COOLDOWN INCIDENT   DATE 05/15/78

THERMAL PROPERTIES

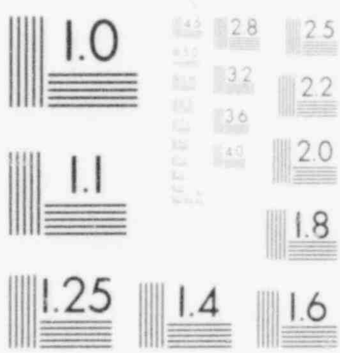
TIME	INSIDE FLUID TEMP.	INSIDE FILM COEFF.	AVE. TEMP.	CONDUC-TIVITY	SPECIFIC HEAT	YOUNGS MODULUS	COEFF. OF EXPANS.	DENSITY
50.000	340.	4460.	350.4419	19.9095	.1213	2.69E+07	.93E-05	490.7479
50.250	339.	4456.	349.4183	19.8511	.1213	2.69E+07	.93E-05	490.7631
50.500	338.	4453.	348.3967	19.7927	.1212	2.69E+07	.93E-05	490.7783
50.750	337.	4449.	347.3768	19.7344	.1212	2.69E+07	.93E-05	490.7934
51.000	336.	4445.	346.3585	19.6762	.1211	2.69E+07	.93E-05	490.8085
51.250	335.	4442.	345.3418	19.6180	.1211	2.69E+07	.93E-05	490.8236
51.500	334.	4438.	344.3264	19.5500	.1210	2.69E+07	.93E-05	490.8387
51.750	333.	4434.	343.3122	19.5020	.1210	2.69E+07	.93E-05	490.8538
52.000	332.	4430.	342.2992	19.4441	.1209	2.69E+07	.93E-05	490.8688
52.250	331.	4426.	341.2873	19.3862	.1208	2.69E+07	.93E-05	490.8838
52.500	330.	4422.	340.2764	19.3284	.1208	2.69E+07	.93E-05	490.8988
52.750	329.	4418.	339.2664	19.2707	.1207	2.69E+07	.93E-05	490.9138
53.000	328.	4414.	338.2573	19.2130	.1207	2.69E+07	.93E-05	490.9288
53.250	327.	4410.	337.2489	19.1553	.1206	2.70E+07	.93E-05	490.9438
53.500	326.	4406.	336.2412	19.0977	.1206	2.70E+07	.93E-05	490.9588
53.750	325.	4402.	335.2342	19.0401	.1205	2.70E+07	.93E-05	490.9737
54.000	324.	4398.	334.2278	18.9826	.1205	2.70E+07	.93E-05	490.9886
54.250	323.	4393.	333.2220	18.9251	.1204	2.70E+07	.93E-05	491.0036
54.500	322.	4389.	332.2167	18.8676	.1203	2.70E+07	.93E-05	491.0185
54.750	321.	4385.	331.2118	18.8102	.1203	2.70E+07	.93E-05	491.0334
55.000	320.	4381.	330.2074	18.7527	.1202	2.70E+07	.93E-05	491.0483
55.250	319.	4376.	329.2034	18.6953	.1202	2.70E+07	.93E-05	491.0633
55.500	318.	4372.	328.1998	18.6379	.1201	2.70E+07	.93E-05	491.0782
55.750	317.	4367.	327.1965	18.5906	.1201	2.70E+07	.93E-05	491.0931
56.000	316.	4363.	326.1935	18.5232	.1200	2.70E+07	.93E-05	491.1079
56.250	315.	4358.	325.1908	18.4559	.1199	2.70E+07	.93E-05	491.1228
56.500	314.	4354.	324.1884	18.4086	.1199	2.70E+07	.93E-05	491.1377
56.750	313.	4349.	323.1862	18.3513	.1198	2.70E+07	.93E-05	491.1526
57.000	312.	4344.	322.1843	18.2940	.1198	2.70E+07	.93E-05	491.1675
57.250	311.	4340.	321.1826	18.2367	.1197	2.70E+07	.93E-05	491.1824
57.500	310.	4335.	320.1810	18.1795	.1197	2.70E+07	.92E-05	491.1972
57.750	309.	4330.	319.1797	18.1222	.1196	2.71E+07	.92E-05	491.2121
58.000	308.	4325.	318.1785	18.0650	.1195	2.71E+07	.92E-05	491.2270
58.250	307.	4320.	317.1774	18.0077	.1195	2.71E+07	.92E-05	491.2418
58.500	306.	4316.	316.1765	17.9505	.1194	2.71E+07	.92E-05	491.2567
58.750	305.	4311.	315.1757	17.8933	.1194	2.71E+07	.92E-05	491.2716
59.000	304.	4306.	314.1750	17.8361	.1193	2.71E+07	.92E-05	491.2864
59.250	303.	4301.	313.1745	17.7788	.1192	2.71E+07	.92E-05	491.3013
59.500	302.	4296.	312.1740	17.7216	.1192	2.71E+07	.92E-05	491.3161
59.750	301.	4291.	311.1736	17.6644	.1191	2.71E+07	.92E-05	491.3310

SPRAY NOZZ_E. SMUD COOLDOWN INCIDENT DATE 05/15/78

THERMAL PROPERTIES

TIME	INSIDE FLUID TEMP.	INSIDE FILM COEFF.	AVE. TEMP.	CONDUC-TIVITY	SPECIFIC HEAT	YOUNGS MODULUS	COEFF. OF EXPANS.	DENSITY
60.000	300.	4285.	310.1733	17.6073	.1191	2.71E+07	.92E-05	491.3458
60.250	300.	4284.	309.2886	17.5567	.1190	2.71E+07	.92E-05	491.3590
60.500	300.	4282.	308.4832	17.5106	.1190	2.71E+07	.92E-05	491.3709
60.750	299.	4281.	307.7297	17.4575	.1189	2.71E+07	.92E-05	491.3821
61.000	299.	4280.	307.0184	17.4269	.1189	2.71E+07	.92E-05	491.3927
61.250	299.	4278.	306.3440	17.3883	.1188	2.71E+07	.92E-05	491.4027
61.500	299.	4277.	305.7030	17.3517	.1188	2.71E+07	.92E-05	491.4122
61.750	298.	4275.	305.0923	17.3167	.1188	2.71E+07	.92E-05	491.4213
62.000	298.	4274.	304.5096	17.2836	.1187	2.71E+07	.92E-05	491.4299
62.250	298.	4273.	303.9527	17.2516	.1187	2.71E+07	.92E-05	491.4382
62.500	298.	4271.	303.4196	17.2211	.1187	2.71E+07	.92E-05	491.4461
62.750	297.	4270.	302.9084	17.1919	.1186	2.71E+07	.92E-05	491.4537
63.000	297.	4268.	302.4174	17.1539	.1186	2.71E+07	.92E-05	491.4610
63.250	297.	4267.	301.9450	17.1368	.1186	2.71E+07	.92E-05	491.4680
63.500	297.	4265.	301.4899	17.1108	.1185	2.71E+07	.92E-05	491.4748
63.750	296.	4264.	301.0506	17.0857	.1185	2.72E+07	.92E-05	491.4813
64.000	296.	4263.	300.6259	17.0614	.1185	2.72E+07	.92E-05	491.4876
64.250	296.	4261.	300.2148	17.0379	.1185	2.72E+07	.92E-05	491.4937
64.500	296.	4260.	299.8162	17.0151	.1184	2.72E+07	.92E-05	491.4996
64.750	295.	4258.	299.4290	16.9929	.1184	2.72E+07	.92E-05	491.5054
65.000	295.	4257.	299.0525	16.9714	.1184	2.72E+07	.92E-05	491.5110
65.250	295.	4255.	298.6858	16.9504	.1184	2.72E+07	.92E-05	491.5164
65.500	295.	4254.	298.3281	16.9300	.1184	2.72E+07	.92E-05	491.5217
65.750	294.	4253.	297.9787	16.9100	.1183	2.72E+07	.92E-05	491.5269
66.000	294.	4251.	297.6370	16.8905	.1183	2.72E+07	.92E-05	491.5320
66.250	294.	4250.	297.3024	16.8713	.1183	2.72E+07	.92E-05	491.5370
66.500	294.	4248.	296.9744	16.8526	.1183	2.72E+07	.92E-05	491.5418
66.750	293.	4247.	296.6524	16.8342	.1183	2.72E+07	.92E-05	491.5466
67.000	293.	4245.	296.3360	16.8161	.1182	2.72E+07	.92E-05	491.5513
67.250	293.	4244.	296.0247	16.7983	.1182	2.72E+07	.92E-05	491.5559
67.500	293.	4243.	295.7181	16.7808	.1182	2.72E+07	.92E-05	491.5605
67.750	292.	4241.	295.4160	16.7635	.1182	2.72E+07	.92E-05	491.5650
68.000	292.	4240.	295.1178	16.7464	.1182	2.72E+07	.92E-05	491.5694
68.250	292.	4238.	294.8234	16.7296	.1181	2.72E+07	.92E-05	491.5738
68.500	292.	4237.	294.5325	16.7130	.1181	2.72E+07	.92E-05	491.5781
68.750	291.	4235.	294.2447	16.6965	.1181	2.72E+07	.92E-05	491.5824
69.000	291.	4234.	293.9598	16.6802	.1181	2.72E+07	.92E-05	491.5866
69.250	291.	4232.	293.6776	16.6641	.1181	2.72E+07	.92E-05	491.5908
69.500	291.	4231.	293.3980	16.6481	.1181	2.72E+07	.92E-05	491.5949
69.750	290.	4229.	293.1206	16.6322	.1180	2.72E+07	.92E-05	491.5990

IMAGE EVALUATION TEST TARGET (MT-3)



6″

MICROCOPY RESOLUTION TEST CHART

SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

DATE 05/15/78

TIME	EQUIV LIN. RAD STR.	DELT1	DELT2	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9
10.0000	-1779.	-10.124	-2.391	-2870.	883.	589.49	586.47	584.14	582.33	580.97	579.98	579.31	578.93	578.81
10.2500	-1701.	-9.684	-1.964	-2630.	964.	589.54	586.97	584.83	583.11	581.77	580.78	580.11	579.72	579.60
10.5000	-1584.	-9.018	-1.738	-2417.	815.	589.58	587.25	585.32	583.73	582.48	581.51	580.88	580.51	580.39
10.7500	-1453.	-8.332	-1.574	-2221.	756.	589.62	587.49	585.72	584.26	583.10	582.22	581.61	581.26	581.14
11.0000	-1348.	-7.675	-1.439	-2042.	698.	589.65	587.70	586.07	584.73	583.66	582.85	582.29	581.96	581.85
11.2500	-1240.	-7.061	-1.320	-1877.	643.	589.68	587.89	586.39	585.16	584.17	583.43	582.91	582.60	582.51
11.5000	-1140.	-6.494	-1.212	-1726.	591.	589.71	588.06	586.68	585.55	584.64	583.96	583.48	583.20	583.11
11.7500	-1048.	-5.971	-1.114	-1587.	544.	589.73	588.22	586.95	585.91	585.08	584.44	584.00	583.75	583.66
12.0000	-964.	-5.489	-1.024	-1459.	500.	589.75	588.36	587.20	586.24	585.47	584.89	584.49	584.25	584.18
12.2500	-886.	-5.047	-.942	-1341.	460.	589.77	588.49	587.42	586.54	585.84	585.30	584.93	584.71	584.64
12.5000	-815.	-4.640	-.866	-1233.	422.	589.79	588.61	587.63	586.82	586.17	585.69	585.34	585.14	585.09
12.7500	-749.	-4.265	-.796	-1133.	389.	589.81	588.71	587.82	587.08	586.48	586.03	585.72	585.53	585.47
13.0000	-689.	-3.921	-.732	-1042.	357.	589.82	588.83	588.00	587.31	586.77	586.35	586.06	585.89	585.84
13.2500	-633.	-3.605	-.673	-958.	328.	589.84	588.92	588.16	587.53	587.03	586.65	586.38	586.22	585.17
13.5000	-582.	-3.314	-.618	-880.	302.	589.85	589.01	588.31	587.73	587.27	586.92	586.67	586.53	585.46
13.7500	-535.	-3.046	-.558	-809.	277.	589.86	589.09	588.44	587.91	587.49	587.17	586.94	586.81	585.77
14.0000	-492.	-2.801	-.523	-744.	255.	589.87	589.15	588.57	588.08	587.69	587.39	587.19	587.07	587.03
14.2500	-452.	-2.574	-.490	-684.	234.	589.88	589.21	588.68	588.24	587.88	587.60	587.41	587.30	587.27
14.5000	-415.	-2.367	-.442	-629.	215.	589.89	589.29	588.79	588.38	588.05	587.80	587.62	587.52	587.49
14.7500	-382.	-2.176	-.406	-578.	199.	589.90	589.35	588.89	588.51	588.21	587.98	587.82	587.72	587.69
15.0000	-351.	-2.000	-.373	-531.	182.	589.91	589.40	588.98	588.63	588.35	588.14	587.99	587.91	587.88
15.2500	41.	.236	1.163	461.	46.	586.87	587.99	588.41	588.47	588.38	588.25	588.14	588.07	588.05
15.5000	551.	3.139	2.035	1349.	-180.	583.79	585.90	[illegible]7.10	587.73	588.02	588.13	588.16	588.15	588.15
15.7500	1052.	6.049	2.676	2164.	-431.	580.69	583.62	585.50	586.66	587.35	587.74	587.95	588.05	588.08
16.0000	1547.	8.810	3.253	2913.	-677.	577.56	581.23	583.71	585.36	586.44	587.11	587.52	587.72	587.79
16.2500	1998.	11.377	3.749	3602.	-989.	574.43	578.76	581.79	583.90	585.33	586.27	586.86	587.17	587.27
16.5000	2415.	13.749	4.198	4235.	-1124.	571.28	576.22	579.76	582.28	584.04	585.23	585.99	586.41	586.54
16.7500	2800.	15.934	4.609	4818.	-1323.	568.13	573.62	577.63	580.53	582.59	584.02	584.94	585.44	585.60
17.0000	3154.	17.945	4.986	5355.	-1507.	564.96	570.97	575.40	578.65	581.00	582.64	583.70	584.30	584.49
17.2500	3480.	19.795	5.333	5849.	-1675.	561.79	568.27	573.10	576.67	579.27	581.10	582.31	582.98	583.20
17.5000	3780.	21.498	5.653	6304.	-1831.	558.62	565.53	570.71	574.58	577.42	579.44	580.76	581.51	581.75
17.7500	4056.	23.064	5.947	6723.	-1974.	555.43	562.74	568.26	572.40	575.46	577.64	579.08	579.90	580.16
18.0000	4311.	24.506	6.218	7109.	-2106.	552.24	559.92	565.74	570.14	573.40	575.73	577.28	578.15	578.43
18.2500	4546.	25.833	6.467	7465.	-2229.	549.05	557.06	563.17	567.80	571.24	573.71	575.36	576.29	576.59
18.5000	4762.	27.055	6.697	7793.	-2340.	545.85	554.17	560.54	565.38	568.99	571.59	573.33	574.32	574.63
18.7500	4961.	28.180	6.909	8095.	-2443.	542.64	551.25	557.86	562.90	566.67	569.39	571.21	572.24	572.57
19.0000	5145.	29.217	7.103	8374.	-2538.	539.43	548.31	555.13	560.35	564.27	567.10	568.99	570.07	570.41
19.2500	5315.	30.172	7.293	8632.	-2626.	535.22	545.34	552.37	557.75	561.80	564.73	566.70	567.82	568.17
19.5000	5472.	31.053	7.449	8869.	-2707.	533.00	542.35	549.56	555.10	559.27	562.30	564.33	565.48	565.85
19.7500	5616.	31.865	7.602	9089.	-2782.	529.78	539.33	546.72	552.41	556.69	559.80	561.89	563.08	563.46

SPRAY NOZZLE, SMUD COOLDOWN INCIDENT DATE 05/15/78

TIME	EQUIV LIN. RAD STR.	DELT1	DELT2	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9
20.0000	5750.	32.613	7.743	9292.	-2851.	526.56	536.30	543.85	549.67	554.05	557.24	559.38	560.61	561.00
20.2500	5711.	32.383	7.201	9054.	-2861.	524.69	533.90	541.24	547.00	551.41	554.64	556.83	558.08	559.48
20.5000	5609.	31.799	6.943	8864.	-2825.	522.83	531.78	538.97	544.56	548.89	552.09	554.27	555.52	556.92
20.7500	5497.	31.155	6.770	8659.	-2774.	520.99	529.73	536.71	542.22	546.47	549.61	551.76	552.99	553.38
21.0000	5387.	30.526	6.634	8487.	-2719.	519.14	527.71	534.55	539.95	544.11	547.19	549.29	550.50	550.89
21.2500	5284.	29.936	6.518	8329.	-2667.	517.30	525.72	532.42	537.72	541.80	544.82	546.88	548.07	548.45
21.5000	5189.	29.389	6.413	8184.	-2617.	515.46	523.74	530.33	535.53	539.53	542.50	544.52	545.68	546.05
21.7500	5101.	28.885	6.319	8051.	-2572.	513.63	521.74	528.26	533.37	537.31	540.21	542.20	543.34	543.70
22.0000	5021.	28.423	6.233	7929.	-2530.	511.80	519.83	526.21	531.24	535.11	537.97	539.92	541.04	541.40
22.2500	4947.	27.999	6.154	7817.	-2492.	509.96	517.84	524.18	529.14	532.95	535.76	537.68	538.78	539.14
22.5000	4879.	27.609	6.091	7715.	-2457.	508.13	515.96	522.17	527.06	530.82	533.59	535.48	536.56	536.91
22.7500	4817.	27.252	6.015	7621.	-2424.	506.30	514.04	520.17	525.00	528.71	531.44	533.31	534.38	534.72
23.0000	4760.	26.924	5.954	7535.	-2395.	504.48	512.13	518.19	522.96	526.63	529.33	531.16	532.22	532.56
23.2500	4707.	26.624	5.898	7456.	-2369.	502.65	510.23	516.23	520.94	524.57	527.23	529.05	530.09	530.43
23.5000	4660.	26.349	5.847	7384.	-2343.	500.82	508.33	514.28	518.94	522.53	525.16	526.96	527.99	528.32
23.7500	4616.	26.096	5.801	7318.	-2320.	499.00	506.44	512.33	516.96	520.51	523.12	524.89	525.92	526.24
24.0000	4576.	25.865	5.758	7257.	-2299.	497.18	504.56	510.40	514.99	518.50	521.09	522.85	523.86	524.19
24.2500	4539.	25.653	5.719	7202.	-2280.	495.35	502.69	508.48	513.03	516.51	519.08	520.82	521.83	522.15
24.5000	4506.	25.4[illegible]9	5.683	7151.	-2263.	493.53	500.81	506.57	511.08	514.54	517.09	518.82	519.81	520.13
24.7500	4475.	25.281	5.650	7105.	-2247.	491.71	498.95	504.67	509.15	512.58	515.11	516.83	517.81	518.13
25.0000	4447.	25.118	5.620	7063.	-2232.	489.89	497.09	502.77	507.22	510.64	513.14	514.85	515.83	516.14
25.2500	4421.	24.970	5.593	7024.	-2219.	488.07	495.23	500.88	505.31	508.70	511.19	512.89	513.86	514.17
25.5000	4398.	24.833	5.568	6989.	-2207.	486.25	493.38	499.00	503.40	506.78	509.25	510.94	511.90	512.21
25.7500	4377.	24.709	5.545	6957.	-2195.	484.43	491.53	497.12	501.50	504.86	507.32	509.00	509.96	510.27
26.0000	4357.	24.595	5.524	6928.	-2185.	482.61	489.68	495.25	499.61	502.95	505.41	507.07	508.03	508.34
26.2500	4339.	24.491	5.505	6901.	-2175.	480.80	487.84	493.39	497.73	501.06	503.50	505.16	506.11	505.41
26.5000	4323.	24.397	5.497	6877.	-2168.	478.98	485.99	491.53	495.85	499.16	501.60	503.25	504.20	504.50
26.7500	4309.	24.310	5.472	6855.	-2160.	677.16	484.15	489.67	493.98	497.28	499.70	501.35	502.29	502.59
27.0000	4295.	24.231	5.457	6835.	-2153.	475.34	482.32	487.82	492.11	495.40	497.82	499.46	500.40	500.70
27.2500	4283.	24.160	5.444	6817.	-2147.	473.53	480.49	485.97	490.25	493.53	495.94	497.57	498.51	498.81
27.5000	4272.	24.094	5.432	6801.	-2141.	471.71	478.65	484.12	488.39	491.66	494.05	495.69	496.63	496.93
27.7500	4263.	24.035	5.422	6786.	-2136.	469.90	476.82	482.28	486.54	489.80	492.20	493.82	494.75	495.05
28.0000	4254.	23.981	5.412	6773.	-2131.	468.08	474.99	480.44	484.69	487.94	490.33	491.95	492.88	493.18
28.2500	4246.	23.932	5.403	6761.	-2127.	466.27	473.17	478.60	482.85	486.09	488.47	490.09	491.02	491.32
28.5000	4238.	23.888	5.395	6750.	-2123.	464.45	471.34	476.76	481.00	484.24	486.62	488.23	489.16	489.46
28.7500	4232.	23.848	5.388	6740.	-2120.	462.64	469.52	474.93	479.16	482.40	484.77	486.38	487.30	487.60
29.0000	4226.	23.812	5.382	6732.	-2117.	460.82	467.69	473.10	477.32	480.55	482.92	484.53	485.45	485.75
29.2500	4221.	23.779	5.376	6724.	-2114.	459.01	465.87	471.27	475.49	478.71	481.08	482.69	483.61	483.90
29.5000	4216.	23.750	5.371	6717.	-2112.	457.19	464.05	469.44	473.66	476.88	479.24	480.84	481.76	482.06
29.7500	4212.	23.724	5.366	6711.	-2110.	455.38	462.23	467.62	471.83	475.04	477.40	479.00	479.92	480.22

SPRAY NOZZLE, SMUD COOLDOWN INCIDENT DATE 05/15/78

TIME	EQUIV RAD	LIN. STR.	DELT1	DELT2	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9
30.0000		4208.	23.700	5.352	6706.	-2108.	453.56	460.41	465.79	470.00	473.21	475.57	477.17	478.09	478.38
30.2500		4205.	23.679	5.358	6701.	-2106.	451.75	458.59	463.97	469.17	471.38	473.74	475.33	476.25	476.54
30.5000		4203.	23.650	5.355	6697.	-2105.	449.93	455.77	462.15	466.34	469.55	471.91	473.50	474.42	474.71
30.7500		4200.	23.644	5.352	6694.	-2103.	448.12	454.95	460.32	464.52	467.73	470.09	471.67	472.59	472.88
31.0000		4199.	23.629	5.350	6691.	-2102.	445.31	453.11	458.50	462.70	465.90	468.25	469.85	470.76	471.05
31.2500		4196.	23.617	5.348	6688.	-2101.	444.49	451.31	456.69	460.88	464.08	466.43	468.02	468.93	469.23
31.5000		4195.	23.606	5.346	6686.	-2101.	442.68	449.50	454.87	459.06	462.26	464.60	466.20	467.11	467.40
31.7500		4194.	23.596	5.345	6684.	-2100.	440.87	447.69	453.05	457.24	460.44	462.78	464.37	465.29	465.58
32.0000		4193.	23.588	5.343	6683.	-2099.	439.05	445.87	451.23	455.42	458.62	460.96	462.55	463.46	463.76
32.2500		4192.	23.581	5.342	6682.	-2099.	437.24	444.05	449.42	453.60	456.80	459.14	460.73	461.64	461.94
32.5000		4192.	23.575	5.342	6682.	-2099.	435.43	442.24	447.60	451.78	454.98	457.32	458.91	459.83	460.12
32.7500		4191.	23.570	5.341	6681.	-2098.	433.61	440.43	445.79	449.97	453.16	455.51	457.10	458.01	459.30
33.0000		4191.	23.566	5.340	6681.	-2098.	431.80	439.61	443.97	448.15	451.35	453.69	455.28	456.19	455.48
33.2500		4191.	23.563	5.340	6681.	-2099.	429.99	436.80	442.16	446.34	449.53	451.87	453.46	454.37	454.67
33.5000		4191.	23.560	5.340	6681.	-2098.	428.17	434.99	440.34	444.52	447.72	450.06	451.65	452.56	452.85
33.7500		4191.	23.559	5.340	6681.	-2099.	426.36	433.17	438.53	442.71	445.90	448.25	449.83	450.75	451.04
34.0000		4191.	23.558	5.340	6682.	-2099.	424.55	431.36	436.72	440.90	444.09	446.43	448.02	448.93	449.22
34.2500		4192.	23.558	5.340	6683.	-2099.	422.74	429.55	434.90	439.09	442.28	444.62	446.21	447.12	447.41
34.5000		4192.	23.558	5.340	6684.	-2099.	420.92	427.74	433.09	437.27	440.47	442.81	444.40	445.31	445.60
34.7500		4193.	23.559	5.341	6685.	-2099.	419.11	425.92	431.28	435.46	438.66	441.00	442.59	443.50	443.79
35.0000		4194.	23.560	5.341	6686.	-2099.	417.30	424.11	429.47	433.65	436.84	439.19	440.77	441.69	441.98
35.2500		4194.	23.562	5.342	6687.	-2100.	415.49	422.30	427.66	431.84	435.03	437.38	438.96	439.87	440.17
35.5000		4195.	23.564	5.342	6689.	-2100.	413.67	420.49	425.85	430.03	433.22	435.56	437.15	438.06	433.35
35.7500		4196.	23.567	5.343	6690.	-2101.	411.86	418.68	424.04	428.22	431.41	433.75	435.34	436.25	435.55
36.0000		4197.	23.570	5.344	6692.	-2101.	410.05	416.86	422.22	426.41	429.60	431.95	433.53	434.45	434.74
36.2500		4198.	23.573	5.345	6693.	-2102.	408.24	415.05	420.41	424.60	427.79	430.14	431.73	432.64	432.93
36.5000		4199.	23.576	5.346	6695.	-2102.	406.42	413.24	418.60	422.79	425.98	428.33	429.92	430.83	431.12
36.7500		4200.	23.580	5.347	6697.	-2103.	404.61	411.43	416.79	420.98	424.17	426.52	428.11	429.02	429.31
37.0000		4201.	23.584	5.347	6698.	-2103.	402.80	409.62	414.98	419.17	422.37	424.71	426.30	427.21	427.50
37.2500		4202.	23.589	5.348	6700.	-2104.	400.99	407.81	413.17	417.36	420.56	422.90	424.49	425.40	425.69
37.5000		4203.	23.592	5.349	6702.	-2104.	399.17	406.00	411.36	415.55	418.75	421.09	422.68	423.59	423.89
37.7500		4205.	23.597	5.351	6704.	-2105.	397.36	404.19	409.55	413.74	416.94	419.28	420.87	421.79	422.08
38.0000		4206.	23.601	5.352	6706.	-2105.	395.55	402.38	407.74	411.93	415.13	417.48	419.07	419.98	420.27
38.2500		4207.	23.606	5.353	6708.	-2106.	393.74	400.56	405.93	410.12	413.32	415.67	417.26	418.17	418.46
38.5000		4208.	23.611	5.354	6710.	-2107.	391.92	398.75	404.12	408.31	411.51	413.86	415.45	416.36	415.66
38.7500		4209.	23.616	5.355	6712.	-2107.	390.11	396.94	402.31	406.50	409.71	412.05	413.64	414.56	414.85
39.0000		4211.	23.620	5.356	6714.	-2108.	388.30	395.13	400.50	404.70	407.90	410.24	411.84	412.75	413.04
39.2500		4212.	23.625	5.357	6715.	-2109.	386.49	393.32	398.69	402.89	406.09	408.44	410.03	410.94	411.24
39.5000		4213.	23.630	5.358	6717.	-2109.	384.68	391.51	396.88	401.08	404.28	406.63	408.22	409.14	409.43
39.7500		4214.	23.635	5.359	6719.	-2110.	382.86	389.70	395.07	399.27	402.47	404.82	406.42	407.33	407.62

SPRAY NOZZLE, SMUD COOLDOWN INCIDENT

DATE 05/15/78

TIME	EQUIV RAD	LIN. STR.	DELT1	DELT2	THERMAL STRESS INSIDE	THERMAL STRESS OUTSIDE	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9
40.0000		4216.	23.641	5.360	6721.	-2110.	381.05	387.89	393.26	397.46	400.66	403.0[illegible]	404.61	405.52	405.81
40.2500		4125.	23.128	4.977	6479.	-2091.	380.01	386.44	391.61	395.72	398.88	401.21	402.80	403.72	404.01
40.5000		4003.	22.444	4.752	6264.	-2028.	378.97	385.16	390.15	394.11	397.19	399.47	401.03	401.93	402.21
40.7500		3879.	21.750	4.600	6065.	-1969.	377.94	383.91	388.75	392.59	395.57	397.78	399.30	400.18	400.46
41.0000		3762.	21.089	4.455	5883.	-1908.	376.91	382.72	387.40	391.12	394.01	396.16	397.63	398.48	398.75
41.2500		3652.	20.471	4.345	5715.	-1852.	375.88	381.54	386.08	389.69	392.50	394.59	396.00	396.83	397.09
41.5000		3550.	19.898	4.237	5560.	-1793.	374.86	380.37	384.79	388.30	391.02	393.05	394.43	395.23	395.49
41.7500		3455.	19.369	4.138	5417.	-1750.	373.84	379.21	383.52	386.94	389.59	391.56	392.90	393.68	393.93
42.0000		3368.	18.881	4.047	5286.	-1705.	372.82	378.07	382.27	385.61	388.19	390.10	391.41	392.17	392.41
42.2500		3288.	18.431	3.963	5165.	-1663.	371.80	376.94	381.05	384.30	386.82	388.69	389.96	390.70	390.94
42.5000		3214.	18.016	3.845	5053.	-1625.	370.78	375.82	379.84	383.02	385.48	387.30	388.55	389.27	389.50
42.7500		3146.	17.633	3.814	4950.	-1590.	369.77	374.71	378.64	381.76	384.17	385.95	387.17	387.87	388.09
43.0000		3084.	17.281	3.748	4855.	-1557.	368.75	373.60	377.46	380.52	382.88	384.62	385.81	386.50	385.72
43.2500		3026.	16.956	3.648	4768.	-1527.	367.74	372.50	376.30	379.30	381.61	383.32	384.49	385.16	385.38
43.5000		2973.	16.657	3.632	4687.	-1500.	366.73	371.42	375.15	378.09	380.37	382.04	383.19	383.85	384.06
43.7500		2923.	16.381	3.581	4613.	-1474.	365.72	370.34	374.01	376.91	379.14	380.79	381.91	382.56	382.77
44.0000		2878.	16.127	3.533	4544.	-1451.	364.71	369.26	372.88	375.73	377.93	379.55	380.66	381.30	381.50
44.2500		2835.	15.892	3.490	4441.	-1429.	363.70	368.19	371.76	374.57	376.74	378.34	379.43	380.05	380.25
44.5000		2798.	15.676	3.449	4423.	-1409.	362.69	367.13	370.65	373.43	375.56	377.14	378.21	378.83	379.03
44.7500		2763.	15.477	3.412	4369.	-1391.	361.68	366.07	369.55	372.29	374.40	375.95	377.01	377.62	377.82
45.0000		2730.	15.294	3.378	4320.	-1374.	360.67	365.02	368.46	371.17	373.25	374.78	375.83	376.43	375.62
45.2500		2700.	15.125	3.347	4275.	-1358.	359.67	363.97	367.37	370.05	372.11	373.63	374.66	375.25	375.44
45.5000		2672.	14.969	3.318	4233.	-1344.	358.66	362.92	366.30	368.95	370.98	372.49	373.50	374.09	374.28
45.7500		2647.	14.825	3.291	4194.	-1331.	357.65	361.88	365.22	367.85	369.87	371.35	372.36	372.94	373.13
46.0000		2623.	14.693	3.266	4158.	-1318.	356.65	360.84	364.16	366.76	368.76	370.23	371.23	371.80	371.99
46.2500		2601.	14.571	3.244	4126.	-1307.	355.64	359.80	363.10	365.68	367.66	369.12	370.11	370.68	370.86
46.5000		2581.	14.459	3.223	4096.	-1297.	354.64	358.77	362.04	364.60	366.57	368.01	368.99	369.56	369.74
46.7500		2563.	14.355	3.203	4068.	-1287.	353.64	357.74	360.99	363.53	365.49	366.92	367.89	368.45	368.63
47.0000		2546.	14.260	3.186	4042.	-1278.	352.63	356.71	359.94	362.47	364.40	365.83	366.80	367.35	367.53
47.2500		2530.	14.172	3.159	4018.	-1270.	351.63	355.69	358.89	361.41	363.33	364.75	365.71	366.26	365.44
47.5000		2516.	14.091	3.154	3997.	-1263.	350.63	354.66	357.85	360.35	362.26	353.67	364.63	365.18	365.35
47.7500		2503.	14.016	3.140	3977.	-1256.	349.62	353.64	356.82	359.30	361.20	362.60	363.55	364.10	364.27
48.0000		2491.	13.948	3.128	3958.	-1250.	348.62	352.62	355.78	358.25	360.15	361.54	362.49	363.03	363.20
48.2500		2479.	13.884	3.116	3941.	-1244.	347.62	351.60	354.75	357.21	359.10	360.49	361.42	361.96	362.14
48.5000		2469.	13.826	3.105	3925.	-1238.	346.61	350.59	353.72	356.17	358.05	359.43	360.36	360.90	361.07
48.7500		2459.	13.772	3.095	3911.	-1233.	345.61	349.57	352.69	355.13	357.00	358.38	359.31	359.85	360.02
49.0000		2451.	13.723	3.086	3898.	-1229.	344.61	348.56	351.67	354.10	355.96	357.33	358.26	358.79	359.97
49.2500		2443.	13.677	3.077	3886.	-1225.	343.61	347.55	350.65	353.07	354.93	356.29	357.22	357.75	357.92
49.5000		2435.	13.636	3.070	3875.	-1221.	342.61	346.53	349.62	352.04	353.89	355.25	356.17	356.70	355.87
49.7500		2428.	13.597	3.062	3864.	-1217.	341.61	345.52	348.60	351.02	352.86	354.22	355.14	355.66	355.83

DECAY HEAT NOZZLE, SMUD COOLDOWN INCIDENT DATE 05/15/78

DIMENSIONS

INSIDE RADIUS = 5.2500 INCHES OUTSIDE RADIUS = 9.6250 INCHES REF A-6

NO. OF NODES = 9 RADIAL INCREMENT = .5469 INCHES

MATERIAL CODE = 1 POISSON S RATIO = .3000

L = .8750

CLADDING THICK. = .1875 CLADDING MATL. = 3

INITIAL CONDITIONS

NODE	RADIUS	TEMPERATURE
1	5.2500	570.0
2	5.7969	570.0
3	6.3434	570.0
4	6.8906	570.0
5	7.4375	570.0
6	7.9844	570.0
7	8.5313	570.0
8	9.0781	570.0
9	9.6250	570.0

DECAY HEAT NOZZLE, SMUD COOLDOWN INCIDENT DATE 05/15/78

TABULATION OF
BOUNDARY CONDITIONS

FLUID TEMP. CURVE APPROXIMATION TIME (MINUTES)	FLUID TEMP. CURVE APPROXIMATION INSIDE FLUID TEMPERATURE	FLUID FLOW CURVE APPROXIMATION TIME (MINUTES)	FLUID FLOW CURVE APPROXIMATION INSIDE FLOW GPM	PRESSURE CURVE APPROXIMATION TIME (MINUTES)	PRESSURE CURVE APPROXIMATION PRESSURE (PSI)
0.0000	570.0	0.0000	.1 *	0.0000	0.
5.0000	570.0	110.0000	.1 *	0.0000	0.
10.0000	590.0	0.0000	0.0	0.0000	0.
15.0000	590.0	0.0000	0.0	0.0000	0.
20.0000	525.0	0.0000	0.0	0.0000	0.
40.0000	380.0	0.0000	0.0	0.0000	0.
60.0000	300.0	0.0000	0.0	0.0000	0.
80.0000	280.0	0.0000	0.0	0.0000	0.
95.0000	285.0	0.0000	0.0	0.0000	0.
110.0000	305.0	0.0000	0.0	0.0000	0.

REF P9 A-5

TEMPERATURE CALCULATION TIMES AND PRINTOUTS

TIME INCREMENT (MINUTES)	TIME LIMIT (MINUTES)	NUMBER OF PRINTOUTS
.2500	110.000	440.

* THIS IS BASED ESSENTIALLY ON A ZERO FLOW RATE.

DECAY HEAT NOZZLE, SMUD COOLDOWN INCIDENT DATE 05/15/78

THERMAL PROPERTIES

TIME	INSIDE FLUID TEMP.	INSIDE FILM COEFF.	EFF. FILM COEFF.	AVE. TEMP.	CONDUC-TIVITY	SPECIFIC HEAT	YOUNGS MODULUS	COEFF. OF EXPANS.	DENSITY
40.000	380.	367.	236.	473.3206	329.1144	.1272	2.72E+07	.70E-05	435.7097
40.250	379.	366.	236.	471.8446	329.2872	.1272	2.72E+07	.70E-05	435.7287
40.500	378.	364.	235.	470.3894	329.4576	.1271	2.72E+07	.70E-05	435.7475
40.750	377.	363.	234.	468.9490	329.6261	.1271	2.72E+07	.70E-05	435.7660
41.000	376.	362.	234.	467.5234	329.7931	.1270	2.72E+07	.70E-05	435.7843
41.250	375.	361.	233.	466.1093	329.9587	.1270	2.73E+07	.70E-05	435.8025
41.500	374.	360.	233.	464.7034	330.1232	.1269	2.73E+07	.70E-05	435.8206
41.750	373.	359.	232.	463.3076	330.2865	.1269	2.73E+07	.70E-05	435.8386
42.000	372.	358.	232.	461.9204	330.4490	.1268	2.73E+07	.70E-05	435.8564
42.250	371.	357.	232.	460.5410	330.6105	.1268	2.73E+07	.70E-05	435.8742
42.500	370.	356.	231.	459.1690	330.7711	.1267	2.73E+07	.70E-05	435.8919
42.750	369.	355.	231.	457.8040	330.9309	.1267	2.73E+07	.70E-05	435.9094
43.000	368.	354.	230.	456.4455	331.0899	.1266	2.73E+07	.70E-05	435.9269
43.250	367.	353.	230.	455.0934	331.2482	.1266	2.73E+07	.70E-05	435.9443
43.500	366.	352.	229.	453.7474	331.4058	.1265	2.74E+07	.70E-05	435.9616
43.750	365.	351.	229.	452.4072	331.5626	.1265	2.74E+07	.70E-05	435.9789
44.000	364.	350.	228.	451.0727	331.7189	.1264	2.74E+07	.70E-05	435.9961
44.250	363.	349.	228.	449.7438	331.8744	.1264	2.74E+07	.70E-05	436.0132
44.500	362.	348.	228.	448.4202	332.0294	.1263	2.74E+07	.69E-05	436.0302
44.750	361.	347.	227.	447.1018	332.1837	.1263	2.74E+07	.69E-05	436.0472
45.000	360.	347.	227.	445.7886	332.3374	.1262	2.74E+07	.69E-05	436.0641
45.250	359.	346.	226.	444.4803	332.4906	.1262	2.74E+07	.69E-05	436.0809
45.500	358.	345.	226.	443.1770	332.6432	.1261	2.74E+07	.69E-05	436.0977
45.750	357.	344.	226.	441.8785	332.7952	.1261	2.75E+07	.69E-05	436.1144
46.000	356.	343.	225.	440.5848	332.9466	.1260	2.75E+07	.69E-05	436.1310
46.250	355.	342.	225.	439.2957	333.0975	.1260	2.75E+07	.69E-05	436.1476
46.500	354.	341.	224.	438.0111	333.2479	.1259	2.75E+07	.69E-05	436.1642
46.750	353.	341.	224.	436.7311	333.3977	.1259	2.75E+07	.69E-05	436.1806
47.000	352.	340.	224.	435.4555	333.5471	.1258	2.75E+07	.69E-05	436.1971
47.250	351.	339.	223.	434.1842	333.6959	.1258	2.75E+07	.69E-05	436.2134
47.500	350.	338.	223.	432.9173	333.8442	.1257	2.75E+07	.69E-05	436.2297
47.750	349.	337.	222.	431.6545	333.9920	.1257	2.75E+07	.69E-05	436.2460
48.000	348.	337.	222.	430.3960	334.1394	.1257	2.75E+07	.69E-05	436.2622
48.250	347.	336.	222.	429.1415	334.2862	.1256	2.76E+07	.69E-05	436.2783
48.500	346.	335.	221.	427.8911	334.4326	.1256	2.75E+07	.69E-05	436.2944
48.750	345.	334.	221.	426.6447	334.5785	.1255	2.76E+07	.69E-05	436.3104
49.000	344.	333.	220.	425.4022	334.7239	.1255	[illegible]	.69E-05	436.3264
49.250	343.	332.	220.	424.1635	334.8589	.1254	2.75E+07	.69E-05	436.3424
49.500	342.	332.	220.	422.9297	335.0135	.1254	2.76E+07	.69E-05	436.3583
49.750	341.	331.	219.	421.6977	335.1576	.1253	2.76E+07	.69E-05	436.3741

DECAY HEAT NOZZLE, SHUD COOLDOWN INCIDENT DATE 05/15/78

THERMAL PROPERTIES

TIME	INSIDE FLUID TEMP.	INSIDE FILM COEFF.	EFF. FILM COEFF.	AVE. TEMP.	CONDUC-TIVITY	SPECIFIC HEAT	YOUNGS MODULUS	COEFF. OF EXPANS.	DENSITY
50.000	340.	330.	219.	420.4703	335.3013	.1253	2.76E+07	.69E-05	436.3899
50.250	339.	329.	218.	419.2457	335.4445	.1252	2.76E+07	.69E-05	436.4057
50.500	338.	329.	218.	418.0256	335.5974	.1252	2.76E+07	.69E-05	436.4214
50.750	337.	328.	218.	416.8101	335.7298	.1252	2.77E+07	.69E-05	436.4370
51.000	336.	327.	217.	415.5970	335.8718	.1251	2.77E+07	.69E-05	436.4526
51.250	335.	326.	217.	414.3875	336.0134	.1251	2.77E+07	.69E-05	436.4682
51.500	334.	325.	217.	413.1913	336.1546	.1250	2.77E+07	.69E-05	436.4837
51.750	333.	325.	216.	411.9795	336.2954	.1250	2.77E+07	.69E-05	436.4992
52.000	332.	324.	216.	410.7790	336.4358	.1249	2.77E+07	.69E-05	436.5146
52.250	331.	323.	215.	409.5827	336.5758	.1249	2.77E+07	.69E-05	436.5300
52.500	330.	322.	215.	408.3937	336.7155	.1248	2.77E+07	.69E-05	436.5454
52.750	329.	322.	215.	407.1998	336.8548	.1248	2.77E+07	.69E-05	436.5607
53.000	328.	321.	214.	406.0131	336.9937	.1248	2.77E+07	.69E-05	436.5760
53.250	327.	320.	214.	404.8295	337.1323	.1247	2.77E+07	.69E-05	436.5912
53.500	326.	319.	214.	403.6499	337.2705	.1247	2.78E+07	.68E-05	436.6064
53.750	325.	319.	213.	402.4717	337.4083	.1246	2.78E+07	.68E-05	436.6216
54.000	324.	318.	213.	401.2366	337.5459	.1246	2.78E+07	.68E-05	436.6367
54.250	323.	317.	213.	400.1248	337.6830	.1245	2.78E+07	.68E-05	436.6518
54.500	322.	316.	212.	398.9559	337.8198	.1245	2.78E+07	.68E-05	436.6668
54.750	321.	316.	212.	397.7839	337.9563	.1245	2.78E+07	.68E-05	436.6818
55.000	320.	315.	211.	396.6266	338.0925	.1244	2.78E+07	.68E-05	436.6968
55.250	319.	314.	211.	395.4661	338.2284	.1244	2.78E+07	.68E-05	436.7117
55.500	318.	314.	211.	394.3091	338.3639	.1243	2.78E+07	.68E-05	436.7266
55.750	317.	313.	210.	393.1531	338.4991	.1243	2.78E+07	.68E-05	436.7413
56.000	316.	312.	210.	392.0006	338.6341	.1242	2.78E+07	.68E-05	436.7563
56.250	315.	311.	210.	390.8507	338.7687	.1242	2.78E+07	.68E-05	436.7711
56.500	314.	311.	209.	389.7034	338.9030	.1242	2.79E+07	.68E-05	436.7859
56.750	313.	310.	209.	388.5595	339.0370	.1241	2.79E+07	.68E-05	436.8006
57.000	312.	309.	209.	387.4162	339.1707	.1241	2.79E+07	.68E-05	436.8153
57.250	311.	309.	208.	386.2753	339.3042	.1240	2.79E+07	.68E-05	436.8300
57.500	310.	308.	208.	385.1398	339.4373	.1240	2.79E+07	.68E-05	436.8446
57.750	309.	307.	207.	384.0037	339.5702	.1239	2.79E+07	.68E-05	436.8592
58.000	308.	306.	207.	382.8710	339.7028	.1239	2.79E+07	.68E-05	436.8738
58.250	307.	306.	207.	381.7406	339.8351	.1239	2.79E+07	.68E-05	436.8884
58.500	306.	305.	206.	380.6124	339.9672	.1238	2.79E+07	.68E-05	436.9029
58.750	305.	304.	206.	379.4855	340.0990	.1238	2.79E+07	.68E-05	436.9174
59.000	304.	304.	206.	378.3628	340.2305	.1237	2.79E+07	.68E-05	436.9318
59.250	303.	303.	205.	377.2414	340.3618	.1237	2.79E+07	.68E-05	436.9463
59.500	302.	302.	205.	376.1220	340.4929	.1236	2.80E+07	.68E-05	436.9607
59.750	301.	302.	205.	375.0048	340.6236	.1236	2.80E+07	.68E-05	436.9751

Y-51

DECAY HEAT NOZZLE, SMUD COOLDOWN INCIDENT DATE 05/15/78

THERMAL PROPERTIES

TIME	INSIDE FLUID TEMP.	INSIDE FILM COEFF.	EFF. FILM COEFF.	AVE. TEMP.	CONDUC-TIVITY	SPECIFIC HEAT	YOUNGS MODULUS	COEFF. OF EXPANS.	DENSITY
60.000	300.	301.	204.	373.8897	340.7542	.1236	2.80E+07	.68E-05	436.9996
60.250	300.	299.	204.	372.7913	340.8828	.1235	2.80E+07	.68E-05	437.0035
60.500	300.	298.	203.	371.7159	341.0085	.1235	2.80E+07	.68E-05	437.0176
60.750	299.	296.	202.	370.6622	341.1320	.1234	2.80E+07	.68E-05	437.0309
61.000	299.	295.	201.	369.6249	341.2534	.1234	2.80E+07	.68E-05	437.0443
61.250	299.	293.	201.	368.6036	341.3730	.1234	2.80E+07	.68E-05	437.0574
61.500	299.	292.	200.	367.5972	341.4908	.1233	2.80E+07	.68E-05	437.0704
61.750	298.	291.	200.	366.6048	341.6070	.1233	2.80E+07	.68E-05	437.0832
62.000	298.	290.	199.	365.6255	341.7216	.1232	2.80E+07	.68E-05	437.0958
62.250	298.	288.	198.	364.6589	341.8348	.1232	2.80E+07	.68E-05	437.1082
62.500	298.	287.	198.	363.7044	341.9465	.1232	2.80E+07	.68E-05	437.1205
62.750	297.	286.	197.	362.7616	342.0569	.1231	2.81E+07	.68E-05	437.1326
63.000	297.	285.	197.	361.8301	342.1659	.1231	2.81E+07	.68E-05	437.1445
63.250	297.	284.	196.	360.9095	342.2737	.1231	2.81E+07	.68E-05	437.1563
63.500	297.	283.	196.	359.9996	342.3802	.1230	2.81E+07	.68E-05	437.1692
63.750	296.	282.	195.	359.1001	342.4855	.1230	2.81E+07	.68E-05	437.1779
64.000	296.	281.	194.	358.2108	342.5896	.1229	2.81E+07	.68E-05	437.1912
64.250	296.	280.	194.	357.3314	342.6926	.1229	2.81E+07	.67E-05	437.2025
64.500	296.	278.	193.	356.4617	342.7944	.1229	2.81E+07	.67E-05	437.2137
64.750	295.	277.	193.	355.6015	342.8951	.1228	2.81E+07	.67E-05	437.2248
65.000	295.	276.	192.	354.7507	342.9947	.1228	2.81E+07	.67E-05	437.2357
65.250	295.	275.	192.	353.9091	343.0932	.1228	2.81E+07	.67E-05	437.2466
65.500	295.	274.	191.	353.0755	343.1907	.1227	2.81E+07	.67E-05	437.2573
65.750	294.	273.	191.	352.2528	343.2871	.1227	2.81E+07	.67E-05	437.2679
66.000	294.	272.	190.	351.4377	343.3425	.1227	2.81E+07	.67E-05	437.2784
66.250	294.	271.	190.	350.6312	343.4769	.1226	2.81E+07	.67E-05	437.2887
66.500	294.	270.	189.	349.8332	343.5703	.1226	2.81E+07	.67E-05	437.2990
66.750	293.	269.	189.	349.0434	343.6628	.1226	2.81E+07	.67E-05	437.3092
67.000	293.	269.	188.	348.2618	343.7543	.1225	2.82E+07	.67E-05	437.3192
67.250	293.	268.	188.	347.4882	343.8448	.1225	2.82E+07	.67E-05	437.3292
67.500	293.	267.	187.	346.7225	343.9345	.1225	2.82E+07	.67E-05	437.3391
67.750	292.	266.	187.	345.9645	344.0232	.1225	2.82E+07	.67E-05	437.3488
68.000	292.	265.	187.	345.2142	344.1110	.1224	2.82E+07	.67E-05	437.3585
68.250	292.	264.	186.	344.4715	344.1980	.1224	2.82E+07	.67E-05	437.3680
68.500	292.	263.	186.	343.7361	344.2841	.1224	2.82E+07	.67E-05	437.3775
68.750	291.	262.	185.	343.0090	344.3693	.1223	2.82E+07	.67E-05	437.3869
69.000	291.	261.	185.	342.2872	344.4537	.1223	2.82E+07	.67E-05	437.3961
69.250	291.	260.	184.	341.5733	344.5373	.1223	2.82E+07	.67E-05	437.4053
69.500	291.	259.	184.	340.8665	344.6200	.1222	2.82E+07	.67E-05	437.4144
69.750	290.	259.	183.	340.1665	344.7019	.1222	2.82E+07	.67E-05	437.4234

DECAY HEAT NOZZLE, SMUD COOLDOWN INCIDENT DATE 05/15/78

THERMAL PROPERTIES

TIME	INSIDE FLUID TEMP.	INSIDE FILM COEFF.	EFF. FILM COEFF.	AVE. TEMP.	CONDUC-TIVITY	SPECIFIC HEAT	YOUNGS MODULUS	COEFF. OF EXPANS.	DENSITY
70.000	290.	258.	193.	339.4733	344.7831	.1222	2.82E+07	.67E-05	437.4326
70.250	290.	257.	192.	338.7857	344.8635	.1222	2.82E+07	.67E-05	437.4412
70.500	290.	256.	192.	338.1066	344.9431	.1221	2.82E+07	.67E-05	437.4499
70.750	289.	255.	192.	337.4330	345.0219	.1221	2.82E+07	.67E-05	437.4586
71.000	289.	254.	191.	336.7[illegible]	345.1001	.1221	2.82E+07	.67E-05	437.4672
71.250	289.	253.	191.	336.[illegible]147	345.1774	.1221	2.82E+07	.67E-05	437.4757
71.500	289.	253.	190.	335.4438	345.2541	.1220	2.82E+07	.67E-05	437.4841
71.750	288.	252.	180.	334.8010	345.3301	.1220	2.82E+07	.67E-05	437.4925
72.000	288.	251.	179.	334.1582	345.4053	.1220	2.83E+07	.67E-05	437.5008
72.250	288.	250.	179.	333.5212	345.4797	.1219	2.83E+07	.67E-05	437.5090
72.500	288.	249.	179.	332.8900	345.5538	.1219	2.83E+07	.67E-05	437.5171
72.750	287.	249.	178.	332.2645	345.6270	.1219	2.83E+07	.67E-05	437.5251
73.000	287.	248.	178.	331.6446	345.6996	.1219	2.83E+07	.67E-05	437.5331
73.250	287.	247.	177.	331.0302	345.7715	.1218	2.83E+07	.67E-05	437.5410
73.500	287.	246.	177.	330.4213	345.8428	.1218	2.83E+07	.67E-05	437.5489
73.750	286.	246.	177.	329.8177	345.9134	.1218	2.83E+07	.67E-05	437.5566
74.000	286.	245.	176.	329.2194	345.9835	.1218	2.83E+07	.67E-05	437.5643
74.250	286.	244.	176.	328.6263	346.0529	.1217	2.83E+07	.67E-05	437.5720
74.500	286.	243.	175.	328.0382	346.1217	.1217	2.83E+07	.67E-05	437.5795
74.750	285.	243.	175.	327.4533	346.1900	.1217	2.83E+07	.67E-05	437.5870
75.000	285.	242.	175.	326.8773	346.2576	.1217	2.83E+07	.67E-05	437.5945
75.250	285.	241.	174.	326.3041	346.3247	.1216	2.83E+07	.67E-05	437.6018
75.500	285.	241.	174.	325.7358	346.3913	.1216	2.83E+07	.67E-05	437.6092
75.750	284.	240.	173.	325.1722	346.4572	.1216	2.83E+07	.67E-05	437.6164
76.000	284.	239.	173.	324.6132	346.5227	.1216	2.83E+07	.67E-05	437.6236
76.250	284.	238.	173.	324.0599	346.5876	.1215	2.83E+07	.67E-05	437.6307
76.500	284.	238.	172.	323.5091	346.6519	.1215	2.83E+07	.67E-05	437.6378
76.750	283.	237.	172.	322.9637	346.7158	.1215	2.83E+07	.67E-05	437.6448
77.000	283.	236.	172.	322.4227	346.7791	.1215	2.83E+07	.67E-05	437.6518
77.250	283.	236.	171.	321.8851	346.8419	.1215	2.83E+07	.67E-05	437.6587
77.500	283.	235.	171.	321.3536	346.9043	.1214	2.83E+07	.67E-05	437.6656
77.750	282.	234.	171.	320.8254	346.9661	.1214	2.83E+07	.67E-05	437.6724
78.000	282.	234.	170.	320.3013	347.0274	.1214	2.83E+07	.67E-05	437.6791
78.250	282.	233.	170.	319.7813	347.0883	.1214	2.83E+07	.67E-05	437.6858
78.500	282.	233.	170.	319.2652	347.1487	.1213	2.84E+07	.67E-05	437.6924
78.750	281.	232.	169.	318.7531	347.2087	.1213	2.84E+07	.67E-05	437.6990
79.000	281.	231.	169.	318.2449	347.2682	.1213	2.84E+07	.67E-05	437.7056
79.250	281.	231.	169.	317.7405	347.3272	.1213	2.84E+07	.67E-05	437.7121
79.500	281.	230.	168.	317.2399	347.3858	.1213	2.84E+07	.67E-05	437.7185
79.750	280.	230.	168.	316.7430	347.4440	.1212	2.84E+07	.67E-05	437.7249

CONTRACT NO. 575-7072 620-0011	DOCUMENT COMMENT FORM	RELEASED BY J M Burnett 11/8/78 TASK ENGINEER DATE
SUPPLIER B&W	PREPARED BY: J M Burnett 11/8/78 NAME DATE	REL. DATE 11-17-78 / PAGE 1 OF 1
PO. NO.		

PART/TGS	B&W DOC. NO.	DOCUMENT TITLE	CUSTOMER/ SUPPLIER DOC. NO.	STATUS	RRL NUMBER
55-01-001	33 0273 00	OTSG SUPPORT SKIRT STRESS EVALUATION OF "RAPID COOLDOWN" EVENT OF MARCH 20, 1978 FOR SACRAMENTO MUNICIPAL UTILITY DISTRICT, B&W CONTRACT NO. 620-0011-55, CUSTOMER ORDER #3075.	620-0011-55 ORDER # 3075	APPROVED	N/A
55-01-001	33 0274 00	OTSG LOWER TUBESHEET AREA AND TUBE STRESS EVALUATION DUE TO THE "RAPID COOLDOWN" EVENT OF MARCH 20, 1978 FOR SACRAMENTO MUNICIPAL UTILITY DISTRICT, B&W CONTRACT #620-0011-55, CUSTOMER ORDER NO. 3075.	620-0011-55 ORDER # 3075	APPROVED	N/A

DISTRIBUTION:

J. M. BURNETT (W/1 ATTACH)
J. D. BREW (W/1 ATTACH) -MTV
J. J. KELLY (W/6 ATTACH)
J. T. JANIS (W/O ATTACH)

OTSG SUPPORT SKIRT STRESS EVALUATION
OF "RAPID COOLDOWN" EVENT OF
MARCH 20, 1978
FOR
SACRAMENTO MUNICIPAL UTILITY DISTRICT
B&W CONTRACT NO. 620-0011-55
CUSTOMER ORDER #3075

BY: J. L. Hankins / Engineer / 08/28/78

APPROVED BY: John D. Brun / Supervisor / 8-29-78

B & W DOCUMENT NUMBER
33 0273 00

COMPONENT ENGINEERING
MT. VERNON WORKS
MT. VERNON, INDIANA

INTRODUCTION:

The Thermal Model was taken from the 'Stress Analysis of Support Skirt' for Sacramento Municipal Utility District, Report No. 3, B&W Contract No. 620-0011-55 and the cooldown transient experienced on March 20, 1978, was analyzed for cumulative damage. The cumulative fatigue from this occurrence was then combined with the usage factor anticipated for the service life of the plant.

The original analysis of the support skirt yielded primary plus secondary stress intensity ranges in excess of the 3 S_m allowable limit. Therefore, a simplified elastic analysis was performed to calculate the cumulative usage factor. The one cycle cooldown incident has been analyzed by the simplified elastic plastic method also.

DISCUSSION:

The thermal model from the stress report was subjected to the "cool-down" transient with the use of B&W computer program 91167, Transient Temperature Distribution. Heat balance equations were calculated by the program and the time-temperature history determined.

By comparing the thermal gradients between selected nodes in the 91167 output summary to those plotted in the stress report, it was found the cooldown transient produced more severe thermal gradients at the support skirt to head juncture; therefore, a stress evaluation was necessary.

The thermal and pressure motions ot the juncture of the head and tube-sheet were calculated in the evaluation of stresses produced by the cool-down incident on the tubesheet. These motions were imposed on the top edge of the head as boundary conditions. The dead weight at the head and support skirt interface produces a moment on the head due to the diameter of the support skirt being greater than the head diameter. The deadweight force and moment were imposed on the head at the juncture with the support skirt. These boundary conditions at the top of the head and at the interface between the head and support skirt along with the pressure and temperature distributions that produced the most severe gradients were applied to the stress model for the lower head by using B&W Program 91206, Save 55-2. The motions that resulted at the support skirt to head juncture were then imposed on the stress model for the support skirt and primary plus secondary and peak stress intensities were calculated.

JJH
620-0011-55

RESULTS:

The maximum primary plus secondary stress intensity range = 168.8 KSI > 80.1 KSI = 3 S_m; therefore, a simplified elastic plastic analysis was performed.

The usage factor for the 1 cycle of "Rapid Cooldown" is 0.02.

The usage factor for 240 cycles of heatup and cooldown from the stress report is 0.89.

The cumulative usage factor is 0.89 + 0.02 = 0.91 < 1.0.

CONCLUSION:

The analysis of the "Cooldown" transient on the support skirt shows that the cumulative usage factor of the support skirt is less than the allowable; therefore, the structural integrity of the skirt is adequate for its anticipated service life.

THERMAL/MECHANICAL ANALYSIS

REFERENCES:

1. Report No. 3, Stress Analysis of Support Skirt for Sacramento Municipal Utility District, B&W Contract No. 620-0011-55.

2. B&W letter from J.M. Burnett-RCS Components to Distribution, subject SMUD Cooldown Incident dated 4/4/78.

3. "OTSG Lower Tubesheet Area and Tube Stress Evaluation Due to the 'Rapid Cooldown' Event of March 20, 1978 for Sacramento Municipal Utility District", B&W Contract 620-0011-55.

4. ASME Code, Section III, 1965 Edition, with Addenda through Summer 1967.

5. USAS B31.7 Nuclear Power Piping Code, Draft USA Standard (Feb. 1968).

6. B&W Computer Program 91167, 'Explicit and Implicit Transient Temperature Distribution'.

7. B&W Computer Program 91032, 'Temperature Interpolation and Free-body Thermal Motions and Stresses'.

8. B&W Computer Program 91206, 'SAVE SS-2'.

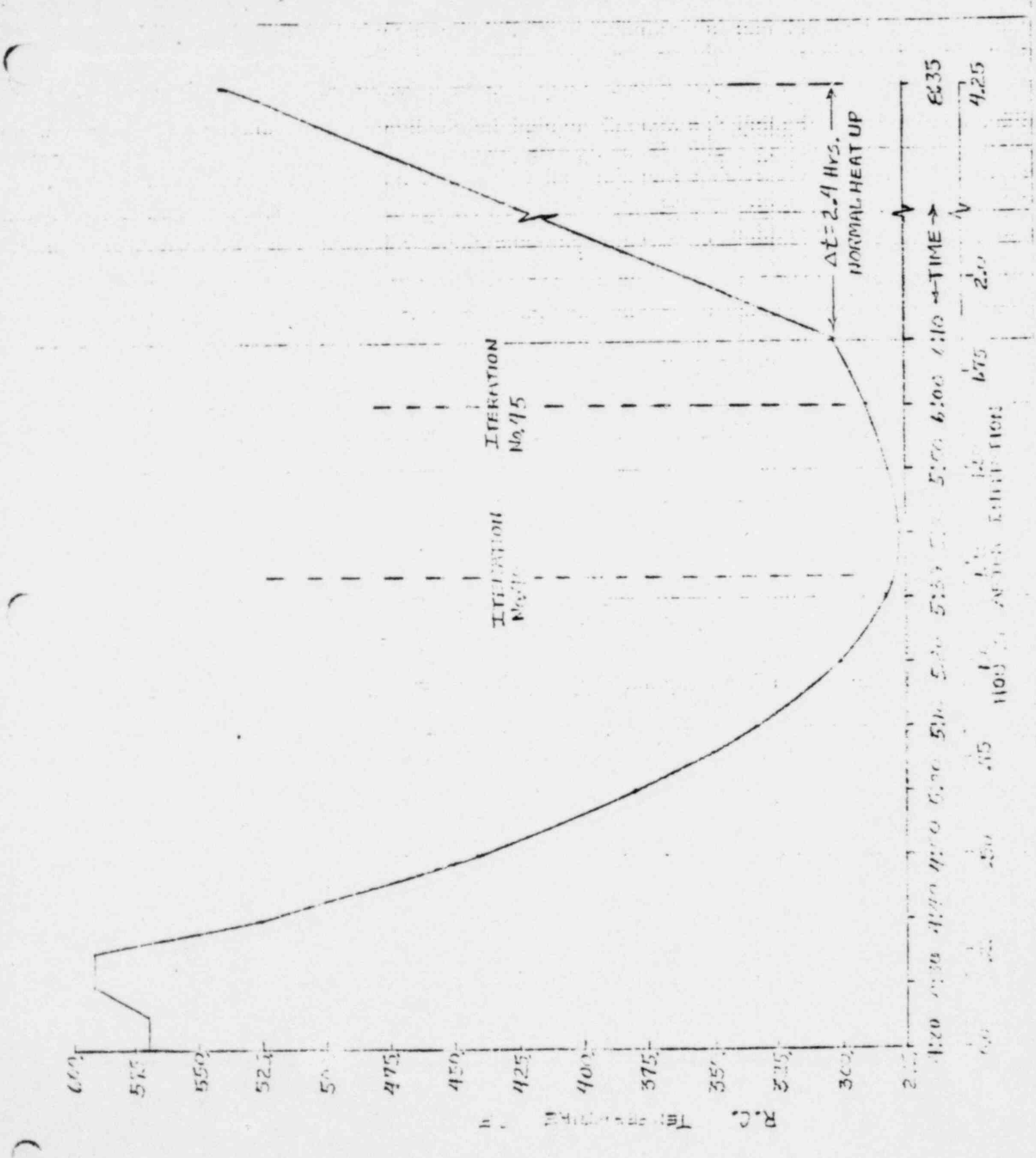
9. B&W letter from J. M. Burnett - RCS Components to Distribution, Subject: SMUD Cooldown Incident, dated 4/7/78.

10. B&W letter from J. M. Burnett - RCS Components to Distribution, Subject: SMUD Cooldown Incident, dated 4/20/78.

JLH
08/78
620-0011-55

The thermal model of the support skirt and lower head as shown in Reference 1 was used in this analysis. The thermal parameters of the thermal grid in Reference 1 were also used.

The analyzed transient from Reference 2, is shown on the following page.



REACTOR COOLANT TEMPERATURE VS TIME

J.L.H.
07/73
620-0011-55

The thermal model, thermal parameters and thermal transient were input into Program 91167, Transient Temperature Distribution, and the time-temperature history was determined.

A summary of certain nodes selected to show axial and radial gradients through the head and support skirt was obtained in the 91167 output.

Two times during the transient that produced the most severe gradients were selected by reviewing the summary.

The following pages contain sample output through Iteration 1 along with the selected iterations (40 and 45) and the nodal summary.

JLH
07/78
620-0011-55

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

TITLE(SMUD COOLDOWN SUPPORT SKIRT)

GENERAL INPUT DATA

NO SOLID BLOCKS	NO FLUID BLOCKS	NO OF EDGES	NO OF LINES	NO OF CYCLES
239	3	4	11	5

BASE TEMP	STARTING TEMP	STARTING TIME	STARTING ITER	PUNCH CARD TIME
0.0	0.0	0.00000	0	0.60000

TIME IS IN HOURS

GEOMETRY OF THE COLUMNS

ROW NO	BLOCK NO. LOW	HI	ADJ	RADIAL DIMS	MEAN RADIUS	LOW EDGE NO	ROW NO	BLOCK NO. LOW	HI	ADJ	RADIAL DIMS	MEAN RADIUS	LOW EDGE NO
1	1	26	11	2.00000	57.00000	1	2	27	52	37	2.00000	59.00000	1
3	53	78	63	2.00000	61.00000	1	4	79	104	89	2.00000	63.00000	1
5	105	125	110	2.00000	65.00000	6	6	126	145	130	1.45000	66.73000	7
7	146	180	149	.75000	67.84000	8	8	181	215	184	.76000	68.59999	8
9	216	226	219	1.04000	69.50000	8	10	227	234	229	1.49000	70.75999	9
11	235	239	236	1.48000	72.23999	10							

TEMPERATURES PER NODE

```
575. 575. 574. 574. 574. 574. 573. 573. 573. 573. 573. 573. 573. 574. 574. 574. 575. 575. 575. 575.
575. 575. 575. 575. 575. 575. 574. 574. 573. 573. 572. 571. 571. 570. 570. 570. 570. 570. 571. 572.
573. 573. 574. 574. 574. 574. 574. 574. 575. 575. 575. 575. 574. 573. 573. 572. 571. 569. 568. 568.
567. 567. 567. 567. 569. 570. 572. 573. 573. 574. 574. 574. 574. 574. 574. 574. 574. 574. 574. 573.
572. 571. 569. 557. 565. 564. 564. 563. 563. 563. 567. 569. 571. 572. 573. 573. 574. 574. 574. 574.
574. 574. 574. 574. 564. 562. 561. 560. 559. 558. 557. 557. 556. 554. 551. 546. 540. 535. 528. 520.
512. 511. 503. 494. 495. 559. 557. 556. 559. 553. 550. 544. 535. 526. 515. 502. 487. 471. 452. 430.
404. 381. 357. 339. 327. 554. 553. 552. 550. 546. 535. 526. 515. 502. 484. 466. 445. 420. 393. 359.
317. 251. 255. 238. 222. 210. 201. 193. 188. 182. 177. 171. 163. 153. 146. 140. 136. 134. 132. 132.
553. 552. 551. 549. 544. 535. 526. 515. 502. 484. 467. 445. 420. 393. 359. 317. 280. 254. 237. 222.
209. 200. 193. 187. 182. 177. 171. 163. 153. 146. 140. 136. 134. 132. 132. 551. 550. 549. 547. 542.
534. 527. 515. 504. 485. 472. 548. 547. 545. 540. 534. 527. 516. 507. 545. 544. 539. 534. 530. 575.
300. 120.
```

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

DETERMINATION OF BLOCKS WITH FLUID BOUNDARIES

SERIES NO	BLOCK NO. FLUID	FIRST	LAST	SIDE NO	SERIES NO	BLOCK NO. FLUID	FIRST	LAST	SIDE NO	SERIES NO	BLOCK NO. FLUID	FIRST	LAST	SIDE NO
1	240	1	26	1	2	241	161	173	1	3	242	196	215	3

AXIAL DIMENSION PER EDGE

EDGE	DIMENSION	EDGE	DIMENSION	EDGE	DIMENSION	EDGE	DIMENSION	EDGE	DIMENSION	EDGE	DIMENSION
1	4.00000	2	3.00000	3	2.00000	4	2.00000	5	2.00000	6	1.50000
7	1.50000	8	1.00000	9	1.00000	10	1.00000	11	2.00000	12	2.40000
13	1.40000	14	2.10000	15	2.20000	16	2.14000	17	2.28000	18	1.58000
19	1.59000	20	2.00000	21	2.00000	22	3.00000	23	3.00000	24	4.00000
25	3.00000	26	3.12000	27	4.00000	28	4.00000	29	4.00000	30	4.00000
31	4.00000	32	4.00000	33	4.00000	34	4.00000	35	4.00000	36	4.00000
37	4.00000	38	4.00000	39	4.00000	40	4.00000	41	4.00000	42	1.50000

J.L.H.
07/79
620-0011-55

TRANSIENT TEMPERATURE DISTRIBUTION   PROGRAM 91167

MATERIAL SERIES

MATL NO	LAST BLOCK	MATL NO	LAST BLOCK	MATL NO	LAST BLOCK	MATL NO	LAST BLOCK	MATL NO	LAST BLOCK	MATL NO	LAST BLOCK	MATL NO	LAST BLOCK
2	111	13	125	2	131	13	141	10	145	2	239		

FLUID BLOCK	FILM COEF.				
240	875.00	875.00	875.00	875.00	875.00
241	1.30	1.30	.65	.65	1.30
242	2.34	2.34	1.17	1.17	2.34

J.L.H.
07/28
620-0011-55

11

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

CYCLE NO. 1 IS IMPLICIT

CYCLE NO. 2 IS IMPLICIT

CYCLE NO. 3 IS IMPLICIT

CYCLE NO. 4 IS IMPLICIT

CYCLE NO. 5 IS IMPLICIT

IMPLICIT CYCLE INFORMATION

LAST STEP NO.	TIME STEP	LAST STEP NO.	TIME STEP	LAST STEP NO.	TIME STEP	LAST STEP NO.	TIME STEP	LAST STEP NO.	TIME STEP	LAST STEP NO.	TIME STEP	LAST STEP NO.	TIME STEP	LAST STEP NO.	TIME STEP
6	.028														
6	.028														
6	.028														
6	.028														
12	.028	18	.056	23	.100	31	.300								

J.L.H.
07/78
620-0011-55

12

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

TIMES AT WHICH EQUATIONS WILL VARY

.16680 .33360 .50040 .66720 4.23380

TIMES FOR PRINTOUT

TIME LIMIT	TIME MULTIPLE
.00080	.02780
.33380	.05550
.83380	.10000
4.23380	.30000

J.L.H.
07/79
620-0::-55

13

TRANSIENT TEMPERATURE DISTRIBUTION   PROGRAM   91167

POINT NO. 240   TYPE 1

TIME	0.00000	.16680	.25020	.33360	.50040	.66720	.83400	1.00080	1.16730
TEMP	570.00000	592.00000	592.00000	525.00000	440.00000	380.00000	332.00000	300.00000	282.00000
TIME	1.33380	1.63380	1.83380	4.23380	999.99000	0.00000	0.00000	0.00000	0.00000
TEMP	277.00000	290.00000	302.00000	540.00000	540.00000	0.00000	0.00000	0.00000	0.00000

POINT NO. 241   TYPE 1

TIME	0.00000	4.23380	999.99000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TEMP	300.00000	300.00000	300.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

J.L.H.
07/78
620-[illegible]-55
14

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

POINT NO. 242 TYPE 1

TIME	0.00000	4.23380	999.99000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TEMP	120.00000	120.00000	120.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

J.L.H.
07/78
620-0011-55
15

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

	PT	K	A	TA	B	TB	C	TC	D	TD	E	TE
0	1	1.0	.043	240	.008	2	.029	27	0.000	24	.820	1
0	2	1.0	.043	240	.015	3	.029	28	.011	1	.901	2
0	3	1.0	.043	240	.029	4	.029	29	.023	2	.876	3
0	4	1.0	.043	240	.029	5	.029	30	.029	3	.870	4
0	5	1.0	.043	240	.033	6	.029	31	.029	4	.866	5
0	6	1.0	.043	240	.051	7	.029	32	.044	5	.832	6
0	7	1.0	.043	240	.062	8	.029	33	.051	6	.815	7
0	8	1.0	.043	240	.116	9	.029	34	.092	7	.720	8
0	9	1.0	.043	240	.116	10	.029	35	.116	8	.696	9
0	10	1.0	.043	240	.077	11	.029	36	.116	9	.735	10
0	11	1.0	.043	240	.026	12	.029	37	.039	10	.863	11
0	12	1.0	.043	240	.025	13	.029	38	.022	11	.890	12
0	13	1.0	.043	240	.047	14	.029	39	.043	12	.837	13
0	14	1.0	.043	240	.026	15	.029	40	.031	13	.871	14
0	15	1.0	.043	240	.024	16	.029	41	.026	14	.870	15
0	16	1.0	.043	240	.024	17	.029	42	.025	15	.878	16
0	17	1.0	.043	240	.026	18	.029	43	.023	16	.879	17
0	18	1.0	.043	240	.046	19	.029	44	.038	17	.844	18
0	19	1.0	.043	240	.041	20	.029	45	.046	18	.841	19
0	20	1.0	.043	240	.029	21	.029	46	.032	19	.867	20
0	21	1.0	.043	240	.023	22	.029	47	.029	20	.876	21
0	22	1.0	.043	240	.013	23	.029	48	.015	21	.900	22
0	23	1.0	.043	240	.011	24	.029	49	.013	22	.904	23
0	24	1.0	.043	240	.008	25	.029	50	.008	23	.911	24
0	25	1.0	.043	240	.013	26	.029	51	.011	24	.906	25
0	26	1.0	.043	240	0.000	243	.029	52	.012	25	.916	26
0	27	1.0	.028	1	.008	28	.029	53	0.000	243	.934	27
0	28	1.0	.028	2	.015	29	.029	54	.011	27	.916	28
0	29	1.0	.028	3	.029	30	.029	55	.023	28	.890	29
0	30	1.0	.028	4	.029	31	.029	56	.029	29	.884	30
0	31	1.0	.028	5	.033	32	.029	57	.029	30	.880	31
0	32	1.0	.028	6	.051	33	.029	58	.044	31	.847	32
0	33	1.0	.028	7	.062	34	.029	59	.051	32	.820	33
0	34	1.0	.028	8	.116	35	.029	60	.093	33	.714	34
0	35	1.0	.028	9	.116	36	.029	61	.116	34	.710	35
0	36	1.0	.028	10	.077	37	.029	62	.116	35	.749	36
0	37	1.0	.028	11	.026	38	.029	63	.039	36	.877	37
0	38	1.0	.028	12	.025	39	.029	64	.022	37	.895	38
0	39	1.0	.028	13	.047	40	.029	65	.044	38	.851	39
0	40	1.0	.028	14	.026	41	.029	66	.031	39	.885	40

J.L.H.
07/78
6E0-00..-55

16

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

	PT	K	A	IA	B	IB	C	IC	D	ID	E	IF
0	41	1.0	.028	15	.024	42	.029	67	.024	60	.894	41
0	42	1.0	.028	16	.024	43	.029	68	.025	41	.893	42
0	43	1.0	.028	17	.026	44	.029	69	.023	42	.893	43
0	44	1.0	.028	18	.046	45	.029	70	.038	43	.858	44
0	45	1.0	.028	19	.041	46	.029	71	.046	44	.855	45
0	46	1.0	.028	20	.029	47	.029	72	.032	45	.881	46
0	47	1.0	.028	21	.023	48	.029	73	.029	46	.890	47
0	48	1.0	.028	22	.013	49	.029	74	.015	47	.914	48
0	49	1.0	.028	23	.011	50	.029	75	.013	48	.918	49
0	50	1.0	.028	24	.008	51	.029	76	.008	49	.926	50
0	51	1.0	.028	25	.013	52	.029	77	.011	50	.919	51
0	52	1.0	.028	26	0.000	243	.029	78	.012	51	.930	52
0	53	1.0	.028	27	.008	54	.029	79	0.000	243	.934	53
0	54	1.0	.028	28	.015	55	.029	80	.011	53	.916	54
0	55	1.0	.028	29	.029	56	.029	81	.023	54	.890	55
0	56	1.0	.028	30	.029	57	.029	82	.029	55	.886	56
0	57	1.0	.028	31	.033	58	.029	83	.029	56	.880	57
0	58	1.0	.028	32	.052	59	.029	84	.044	57	.868	58
0	59	1.0	.028	33	.062	60	.029	85	.052	58	.829	59
0	60	1.0	.029	34	.116	61	.029	86	.093	59	.733	60
0	61	1.0	.029	35	.116	62	.029	87	.116	60	.710	61
0	62	1.0	.029	36	.077	63	.029	88	.116	61	.749	62
0	63	1.0	.029	37	.026	64	.029	89	.039	62	.877	63
0	64	1.0	.029	38	.025	65	.029	90	.022	63	.895	64
0	65	1.0	.028	39	.047	66	.029	91	.044	64	.851	65
0	66	1.0	.028	40	.026	67	.029	92	.032	65	.885	66
0	67	1.0	.028	41	.024	68	.029	93	.026	66	.893	67
0	68	1.0	.028	42	.024	69	.029	94	.025	67	.893	68
0	69	1.0	.028	43	.026	70	.029	95	.023	68	.893	69
0	70	1.0	.028	44	.046	71	.029	96	.038	69	.858	70
0	71	1.0	.029	45	.041	72	.029	97	.046	70	.855	71
0	72	1.0	.028	46	.029	73	.029	98	.032	71	.881	72
0	73	1.0	.028	47	.023	74	.029	99	.029	72	.890	73
0	74	1.0	.028	48	.013	75	.029	100	.015	73	.914	74
0	75	1.0	.028	49	.011	76	.029	101	.013	74	.918	75
0	76	1.0	.028	50	.008	77	.029	102	.008	75	.926	76
0	77	1.0	.028	51	.013	78	.029	103	.011	76	.919	77
0	78	1.0	.028	52	0.000	243	.029	104	.012	77	.930	78
0	79	1.0	.028	53	.008	80	0.000	243	0.000	243	.963	79
0	80	1.0	.028	54	.015	81	0.000	243	.011	79	.965	80
0	81	1.0	.028	55	.029	82	0.000	243	.023	80	.919	81

JCH
07/78
620-0011-55

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

	PI	K	A	TA	B	TB	C	TC	D	TD	E	TE
0	82	1.0	.028	56	.029	83	0.000	243	.029	81	.916	82
0	83	1.0	.029	57	.033	84	0.000	243	.029	82	.909	83
0	84	1.0	.029	58	.052	85	.029	105	.044	83	.846	84
0	85	1.0	.029	59	.062	86	.029	106	.052	84	.828	85
0	86	1.0	.029	60	.116	87	.030	107	.093	85	.733	86
0	87	1.0	.029	61	.116	88	.030	108	.116	86	.709	87
0	88	1.0	.029	62	.078	89	.030	109	.116	87	.748	88
0	89	1.0	.029	63	.026	90	.030	110	.039	88	.877	89
1	90	1.0	.029	64	.025	91	.030	111	.022	89	.894	90
0	91	1.0	.029	65	.047	92	.000	112	.044	90	.880	91
0	92	1.0	.029	66	.026	93	.000	113	.032	91	.914	92
0	93	1.0	.028	67	.026	94	.000	114	.024	92	.923	93
0	94	1.0	.028	68	.024	95	.000	115	.025	93	.922	94
0	95	1.0	.028	69	.026	96	.000	116	.023	94	.922	95
0	96	1.0	.028	70	.044	97	.000	117	.039	95	.887	96
0	97	1.0	.028	71	.041	98	.000	118	.044	96	.886	97
0	98	1.0	.029	72	.029	99	.000	119	.032	97	.910	98
0	99	1.0	.028	73	.023	100	.000	120	.029	98	.919	99
1	100	1.0	.028	74	.013	101	.000	121	.015	99	.943	100
0	101	1.0	.028	75	.011	102	.000	122	.013	100	.948	101
0	102	1.0	.028	76	.008	103	.000	123	.008	101	.955	102
0	103	1.0	.028	77	.013	104	.000	124	.011	102	.949	103
0	104	1.0	.028	78	0.000	243	.000	125	.012	103	.959	104
0	105	1.0	.029	84	.052	106	0.000	243	0.000	243	.920	105
0	106	1.0	.029	85	.062	107	.034	126	.052	105	.826	106
0	107	1.0	.029	86	.116	108	.034	127	.093	106	.728	107
0	108	1.0	.029	87	.116	109	.034	128	.116	107	.704	108
0	109	1.0	.029	88	.078	110	.034	129	.117	108	.743	109
0	110	1.0	.029	89	.026	111	.034	130	.039	109	.872	110
0	111	1.0	.029	90	.000	112	.034	131	.022	110	.915	111
0	112	1.0	.005	91	.004	113	.003	132	.018	111	.977	112
0	113	1.0	.005	92	.002	114	.003	133	.003	112	.987	113
0	114	1.0	.005	93	.002	115	.003	134	.002	113	.988	114
0	115	1.0	.005	94	.002	116	.003	135	.002	114	.988	115
0	116	1.0	.005	95	.002	117	.003	136	.002	115	.988	116
0	117	1.0	.005	96	.004	118	.003	137	.003	116	.984	117
0	118	1.0	.005	97	.004	119	.003	138	.004	117	.984	118
0	119	1.0	.005	98	.003	120	.003	139	.003	118	.986	119
0	120	1.0	.005	99	.002	121	.003	140	.003	119	.987	120
0	121	1.0	.005	100	.001	122	.003	141	.001	120	.989	121
0	122	1.0	.005	101	.001	123	.003	142	.001	121	.990	122

JFH
07/78
620-0011-55

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

	PT	K	A	TA	B	TB	C	TC	D	TD	E	TF
0	23	.0	.005	02	.001	124	.002	143	.001	122	.991	23
0	24	.0	.005	03	.001	125	.002	144	.001	123	.990	24
0	25	.0	.005	04	0.000	243	.002	145	.001	124	.991	25
0	26	.0	.046	06	.062	127	0.000	243	0.000	243	.892	26
0	27	.0	.045	07	.117	128	.073	146	.093	126	.672	27
0	28	.0	.046	08	.117	129	.073	147	.117	127	.648	28
0	29	.0	.045	09	.078	130	.073	148	.117	128	.687	29
0	30	.0	.046	10	.027	131	.073	149	.039	129	.816	30
0	31	.0	.046	11	.000	132	.073	150	.022	130	.859	31
0	32	.0	.004	12	.004	133	.010	151	.010	131	.971	32
0	33	.0	.004	13	.002	134	.010	152	.003	132	.981	33
0	34	.0	.004	14	.002	135	.010	153	.002	133	.982	34
0	35	.0	.004	15	.002	136	.010	154	.002	134	.982	35
0	36	.0	.004	16	.002	137	.010	155	.002	135	.982	36
0	37	.0	.004	17	.004	138	.010	156	.003	136	.979	37
0	38	.0	.004	18	.004	139	.010	157	.004	137	.978	38
0	39	.0	.004	19	.003	140	.010	158	.003	138	.981	39
0	40	.0	.004	20	.002	141	.010	159	.003	139	.982	40
0	41	.0	.004	21	.001	142	.010	160	.001	140	.984	41
0	42	.0	.292	22	.057	143	.572	161	.080	141	-.000	42
0	43	.0	.280	23	.048	144	.561	162	.041	142	.097	43
0	44	.0	.271	24	.059	145	.520	163	.053	143	.097	44
0	45	.0	.265	25	0.000	243	.507	164	.056	144	.172	45
0	46	.0	.138	27	.117	147	.203	81	0.000	243	.542	46
0	47	.0	.138	28	.117	148	.203	82	.117	146	.425	47
0	48	.0	.138	29	.078	149	.204	83	.117	147	.464	48
0	49	.0	.138	30	.027	150	.204	84	.039	148	.593	49
0	50	.0	.138	31	.026	151	.204	85	.022	149	.610	50
0	51	.0	.000	32	.048	152	.205	86	.046	150	.702	51
0	52	.0	.000	33	.026	153	.206	87	.032	151	.735	52
0	53	.0	.000	34	.025	154	.207	88	.025	152	.742	53
0	54	.0	.000	35	.025	155	.209	89	.026	153	.740	54
0	55	.0	.000	36	.028	156	.211	90	.026	154	.738	55
0	56	.0	.000	37	.049	157	.212	91	.040	155	.698	56
0	57	.0	.000	38	.046	158	.215	92	.049	156	.692	57
0	58	.0	.000	39	.031	159	.217	93	.035	157	.717	58
0	59	.0	.000	40	.025	160	.220	94	.032	158	.723	59
0	60	.0	.000	41	.014	161	.224	95	.017	159	.744	60
0	61	.0	.001	241	.013	162	.229	96	.015	160	.744	61
0	62	.0	.001	241	.010	163	.233	97	.010	161	.747	62
0	63	.0	.001	241	.015	164	.237	98	.013	162	.734	63

JLH
07/78
620-0011-55
19

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

	PT	K	A	TA	B	TB	C	TC	D	TD	E	TF
0	164	1.0	.001	241	.012	165	.240	199	.014	163	.733	164
0	165	1.0	.001	241	.009	166	.242	200	.010	164	.738	165
0	166	1.0	.001	241	.009	167	.244	201	.009	165	.737	166
0	167	1.0	.001	241	.009	168	.246	202	.009	166	.735	167
0	168	1.0	.001	241	.009	169	.247	203	.009	167	.734	168
0	169	1.0	.001	241	.009	170	.249	204	.009	168	.733	169
0	170	1.0	.001	241	.009	171	.250	205	.009	169	.732	170
0	171	1.0	.001	241	.009	172	.251	206	.009	170	.731	171
0	172	1.0	.001	241	.009	173	.252	207	.009	171	.729	172
0	173	1.0	.001	241	.009	174	.253	208	.009	172	.728	173
0	174	1.0	.001	241	.009	175	.256	209	.009	173	.726	174
0	175	1.0	0.000	243	.009	176	.257	210	.009	174	.724	175
0	176	1.0	0.000	243	.009	177	.259	211	.009	175	.723	176
0	177	1.0	0.000	243	.009	178	.259	212	.009	176	.722	177
0	178	1.0	0.000	243	.009	179	.260	213	.009	177	[illegible]	178
0	179	1.0	0.000	243	.014	180	.260	214	.009	178	.717	179
0	180	1.0	0.000	243	0.000	243	.260	215	.036	179	.703	180
0	181	1.0	.201	146	.117	182	.172	216	0.000	243	.510	181
0	182	1.0	.201	147	.117	183	.172	217	.117	181	.393	182
0	183	1.0	.201	148	.078	184	.172	218	.117	182	.431	183
0	184	1.0	.202	149	.027	185	.172	219	.039	183	.560	184
0	185	1.0	.202	150	.026	186	.173	220	.072	184	.577	185
0	186	1.0	.203	151	.048	187	.173	221	.044	185	.531	186
0	187	1.0	.204	152	.026	188	.174	222	.032	186	.561	187
0	188	1.0	.205	153	[illegible]	189	.175	223	.025	187	.570	188
0	189	1.0	.206	154	.025	190	.176	224	.025	188	.566	189
0	190	1.0	.208	155	.028	191	.178	225	.024	189	.562	190
0	191	1.0	.210	156	.049	192	.179	226	.040	190	.522	191
0	192	1.0	.212	157	.044	193	0.000	243	.040	191	.695	192
0	193	1.0	.215	158	.031	194	0.000	243	.035	192	.719	193
0	194	1.0	.218	159	.025	195	0.000	243	.032	193	.726	194
0	195	1.0	.221	160	.014	196	0.000	243	.017	194	.747	195
0	196	1.0	.226	161	.013	197	.001	242	.015	195	.745	196
0	197	1.0	.231	162	.010	198	.001	242	.010	196	.749	197
0	198	1.0	.235	163	.015	199	.001	242	.013	197	.736	198
0	199	1.0	.237	164	.012	200	.001	242	.014	198	.735	199
0	200	1.0	.240	165	.009	201	.001	242	.010	199	.740	200
0	201	1.0	.242	166	.009	202	.001	242	.009	200	.739	201
0	202	1.0	.243	167	.009	203	.001	242	.009	201	.737	202
0	203	1.0	.245	168	.009	204	.001	242	.009	202	.736	203
0	204	1.0	.246	169	.009	205	.001	242	.009	203	.735	204

J.P.H
07/78
620-0011-55
20

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

	PI	K	A	TA	B	TB	C	TC	D	TD	E	TF
0	205	1.0	.247	170	.009	206	.001	242	.009	204	.734	205
0	206	1.0	.248	171	.009	207	.001	242	.009	205	.733	206
0	207	1.0	.249	172	.009	208	.001	242	.009	206	.731	207
0	208	1.0	.251	173	.009	209	.001	242	.009	207	.730	208
0	209	1.0	.253	174	.009	210	.001	242	.009	208	.727	209
0	210	1.0	.255	175	.009	211	.001	242	.009	209	.726	210
0	211	1.0	.256	176	.009	212	.001	242	.009	210	.724	211
0	212	1.0	.257	177	.009	213	.001	242	.009	211	.723	212
0	213	1.0	.257	178	.009	214	.001	242	.009	212	.723	213
0	214	1.0	.258	179	.014	215	.001	242	.009	213	.718	214
0	215	1.0	.258	180	0.000	243	.001	242	.036	214	.705	215
0	216	1.0	.124	181	.117	217	0.000	243	0.000	243	.759	216
0	217	1.0	.124	182	.117	218	.090	227	.117	216	.552	217
0	218	1.0	.124	183	.078	219	.090	228	.117	217	.591	218
0	219	1.0	.124	184	.027	220	.090	229	.039	218	.720	219
0	220	1.0	.125	185	.026	221	.090	230	.022	219	.737	220
0	221	1.0	.125	186	.048	222	.091	231	.044	220	.692	221
0	222	1.0	.126	187	.026	223	.091	232	.032	221	.725	222
0	223	1.0	.126	188	.025	224	.092	233	.025	222	.732	223
0	224	1.0	.127	189	.025	225	.092	234	.026	223	.730	224
0	225	1.0	.128	190	.028	226	0.000	243	.024	224	.820	225
0	226	1.0	.129	191	0.000	243	0.000	243	.040	225	.831	226
0	227	1.0	.062	217	.117	228	0.000	243	0.000	243	.821	227
0	228	1.0	.062	218	.078	229	.054	235	.117	227	.688	228
0	229	1.0	.062	219	.027	230	.054	236	.039	228	.818	229
0	230	1.0	.062	220	.026	231	.054	237	.022	229	.835	230
0	231	1.0	.063	221	.048	232	.054	238	.044	230	.790	231
0	232	1.0	.063	222	.026	233	.055	239	.032	231	.824	232
0	233	1.0	.063	223	.025	234	0.000	243	.025	232	.887	233
0	234	1.0	.063	224	0.000	243	0.000	243	.026	233	.911	234
0	235	1.0	.053	228	.078	236	0.000	243	0.000	243	.860	235
0	236	1.0	.053	229	.027	237	0.000	243	.039	235	.881	236
0	237	1.0	.053	230	.026	238	0.000	243	.022	236	.899	237
0	238	1.0	.053	231	.048	239	0.000	243	.044	237	.854	238
0	239	1.0	.053	232	0.000	243	0.000	243	.032	238	.914	239

DELTA THETA = .215E-02HRS/ITER BLOCK 142

JLH
07/78
620-0011-55
21

TEMPERATURE DISTRIBUTION

ITER	PT	TEMPERATURE										TIME
1	1	573	573	573	573	573	572	572	572	572	572	.02780
1	11	572	572	572	573	573	573	573	573	573	573	.02780
1	21	574	574	574	574	574	574	574	574	573	573	.02780
1	31	572	571	571	570	570	570	570	570	571	572	.02780
1	41	573	573	574	574	574	574	574	574	574	574	.02780
1	51	574	574	574	573	573	572	571	569	568	568	.02780
1	61	567	567	567	567	569	570	572	573	573	574	.02780
1	71	574	574	574	574	574	574	574	574	574	573	.02780
1	81	572	571	569	567	565	564	564	563	563	563	.02780
1	91	567	569	571	572	573	573	574	574	574	574	.02780
1	101	574	574	574	574	566	562	561	560	559	558	.02780
1	111	557	557	556	554	551	546	540	535	528	520	.02780
1	121	512	511	503	498	495	559	557	556	555	553	.02780
1	131	551	544	535	526	515	502	487	471	452	430	.02780
1	141	404	383	357	338	327	554	553	552	550	546	.02780
1	151	535	526	515	502	484	466	445	420	393	359	.02780
1	161	318	281	255	238	222	210	201	193	188	182	.02780
1	171	177	171	163	153	146	140	136	134	132	132	.02780
1	181	553	552	551	549	544	535	526	515	502	486	.02780
1	191	468	445	420	393	359	317	280	255	237	222	.02780
1	201	209	200	193	187	182	177	171	163	153	145	.02780
1	211	140	136	134	132	132	551	550	549	547	542	.02780
1	221	534	527	515	504	485	472	548	547	545	540	.02780
1	231	534	527	516	507	545	544	539	534	530	574	.02780
1	241	300	120									

H°J
07/78
620-0011-55

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

	PI	K	A	TA	B	TB	C	TC	D	TD	E	TE
0	1	1.0	.045	240	.009	2	.031	27	0.000	243	.915	1
0	2	1.0	.045	240	.016	3	.031	28	.012	1	.895	2
0	3	1.0	.045	240	.031	4	.031	29	.025	2	.868	3
0	4	1.0	.045	240	.031	5	.031	30	.031	3	.862	4
0	5	1.0	.045	240	.035	6	.031	31	.031	4	.858	5
0	6	1.0	.045	240	.055	7	.031	32	.047	5	.822	6
0	7	1.0	.045	240	.066	8	.031	33	.055	6	.803	7
0	8	1.0	.045	240	.123	9	.031	34	.099	7	.702	8
0	9	1.0	.045	240	.123	10	.031	35	.123	8	.677	9
0	10	1.0	.045	240	.082	11	.031	36	.123	9	.718	10
0	11	1.0	.045	240	.029	12	.031	37	.041	10	.854	11
0	12	1.0	.045	240	.027	13	.031	38	.023	11	.873	12
0	13	1.0	.045	240	.050	14	.031	39	.046	12	.827	13
0	14	1.0	.045	240	.027	15	.031	40	.036	13	.863	14
0	15	1.0	.045	240	.026	16	.031	41	.026	14	.872	15
0	16	1.0	.045	240	.026	17	.031	42	.027	15	.871	16
0	17	1.0	.045	240	.028	18	.031	43	.026	16	.871	17
0	18	1.0	.045	240	.049	19	.031	44	.040	17	.834	18
0	19	1.0	.045	240	.044	20	.031	45	.049	18	.831	19
0	20	1.0	.045	240	.031	21	.031	46	.036	19	.858	20
0	21	1.0	.045	240	.025	22	.031	47	.031	20	.868	21
0	22	1.0	.045	240	.014	23	.031	48	.016	21	.893	22
0	23	1.0	.045	240	.012	24	.031	49	.014	22	.898	23
0	24	1.0	.045	240	.009	25	.031	50	.009	23	.906	24
0	25	1.0	.045	240	.013	26	.031	51	.012	24	.898	25
0	26	1.0	.045	240	0.000	243	.031	52	.013	25	.911	26
0	27	1.0	.030	1	.009	28	.030	53	0.000	243	.931	27
0	28	1.0	.030	2	.016	29	.030	54	.011	27	.913	28
0	29	1.0	.030	3	.030	30	.030	55	.026	28	.888	29
0	30	1.0	.030	4	.030	31	.030	56	.030	29	.880	30
0	31	1.0	.030	5	.034	32	.030	57	.030	30	.876	31
0	32	1.0	.030	6	.053	33	.030	58	.046	31	.841	32
0	33	1.0	.030	7	.064	34	.030	59	.053	32	.822	33
0	34	1.0	.030	8	.120	35	.030	60	.096	33	.724	34
0	35	1.0	.030	9	.120	36	.030	61	.120	34	.700	35
0	36	1.0	.030	10	.080	37	.030	62	.120	35	.740	36
0	37	1.0	.030	11	.027	38	.030	63	.040	36	.873	37
0	38	1.0	.030	12	.026	39	.030	64	.023	37	.891	38
0	39	1.0	.030	13	.049	40	.030	65	.045	38	.846	39
0	40	1.0	.030	14	.027	41	.030	66	.033	39	.881	40

JEH
07/78
620-0011-55
23

TRANSIENT TEMPERATURE DISTRIBUTION   PROGRAM 91167

	PT	K	A	TA	B	TB	C	TC	D	TD	E	TE
0	41	1.0	.030	15	.025	42	.030	67	.025	40	.889	41
0	42	1.0	.030	16	.025	43	.030	68	.026	41	.889	42
0	43	1.0	.030	17	.027	44	.030	69	.024	42	.889	43
0	44	1.0	.030	18	.048	45	.030	70	.030	43	.853	44
0	45	1.0	.030	19	.042	46	.030	71	.048	44	.849	45
0	46	1.0	.030	20	.030	47	.030	72	.034	45	.876	46
0	47	1.0	.030	21	.024	48	.030	73	.030	46	.886	47
0	48	1.0	.030	22	.013	49	.030	74	.016	47	.911	48
0	49	1.0	.030	23	.011	50	.030	75	.013	48	.915	49
0	50	1.0	.030	24	.009	51	.030	76	.009	49	.923	50
0	51	1.0	.030	25	.013	52	.030	77	.011	50	.915	51
0	52	1.0	.030	26	0.000	243	.030	78	.013	51	.927	52
0	53	1.0	.029	27	.008	54	.030	79	0.000	243	.933	53
0	54	1.0	.029	28	.016	55	.030	80	.011	53	.914	54
0	55	1.0	.029	29	.030	56	.030	81	.024	54	.888	55
0	56	1.0	.029	30	.030	57	.030	82	.030	55	.882	56
0	57	1.0	.029	31	.034	58	.030	83	.030	56	.878	57
0	58	1.0	.029	32	.052	59	.030	84	.045	57	.863	58
0	59	1.0	.029	33	.063	60	.030	85	.052	58	.825	59
0	60	1.0	.029	34	.119	61	.030	86	.096	59	.728	60
0	61	1.0	.029	35	.118	62	.030	87	.118	60	.705	61
0	62	1.0	.029	36	.079	63	.030	88	.118	61	.744	62
0	63	1.0	.029	37	.027	64	.030	89	.039	62	.875	63
0	64	1.0	.029	38	.026	65	.030	90	.022	63	.893	64
0	65	1.0	.029	39	.048	66	.030	91	.044	64	.848	65
0	66	1.0	.029	40	.026	67	.030	92	.032	65	.883	66
0	67	1.0	.029	41	.025	68	.030	93	.025	66	.891	67
0	68	1.0	.029	42	.025	69	.030	94	.025	67	.891	68
0	69	1.0	.029	43	.027	70	.030	95	.023	68	.891	69
0	70	1.0	.029	44	.067	71	.030	96	.039	69	.855	70
0	71	1.0	.029	45	.042	72	.030	97	.047	70	.852	71
0	72	1.0	.029	46	.029	73	.030	98	.033	71	.878	72
0	73	1.0	.029	47	.024	74	.030	99	.029	72	.888	73
0	74	1.0	.029	48	.013	75	.030	100	.016	73	.912	74
0	75	1.0	.029	49	.011	76	.030	101	.013	74	.917	75
0	76	1.0	.029	50	.008	77	.030	102	.008	75	.924	76
0	77	1.0	.029	51	.013	78	.030	103	.011	76	.917	77
0	78	1.0	.029	52	0.000	243	.030	104	.012	77	.929	78
0	79	1.0	.029	53	.008	80	0.000	243	0.000	243	.963	79
0	80	1.0	.029	54	.016	81	0.000	243	.011	79	.944	80
0	81	1.0	.029	55	.029	82	0.000	243	.023	80	.918	81

24

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

	PT	K	A	TA	B	TB	C	TC	D	TD	E	TE
0	82	1.0	.029	56	.029	83	0.000	243	.029	81	.913	82
0	83	1.0	.029	57	.033	84	0.000	243	.029	82	.908	83
0	84	1.0	.029	58	.052	85	.030	105	.045	83	.845	84
0	85	1.0	.029	59	.062	86	.030	106	.052	84	.827	85
0	86	1.0	.029	60	.117	87	.030	107	.096	85	.731	86
0	87	1.0	.029	61	.117	88	.030	108	.117	86	.704	87
0	88	1.0	.029	62	.078	89	.030	109	.117	87	.746	88
0	89	1.0	.029	63	.027	90	.030	110	.039	88	.876	89
0	90	1.0	.029	64	.026	91	.030	111	.022	89	.896	90
0	91	1.0	.029	65	.049	92	.000	112	.046	90	.879	91
0	92	1.0	.029	66	.026	93	.000	113	.032	91	.913	92
0	93	1.0	.029	67	.025	94	.003	114	.025	92	.922	93
0	94	1.0	.029	68	.025	95	.000	115	.025	93	.921	94
0	95	1.0	.029	69	.027	96	.000	116	.023	94	.921	95
0	96	1.0	.029	70	.047	97	.000	117	.039	95	.886	96
0	97	1.0	.029	71	.041	98	.000	118	.047	96	.893	97
0	98	1.0	.029	72	.029	99	.000	119	.033	97	.900	98
0	99	1.0	.029	73	.023	100	.000	120	.029	98	.918	99
0	100	1.0	.029	74	.013	101	.000	121	.016	99	.942	100
0	101	1.0	.029	75	.011	102	.000	122	.013	100	.947	101
0	102	1.0	.029	76	.009	103	.000	123	.009	101	.954	102
0	103	1.0	.029	77	.013	104	.000	124	.011	102	.947	103
0	104	1.0	.029	78	0.000	243	.000	125	.012	103	.959	104
0	105	1.0	.029	84	.052	106	0.000	243	0.000	243	.920	105
0	106	1.0	.029	85	.062	107	.034	126	.052	105	.823	106
0	107	1.0	.029	86	.116	108	.034	127	.093	106	.728	107
0	108	1.0	.029	87	.116	109	.034	128	.116	107	.704	108
0	109	1.0	.029	88	.079	110	.034	129	.116	108	.743	109
0	110	1.0	.029	89	.026	111	.034	130	.039	109	.872	110
0	111	1.0	.029	90	.000	112	.034	131	.022	110	.915	111
0	112	1.0	.005	91	.006	113	.003	132	.010	111	.977	112
0	113	1.0	.005	92	.002	114	.003	133	.003	112	.987	113
0	114	1.0	.005	93	.002	115	.003	134	.002	113	.988	114
0	115	1.0	.005	94	.002	116	.003	135	.002	114	.988	115
0	116	1.0	.005	95	.002	117	.003	136	.002	115	.988	116
0	117	1.0	.005	96	.006	118	.003	137	.003	116	.984	117
0	118	1.0	.005	97	.004	119	.003	138	.006	117	.984	118
0	119	1.0	.005	98	.003	120	.003	139	.003	118	.987	119
0	120	1.0	.005	99	.002	121	.003	140	.003	119	.987	120
0	121	1.0	.005	100	.001	122	.003	141	.001	120	.989	121
0	122	1.0	.005	101	.001	123	.002	142	.001	121	.990	122

620-0011-55

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

	PT	K	A	TA	B	TB	C	TC	D	TD	E	TF
0	123	1.0	.005	102	.001	124	.002	143	.001	122	.991	123
0	124	1.0	.005	103	.001	125	.002	144	.001	123	.998	124
0	125	1.0	.005	104	0.000	243	.002	145	.001	124	.991	125
0	126	1.0	.046	106	.062	127	0.000	243	0.000	243	.892	126
0	127	1.0	.046	107	.116	128	.073	146	.093	126	.873	127
0	128	1.0	.046	108	.116	129	.073	147	.116	127	.849	128
0	129	1.0	.046	109	.078	130	.073	148	.116	128	.888	129
0	130	1.0	.046	110	.026	131	.073	149	.039	129	.816	130
0	131	1.0	.046	111	.000	132	.073	150	.022	130	.859	131
0	132	1.0	.004	112	.004	133	.010	151	.010	131	.972	132
0	133	1.0	.004	113	.002	134	.010	152	.003	132	.991	133
0	134	1.0	.004	114	.002	135	.010	153	.002	133	.982	134
0	135	1.0	.004	115	.002	136	.010	154	.002	134	.982	135
0	136	1.0	.004	116	.002	137	.010	155	.002	135	.982	136
0	137	1.0	.004	117	.004	138	.010	156	.003	136	.979	137
0	138	1.0	.004	118	.004	139	.010	157	.006	137	.979	138
0	139	1.0	.004	119	.003	140	.010	158	.003	138	.981	139
0	140	1.0	.004	120	.002	141	.010	159	.003	139	.982	140
0	141	1.0	.004	121	.001	142	.010	160	.001	140	.986	141
0	142	1.0	.291	122	.057	143	.572	161	.080	141	.000	142
0	143	1.0	.280	123	.041	144	.542	162	.041	142	.096	143
0	144	1.0	.271	124	.059	145	.570	163	.053	143	.097	144
0	145	1.0	.265	125	0.000	243	.505	164	.055	144	.174	145
0	146	1.0	.137	127	.116	147	.203	181	0.000	243	.544	146
0	147	1.0	.137	128	.116	148	.203	182	.116	146	.428	147
0	148	1.0	.137	129	.078	149	.203	183	.116	147	.466	148
0	149	1.0	.137	130	.026	150	.203	184	.039	148	.594	149
0	150	1.0	.138	131	.026	151	.203	185	.022	149	.611	150
0	151	1.0	.000	132	.048	152	.204	186	.044	150	.706	151
0	152	1.0	.000	133	.026	153	.205	187	.032	151	.737	152
0	153	1.0	.000	134	.025	154	.206	188	.025	152	.744	153
0	154	1.0	.000	135	.025	155	.207	189	.026	153	.741	154
0	155	1.0	.000	136	.027	156	.209	190	.026	154	.739	155
0	156	1.0	.000	137	.049	157	.211	191	.040	155	.700	156
0	157	1.0	.000	138	.043	158	.213	192	.049	156	.694	157
0	158	1.0	.000	139	.031	159	.216	193	.035	157	.719	158
0	159	1.0	.000	140	.025	160	.218	194	.031	158	.725	159
0	160	1.0	.000	141	.014	161	.222	195	.017	159	.747	160
0	161	1.0	.001	241	.012	162	.226	196	.016	160	.746	161
0	162	1.0	.001	241	.009	163	.231	197	.009	161	.750	162
0	163	1.0	.001	241	.015	164	.235	198	.013	162	.737	163

SCH
8/1/78
620-0011-55

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

	PT	K	A	TA	B	TB	C	TC	D	TD	E	TF
0	164	1.0	.001	241	.012	165	.237	199	.016	163	.735	164
0	165	1.0	.001	241	.009	166	.240	200	.010	164	.741	165
0	166	1.0	.001	241	.009	167	.242	201	.009	165	.739	166
0	167	1.0	.001	241	.009	168	.244	202	.009	166	.737	167
0	168	1.0	.001	241	.009	169	.245	203	.009	167	.736	168
0	169	1.0	.001	241	.009	170	.247	204	.009	168	.735	169
0	170	1.0	.001	241	.009	171	.248	205	.009	169	.733	170
0	171	1.0	.001	241	.009	172	.249	206	.009	170	.732	171
0	172	1.0	.001	241	.009	173	.250	207	.009	171	.731	172
0	173	1.0	.001	241	.009	174	.252	208	.009	172	.729	173
0	174	1.0	0.000	243	.009	175	.254	209	.009	173	.728	174
0	175	1.0	0.000	243	.009	176	.255	210	.009	174	.726	175
0	176	1.0	0.000	243	.009	177	.257	211	.009	175	.725	176
0	177	1.0	0.000	243	.009	178	.258	212	.009	176	.724	177
0	178	1.0	0.000	243	.009	179	.258	213	.009	177	.723	178
0	179	1.0	0.000	243	.014	180	.259	214	.009	178	.719	179
0	180	1.0	0.000	243	0.000	243	.250	215	.036	179	.705	180
0	181	1.0	.200	246	.116	182	.171	216	0.000	243	.512	181
0	182	1.0	.200	247	.116	183	.171	217	.116	181	.396	182
0	183	1.0	.200	248	.078	184	.171	218	.116	182	.434	183
0	184	1.0	.201	249	.027	185	.171	219	.030	183	.543	184
0	185	1.0	.201	250	.026	186	.172	220	.022	184	.570	185
0	186	1.0	.202	251	.068	187	.172	221	.044	185	.534	186
0	187	1.0	.203	252	.026	188	.173	222	.032	186	.566	187
0	188	1.0	.204	253	.025	189	.174	223	.025	187	.572	188
0	189	1.0	.205	254	.025	190	.175	224	.025	188	.569	189
0	190	1.0	.207	255	.027	191	.177	225	.026	189	.565	190
0	191	1.0	.209	256	.049	192	.178	226	.040	190	.525	191
0	192	1.0	.211	257	.043	193	0.000	243	.049	191	.697	192
0	193	1.0	.213	258	.031	194	0.000	243	.035	192	.721	193
0	194	1.0	.216	259	.025	195	0.000	243	.031	193	.728	194
0	195	1.0	.219	260	.014	196	0.000	243	.017	194	.740	195
0	196	1.0	.224	261	.017	197	.001	242	.016	195	.748	196
0	197	1.0	.228	262	.009	198	.001	242	.009	196	.752	197
0	198	1.0	.232	263	.015	199	.001	242	.013	197	.739	198
0	199	1.0	.235	264	.012	200	.001	242	.014	198	.737	199
0	200	1.0	.237	265	.009	201	.001	242	.010	199	.743	200
0	201	1.0	.240	266	.009	202	.001	242	.009	200	.741	201
0	202	1.0	.242	267	.009	203	.001	242	.009	201	.739	202
0	203	1.0	.243	268	.009	204	.001	242	.009	202	.738	203
0	204	1.0	.244	269	.009	205	.001	242	.009	203	.737	204

57-1102-029

27

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

	PT	K	A	TA	B	TB	C	TC	D	TD	E	TE
0	205	1.0	.245	170	.009	206	.001	242	.009	204	.735	205
0	206	1.0	.246	171	.009	207	.001	242	.009	205	.734	206
0	207	1.0	.248	172	.009	208	.001	242	.009	206	.733	207
0	208	1.0	.249	173	.009	209	.001	242	.009	207	.731	208
1	209	1.0	.251	174	.009	210	.001	242	.009	208	.729	209
0	210	1.0	.253	175	.009	211	.001	242	.009	209	.728	210
0	211	1.0	.254	176	.009	212	.001	242	.009	210	.726	211
0	212	1.0	.255	177	.009	213	.001	242	.009	211	.725	212
0	213	1.0	.255	178	.009	214	.001	242	.009	212	.725	213
0	214	1.0	.256	179	.014	215	.001	242	.009	213	.720	214
0	215	1.0	.256	180	0.000	243	.001	242	.034	214	.707	215
0	216	1.0	.123	181	.116	217	0.000	243	0.000	243	.760	216
0	217	1.0	.123	182	.116	218	.090	227	.116	216	.554	217
0	218	1.0	.124	183	.079	219	.090	228	.115	217	.593	218
0	219	1.0	.124	184	.027	220	.090	229	.039	218	.721	219
1	220	1.0	.124	185	.026	221	.090	230	.022	219	.738	220
0	221	1.0	.124	186	.048	222	.090	231	.044	220	.693	221
0	222	1.0	.125	187	.026	223	.091	232	.032	221	.727	222
0	223	1.0	.126	188	.025	224	.091	233	.025	222	.734	223
0	224	1.0	.126	189	.025	225	.091	234	.026	223	.731	224
0	225	1.0	.127	190	.027	226	0.000	243	.024	224	.821	225
1	226	1.0	.128	191	0.000	243	0.000	243	.040	225	.832	226
0	227	1.0	.062	217	.117	228	0.000	243	0.000	243	.822	227
0	228	1.0	.062	218	.079	229	.054	235	.117	227	.690	228
0	229	1.0	.062	219	.027	230	.054	236	.039	228	.819	229
0	230	1.0	.062	220	.026	231	.054	237	.022	229	.836	230
0	231	1.0	.062	221	.048	232	.054	238	.044	230	.792	231
0	232	1.0	.062	222	.026	233	.054	239	.032	231	.825	232
1	233	1.0	.063	223	.025	234	0.000	243	.025	232	.887	233
0	234	1.0	.063	224	0.000	243	0.000	243	.026	233	.911	234
0	235	1.0	.053	228	.078	236	0.000	243	0.000	243	.870	235
0	236	1.0	.053	229	.027	237	0.000	243	.039	235	.882	236
0	237	1.0	.053	230	.026	238	0.000	243	.022	236	.899	237
0	238	1.0	.053	231	.048	239	0.000	243	.044	237	.855	238
0	239	1.0	.053	232	0.000	243	0.000	243	.032	238	.915	239

CELTA THETA = .213E-02HRS/ITER BLOCK 142

TITLE(SMUD COOLDOWN SUPPORT SKIRT) 91167 REV 4 12-15-74 07/17/78 16.33.57 PAGE 79
**** FULL CERTIFICATION **** **** FULL CERTIFICATION **** **** FULL CERTIFICATION **** H01CCMA

TEMPERATURE DISTRIBUTION

ITER	PT	TEMPERATURE										TIME
40		315	315	316	316	317	318	319	320	320	320	.22280
40	1	320	319	318	317	316	315	315	315	315	314	.22280
40	2	314	314	314	314	314	314	358	359	361	363	.22280
40	3	366	369	371	372	373	373	373	370	367	364	.22280
40	4	361	360	359	358	358	358	358	359	359	358	.22280
40	5	358	358	389	391	393	397	402	409	413	415	.22280
40	6	416	417	416	412	405	399	394	391	390	389	.22280
40	7	389	389	389	389	389	389	389	389	405	407	.22280
40	8	410	415	423	438	445	449	451	451	451	446	.22280
40	9	428	419	411	408	406	406	405	405	405	405	.22280
40	10	405	405	405	405	463	470	475	477	479	480	.22280
40	11	479	485	488	485	480	475	469	463	457	449	.22280
40	12	441	436	428	422	419	485	491	494	496	497	.22280
40	13	498	511	515	509	509	487	473	459	479	419	.22280
40	14	303	364	317	317	305	502	503	504	506	507	.22280
40	15	514	515	509	499	484	467	447	424	307	364	.22280
40	16	325	289	262	243	227	213	203	195	188	183	.22280
40	17	177	171	163	153	146	141	137	135	133	133	.22280
40	18	507	508	509	510	512	515	515	509	508	486	.22280
40	19	468	447	424	397	364	326	288	261	263	226	.22280
40	20	212	202	194	188	182	177	171	163	153	146	.22280
40	21	141	137	135	137	133	510	512	513	515	516	.22280
40	22	517	516	510	501	484	472	517	518	519	519	.22280
40	23	519	517	511	504	521	522	521	521	519	280	.22280
40	24	300	120									

HJ
07/76
620-0011-55

TEMPERATURE DISTRIBUTION

ITER	PT					TEMPERATURE						TIME
45		302	303	304	305	307	308	309	310	310	311	.63380
45	1	311	309	308	306	305	303	303	302	302	302	.63380
45	2	302	301	301	301	301	301	320	322	325	328	.63380
45	3	332	336	339	341	342	342	342	330	335	330	.63380
45	4	326	323	321	320	320	310	319	319	318	318	.63380
45	5	318	318	334	337	341	346	354	362	367	371	.63380
45	6	372	373	373	368	358	350	343	330	336	334	.63380
45	7	334	333	333	332	332	332	332	332	342	345	.63380
45	8	350	357	363	384	393	398	401	403	403	397	.63380
45	9	376	363	353	349	346	342	341	341	340	340	.63380
45	10	340	339	339	339	408	418	424	427	410	432	.63380
45	11	413	436	435	432	426	420	414	409	401	394	.63380
45	12	384	376	367	351	358	436	443	447	450	454	.63380
45	13	457	475	486	485	478	467	456	449	422	401	.63380
45	14	376	361	315	295	283	457	459	462	455	471	.63380
45	15	488	494	494	488	476	462	443	421	395	363	.63380
45	16	324	287	260	242	226	212	203	195	189	183	.63380
45	17	177	171	164	153	146	[illegible]	137	135	133	133	.63380
45	18	463	466	468	472	478	486	495	494	489	477	.63380
45	19	463	443	421	395	363	323	286	260	242	225	.63380
45	20	212	202	194	188	183	177	171	163	153	146	.63380
45	21	141	137	134	133	133	468	472	475	478	486	.63380
45	22	491	495	495	490	477	466	480	482	485	489	.63380
45	23	494	497	496	492	488	489	493	496	498	290	.63380
45	24	300	170									

JEH
07/78
620-0011-55

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

TITLE(SMUD COOLDOWN SUPPORT SKIRT)

ITERATION	12	90	100	131	153	158	160	189	199	200	TIME
1	572.	563.	574.	551.	515.	420.	359.	502.	237.	153.	.02780
2	573.	563.	574.	551.	515.	420.	359.	502.	237.	153.	.05560
3	575.	563.	574.	551.	515.	420.	359.	502.	237.	153.	.08340
4	577.	563.	574.	551.	515.	420.	359.	502.	238.	153.	.11120
5	579.	563.	574.	551.	515.	420.	359.	502.	238.	153.	.13900
6	582.	564.	574.	551.	515.	420.	359.	502.	238.	153.	.16680
7	584.	564.	574.	551.	515.	421.	359.	502.	238.	153.	.19460
8	585.	564.	575.	551.	515.	421.	359.	502.	238.	153.	.22240
9	585.	564.	575.	551.	515.	421.	359.	502.	238.	153.	.25020
10	581.	565.	576.	551.	515.	421.	360.	502.	238.	153.	.27800
11	571.	565.	576.	551.	515.	421.	360.	502.	238.	153.	.30580
12	559.	565.	577.	551.	515.	421.	360.	502.	238.	153.	.33360
13	546.	565.	577.	551.	515.	421.	360.	502.	239.	153.	.36140
14	534.	565.	576.	551.	515.	421.	360.	503.	239.	153.	.38920
15	523.	564.	575.	551.	515.	421.	360.	503.	240.	153.	.41700
16	512.	562.	573.	551.	515.	421.	361.	503.	240.	153.	.44480
17	501.	560.	570.	551.	515.	421.	361.	503.	241.	153.	.47260
18	489.	558.	567.	551.	515.	421.	361.	503.	241.	154.	.50040
19	478.	555.	563.	550.	515.	421.	362.	503.	242.	154.	.52820
20	469.	552.	559.	549.	515.	422.	362.	503.	242.	154.	.55600
21	459.	549.	554.	549.	515.	422.	362.	503.	242.	154.	.58380
22	450.	545.	549.	548.	515.	422.	363.	503.	243.	154.	.61160
23	441.	541.	544.	546.	515.	422.	363.	503.	243.	154.	.63940
24	432.	537.	538.	545.	515.	422.	363.	503.	244.	154.	.66720
25	424.	533.	532.	[illegible]	515.	422.	364.	503.	244.	154.	.69500
26	416.	529.	526.	[illegible]	515.	421.	364.	503.	244.	154.	.72280
27	408.	524.	519.	540.	515.	423.	364.	503.	244.	154.	.75060
28	400.	520.	513.	538.	515.	423.	364.	503.	244.	154.	.77840
29	393.	515.	506.	536.	515.	423.	364.	503.	244.	153.	.80620
30	385.	510.	499.	534.	515.	423.	364.	503.	244.	153.	.83400
31	378.	506.	492.	532.	515.	423.	364.	503.	244.	153.	.86180
32	372.	501.	485.	530.	514.	423.	364.	503.	244.	153.	.88960
33	366.	496.	478.	528.	514.	423.	364.	502.	244.	153.	.91740
34	360.	491.	471.	525.	514.	423.	364.	502.	243.	153.	.94520
35	355.	487.	464.	523.	514.	423.	364.	502.	243.	153.	.97300
36	349.	482.	457.	520.	513.	424.	364.	502.	243.	153.	1.00080
37	340.	[illegible]	443.	515.	512.	424.	364.	502.	243.	153.	1.05630
38	332.	463.	430.	509.	511.	424.	364.	501.	243.	153.	1.11180
39	325.	454.	417.	504.	510.	424.	364.	500.	243.	153.	1.16730
40	319.	446.	405.	498.	509.	424.	364.	500.	243.	153.	1.22280
41	315.	438.	393.	492.	507.	423.	364.	499.	243.	153.	1.27830
42	311.	430.	383.	486.	506.	423.	364.	497.	243.	153.	1.33380
43	308.	417.	365.	476.	502.	423.	364.	495.	242.	153.	1.43380
44	309.	406.	351.	466.	498.	422.	364.	492.	242.	153.	1.53380
45	309.	397.	340.	457.	494.	421.	363.	489.	242.	153.	1.63380
46	312.	389.	331.	448.	489.	420.	362.	485.	241.	153.	1.73380
47	315.	383.	325.	440.	484.	418.	361.	481.	241.	153.	1.83380
48	333.	373.	318.	421.	469.	412.	358.	468.	240.	153.	2.13380
49	357.	372.	326.	408.	452.	405.	354.	453.	238.	153.	2.43380
50	382.	379.	344.	402.	437.	396.	348.	438.	237.	153.	2.73380

JEH
07/78
620-0011-55

ITERATION	12	90	100	131	153	158	160	189	199	209	TIME
51	408.	389.	367.	401.	425.	387.	342.	425.	235.	153.	3.0133D0
52	435.	403.	392.	403.	415.	378.	336.	414.	234.	153.	3.3133D0
53	462.	419.	419.	409.	408.	370.	329.	406.	233.	153.	3.6133D0
54	490.	437.	448.	418.	404.	362.	324.	401.	231.	153.	3.9133D0
55	518.	457.	476.	429.	403.	357.	319.	398.	230.	153.	4.2133D0

32

ITERATION	220	226	233	0	0	0	0	0	0	0	TIME
1	542.	472.	516.	0.	0.	0.	0.	0.	0.	0.	.02780
2	542.	472.	516.	0.	0.	0.	0.	0.	0.	0.	.05560
3	542.	472.	516.	0.	0.	0.	0.	0.	0.	0.	.08340
4	542.	472.	516.	0.	0.	0.	0.	0.	0.	0.	.11120
5	542.	472.	516.	0.	0.	0.	0.	0.	0.	0.	.13900
6	542.	472.	516.	0.	0.	0.	0.	0.	0.	0.	.16680
7	542.	472.	516.	0.	0.	0.	0.	0.	0.	0.	.19460
8	542.	472.	516.	0.	0.	0.	0.	0.	0.	0.	.22240
9	542.	472.	516.	0.	0.	0.	0.	0.	0.	0.	.25020
10	542.	472.	516.	0.	0.	0.	0.	0.	0.	0.	.27800
11	542.	472.	516.	0.	0.	0.	0.	0.	0.	0.	.30580
12	542.	472.	517.	0.	0.	0.	0.	0.	0.	0.	.33360
13	542.	472.	517.	0.	0.	0.	0.	0.	0.	0.	.36140
14	542.	472.	517.	0.	0.	0.	0.	0.	0.	0.	.38920
15	542.	472.	517.	0.	0.	0.	0.	0.	0.	0.	.41700
16	542.	472.	517.	0.	0.	0.	0.	0.	0.	0.	.44480
17	542.	472.	517.	0.	0.	0.	0.	0.	0.	0.	.47260
18	542.	472.	517.	0.	0.	0.	0.	0.	0.	0.	.50040
19	542.	472.	517.	0.	0.	0.	0.	0.	0.	0.	.52820
20	542.	472.	517.	0.	0.	0.	0.	0.	0.	0.	.55600
21	542.	472.	517.	0.	0.	0.	0.	0.	0.	0.	.58380
22	542.	472.	517.	0.	0.	0.	0.	0.	0.	0.	.61160
23	541.	472.	517.	0.	0.	0.	0.	0.	0.	0.	.63940
24	541.	472.	517.	0.	0.	0.	0.	0.	0.	0.	.66720
25	540.	472.	517.	0.	0.	0.	0.	0.	0.	0.	.69500
26	540.	473.	517.	0.	0.	0.	0.	0.	0.	0.	.72280
27	539.	473.	517.	0.	0.	0.	0.	0.	0.	0.	.75060
28	539.	473.	517.	0.	0.	0.	0.	0.	0.	0.	.77840
29	539.	473.	516.	0.	0.	0.	0.	0.	0.	0.	.80620
30	537.	473.	516.	0.	0.	0.	0.	0.	0.	0.	.83400
31	536.	473.	516.	0.	0.	0.	0.	0.	0.	0.	.86180
32	535.	473.	516.	0.	0.	0.	0.	0.	0.	0.	.88960
33	533.	473.	516.	0.	0.	0.	0.	0.	0.	0.	.91740
34	532.	473.	515.	0.	0.	0.	0.	0.	0.	0.	.94520
35	531.	473.	515.	0.	0.	0.	0.	0.	0.	0.	.97300
36	529.	473.	515.	0.	0.	0.	0.	0.	0.	0.	1.00080
37	525.	473.	514.	0.	0.	0.	0.	0.	0.	0.	1.05630
38	523.	473.	513.	0.	0.	0.	0.	0.	0.	0.	1.11180
39	519.	472.	512.	0.	0.	0.	0.	0.	0.	0.	1.16730
40	516.	472.	511.	0.	0.	0.	0.	0.	0.	0.	1.22280
41	512.	472.	509.	0.	0.	0.	0.	0.	0.	0.	1.27830
42	508.	471.	507.	0.	0.	0.	0.	0.	0.	0.	1.33380
43	500.	470.	504.	0.	0.	0.	0.	0.	0.	0.	1.43380
44	492.	468.	500.	0.	0.	0.	0.	0.	0.	0.	1.53380
45	484.	466.	496.	0.	0.	0.	0.	0.	0.	0.	1.63380
46	476.	464.	491.	0.	0.	0.	0.	0.	0.	0.	1.73380
47	468.	461.	486.	0.	0.	0.	0.	0.	0.	0.	1.83380
48	447.	451.	469.	0.	0.	0.	0.	0.	0.	0.	2.13380
49	430.	439.	453.	0.	0.	0.	0.	0.	0.	0.	2.43380
50	417.	427.	437.	0.	0.	0.	0.	0.	0.	0.	2.73380

SS-1144-029
07/78
33

ITERATION	220	226	233	0	0	0	0	0	0	0	TIME
51	409.	415.	425.	0.	0.	0.	0.	0.	0.	0.	3.033E0
52	406.	405.	415.	0.	0.	0.	0.	0.	0.	0.	3.333E0
53	406.	396.	408.	0.	0.	0.	0.	0.	0.	0.	3.633E0
54	410.	389.	404.	0.	0.	0.	0.	0.	0.	0.	3.933E0
55	416.	384.	403.	0.	0.	0.	0.	0.	0.	0.	4.233E0

11A
07/75
620-0011-55

34

ITERATION	12-220	90-131	90-100	153-160	153-226	180-190	199-209	0- 0	0- 0	0- 0	TIME
1	30.	13.	-11.	156.	43.	121.	86.	0.	0.	0.	.02780
2	31.	13.	-11.	156.	43.	121.	86.	0.	0.	0.	.05560
3	33.	13.	-11.	156.	43.	121.	85.	0.	0.	0.	.08340
4	35.	13.	-11.	155.	43.	121.	85.	0.	0.	0.	.11120
5	37.	13.	-11.	156.	43.	121.	85.	0.	0.	0.	.13900
6	40.	13.	-11.	156.	43.	121.	85.	0.	0.	0.	.16680
7	42.	13.	-11.	156.	43.	121.	85.	0.	0.	0.	.19460
8	43.	13.	-11.	156.	43.	121.	85.	0.	0.	0.	.22240
9	43.	14.	-11.	155.	43.	121.	85.	0.	0.	0.	.25020
10	39.	14.	-11.	155.	43.	121.	85.	0.	0.	0.	.27800
11	29.	14.	-11.	155.	43.	121.	85.	0.	0.	0.	.30580
12	17.	14.	-11.	155.	43.	121.	85.	0.	0.	0.	.33360
13	4.	14.	-11.	155.	43.	121.	86.	0.	0.	0.	.36140
14	-8.	13.	-11.	155.	43.	121.	86.	0.	0.	0.	.38920
15	-19.	12.	-11.	155.	43.	121.	87.	0.	0.	0.	.41700
16	-30.	11.	-11.	154.	43.	121.	87.	0.	0.	0.	.44480
17	-42.	9.	-10.	154.	43.	120.	87.	0.	0.	0.	.47260
18	-53.	7.	-9.	154.	43.	120.	84.	0.	0.	0.	.50040
19	-64.	5.	-8.	153.	43.	120.	88.	0.	0.	0.	.52820
20	-73.	3.	-7.	153.	43.	120.	88.	0.	0.	0.	.55600
21	-82.	0.	-6.	153.	43.	120.	89.	0.	0.	0.	.58380
22	-91.	-2.	-4.	153.	43.	120.	89.	0.	0.	0.	.61160
23	-100.	-5.	-3.	152.	43.	120.	89.	0.	0.	0.	.63940
24	-108.	-8.	-1.	152.	43.	120.	90.	0.	0.	0.	.66720
25	-117.	-11.	1.	152.	43.	120.	90.	0.	0.	0.	.69500
26	-124.	-13.	3.	151.	43.	120.	90.	0.	0.	0.	.72280
27	-131.	-16.	5.	151.	43.	120.	90.	0.	0.	0.	.75060
28	-139.	-19.	7.	151.	42.	120.	90.	0.	0.	0.	.77840
29	-145.	-21.	9.	151.	42.	121.	90.	0.	0.	0.	.80620
30	-152.	-24.	11.	151.	42.	121.	90.	0.	0.	0.	.83400
31	-157.	-26.	14.	150.	42.	121.	90	0.	0.	0.	.86180
32	-163.	-29.	16.	150.	42.	121.	90.	0.	0.	0.	.88960
33	-167.	-31.	18.	150.	41.	121.	90.	0.	0.	0.	.91740
34	-172.	-34.	20.	149.	41.	121.	91.	0.	0.	0.	.94520
35	-176.	-36.	23.	149.	41.	121.	90.	0.	0.	0.	.97300
36	-180.	-38.	25.	149.	40.	121.	90.	0.	0.	0.	1.00080
37	-187.	-42.	29.	148.	40.	121.	90.	0.	0.	0.	1.05630
38	-191.	-46.	33.	147.	39.	121.	90.	0.	0.	0.	1.11180
39	-195.	-49.	37.	146.	38.	121.	90.	0.	0.	0.	1.16730
40	-197.	-52.	41.	145.	37.	121.	90.	0.	0.	0.	1.22240
41	-197.	-55.	44.	143.	36.	122.	89.	0.	0.	0.	1.27830
42	-196.	-57.	47.	142.	35.	122.	89.	0.	0.	0.	1.33390
43	-191.	-59.	52.	138.	32.	122.	89.	0.	0.	0.	1.43390
44	-183.	-60.	55.	135.	30.	122.	89.	0.	0.	0.	1.53380
45	-174.	-60.	57.	131.	28.	121.	88.	0.	0.	0.	1.63380
46	-164.	-59.	58.	127.	25.	121.	88.	0.	0.	0.	1.73380
47	-153.	-57.	58.	123.	23.	121.	88.	0.	0.	0.	1.83380
48	-114.	-48.	55.	111.	18.	119.	86.	0.	0.	0.	2.13380
49	-72.	-36.	46.	99.	13.	115.	85.	0.	0.	0.	2.43380
50	-35.	-23.	35.	89.	10.	111.	84.	0.	0.	0.	2.73380

620-0011-55

ITERATION	12-220	90-131	90-100	153-160	153-226	160-199	199-209	0- 0	0- 0	0- 0	TIME
51	-1.	-11.	23.	83.	9.	107.	82.	0.	0.	0.	3.03380
52	29.	-0.	11.	79.	10.	102.	81.	0.	0.	0.	3.33380
53	56.	10.	-0.	78.	12.	97.	79.	0.	0.	0.	3.63380
54	80.	19.	-10.	80.	15.	93.	78.	0.	0.	0.	3.93380
55	102.	28.	-19.	84.	18.	89.	77.	0.	0.	0.	4.23380

S P H
C C H
07/78
620-0011-55

B&W Program 91206 (SAVE SS-2) was used to calculate primary plus secondary and peak stresses. The output for the 91167 thermal model is incompatible with the 91206 stress model input requirements. Program 91032 (Temperature Interpolation and Free-Body Thermal Motions and Stresses) was used to interpolate the temperature distribution onto 2 stress models compatible with Program 91206 input requirements. The support skirt and lower head were modeled separately for stress calculations. Refer to Ref. 1 for the stress model of the lower head and skirt for input into Program 91206 (SAVE SS-2).

The following pages contain the 91032 temperature interpolations for the two iterations selected for analysis onto each of the stress models.

JLH
07/78
620-0011-55

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 07/27/78

HEAD ONLY SMUD ELEMENT -0.

CALCULATION CODE 7

PRINTED OUTPUT ONLY

BASE TEMPERATURE 70.00

NUMBER OF INPUT TEMPERATURES 91167 GRID - 242

INPUT PER EDGE FOR INITIAL GRID

EDGE NO.	TEMP. BLOCK HEIGHT	DIST FROM ZERO LINE TO EDGE	ZERO LINE TO BLOCK BOUNDARY	INSIDE SURFACE RADIUS	INSIDE SURFACE ADJ. BLOCK	INSIDE SURFACE FILM COEFF.	OUTSIDE SURFACE RADIUS	OUTSIDE SURFACE ADJ. BLOCK	OUTSIDE SURFACE FILM COEFF.	MATERIAL TYPE
1	4.0000	2.0000	4.0000	56.0000	240	875.0000	64.0000	0	0.0000	MAG-MOLY
2	3.2000	5.6000	7.2000	56.0000	240	875.0000	64.0000	0	0.0000	MAG-MOLY
3	1.6000	8.0000	8.8000	56.0000	240	875.0000	64.0000	0	0.0000	MAG-MOLY
4	2.4000	10.0000	11.2000	56.0000	240	875.0000	64.0000	0	0.0000	MAG-MOLY
5	1.6000	12.0000	12.8000	56.0000	240	875.0000	64.0000	0	0.0000	MAG-MOLY
6	1.8000	13.7000	14.6000	56.0000	240	875.0000	66.0000	0	0.0000	MAG-MOLY
7	1.2000	15.2000	15.8000	56.0000	240	875.0000	67.5000	0	0.0000	MAG-MOLY
8	1.4000	16.5000	17.2000	56.0000	240	875.0000	70.0000	0	0.0000	MAG-MOLY
9	.6000	17.5000	17.8000	56.0000	240	875.0000	71.5000	0	0.0000	MAG-MOLY
10	1.4000	18.5000	19.2000	56.0000	240	875.0000	73.0000	0	0.0000	MAG-MOLY
11	1.6000	20.0000	20.8000	56.0000	240	875.0000	73.0000	0	0.0000	MAG-MOLY
12	2.8000	22.2000	23.6000	56.0000	240	875.0000	73.0000	0	0.0000	MAG-MOLY
13	1.0000	24.1000	24.6000	56.0000	240	875.0000	64.0000	0	0.0000	MAG-MOLY
14	2.4000	25.8000	27.0000	56.0000	240	875.0000	64.0000	0	0.0000	MAG-MOLY
15	1.9600	27.9800	28.9600	55.0000	240	875.0000	64.0000	0	0.0000	MAG-MOLY
16	2.2800	30.1000	31.2400	56.0000	240	875.0000	64.0000	0	0.0000	MAG-MOLY
17	2.1200	32.3000	33.3600	56.0000	240	875.0000	64.0000	0	0.0000	MAG-MOLY
18	1.6800	34.2000	35.0400	56.0000	240	875.0000	64.0000	0	0.0000	MAG-MOLY
19	1.5200	35.8000	36.5600	56.0000	240	875.0000	64.0000	0	0.0000	MAG-MOLY
20	1.8800	37.5000	38.4400	56.0000	240	875.0000	64.0000	0	0.0000	MAG-MOLY
21	2.1200	39.5000	40.5600	56.0000	240	875.0000	64.0000	0	0.0000	MAG-MOLY
22	2.8800	42.0000	43.4400	56.0000	240	875.0000	64.0000	0	0.0000	MAG-MOLY
23	3.1200	45.0000	46.5600	56.0000	240	875.0000	64.0000	0	0.0000	MAG-MOLY
24	3.8800	48.5000	50.4400	56.0000	240	875.0000	64.0000	0	0.0000	MAG-MOLY
25	3.1200	52.0000	53.5600	56.0000	240	875.0000	64.0000	0	0.0000	MAG-MOLY
26	3.3600	55.2400	56.9200	56.0000	240	875.0000	64.0000	0	0.0000	MAG-MOLY

JFH
07/75
620-0011-55

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 07/27/78

HEAD ONLY SHUD ELEMENT -0.

DIMENSION PER COLUMN OF THE INITIAL GRID

		91167 TEMPERATURE GRID				
COLUMN NO.	INSIDE RADIUS	BLOCK WIDTH	NODAL RADIUS	OUTSIDE RADIUS	LOW BLOCK NO.	HIGH BLOCK NO.
1	56.0000	2.0000	57.0000	58.0000	1	26
2	58.0000	2.0000	59.0000	60.0000	27	52
3	60.0000	2.0000	61.0000	62.0000	53	78
4	62.0000	2.0000	63.0000	64.0000	79	104
5	64.0000	2.0000	65.0000	66.0000	105	125
6	66.0000	1.5000	66.7500	67.5000	126	145
7	67.5000	.8400	67.9200	68.3400	146	150
8	68.3400	.6600	68.6700	69.0000	181	185
9	69.0000	1.1200	69.5600	70.1200	215	220
10	70.1200	1.4400	70.8400	71.5600	227	230
11	71.5600	1.4800	72.3000	73.0400	235	237

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 07/27/78

HEAD ONLY SMUD

ELEMENT -0.

INITIAL INTERNAL RADIUS	I N I T I A L G R I D DISTANCE FROM ZERO LINE TO CLOSEST SURFACE	FURTHEST SURFACE
57.0000	0.0000	56.9201
61.0000	0.0000	56.9201
65.0000	12.8000	23.6000
67.9200	15.9000	23.6000
69.5600	15.8000	23.6000
72.3000	17.8000	23.6000

INITIAL INTERNAL RADIUS	I N I T I A L G R I D DISTANCE FROM ZERO LINE TO CLOSEST SURFACE	FURTHEST SURFACE
59.0000	0.0000	56.9201
63.0000	0.0000	56.9201
66.7500	14.6000	23.6000
68.6700	15.8000	23.6000
70.8400	17.2000	23.6000

07/78
620-0011-55

40

HEAD ONLY SMUD 91032 REV 2 4-15-76 07/27/78 16.33.04 PAGE 8
**** FULL CERTIFICATION **** **** FULL CERTIFICATION **** **** FULL CERTIFICATION ****

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 07/27/78

HEAD ONLY SMUD ELEMENT -0.

FINAL GRID		INITIAL GRID		FINAL GRID				
EDGE NUMBER	DISTANCE FROM ZERO LINE	INSIDE RADIUS	OUTSIDE RADIUS	INSIDE RADIUS	RR(2)	RR(3)	RR(4)	OUTSIDE RADIUS
1	7.0000	56.0000	64.0000	56.0000	58.0000	60.0000	62.0000	64.0000
2	9.0000	56.0000	64.0000	56.0000	58.0000	60.0000	62.0000	64.0000
3	11.0000	56.0000	64.0000	56.0000	59.0000	60.0000	62.0000	64.0000
4	13.1000	56.0000	64.0000	56.0000	58.0000	60.0000	62.0000	64.0000
5	13.1000	56.0000	66.0000	56.0000	58.5000	61.0000	63.5000	66.0000
6	14.5000	56.0000	66.0000	56.0000	58.5000	61.0000	63.5000	66.0000
7	14.5000	56.0000	66.0000	56.0000	58.8750	61.7500	64.6250	67.5000
8	16.1000	56.0000	67.5000	56.0000	58.8750	61.7500	64.6250	67.5000
9	16.1000	56.0000	70.0000	56.0000	59.5000	63.0000	66.5000	70.0000
10	17.1000	56.0000	70.0000	56.0000	59.5000	63.0000	66.5000	70.0000
11	17.1000	56.0000	70.0000	56.0000	59.8750	63.7500	67.6250	71.5000
12	18.1000	56.0000	71.5000	56.0000	59.8750	63.7500	67.6250	71.5000
13	[illegible]	56.0000	73.0000	56.0000	60.2500	64.5000	68.7500	73.0000
14	[illegible]	56.0000	73.0000	56.0000	60.2500	64.5000	68.7500	73.0000
15	[illegible]	56.0000	73.0000	56.0000	60.2500	64.5000	68.7500	73.0000
16	23.4000	56.0000	73.0000	56.0000	60.2500	64.5000	68.7500	73.0000
17	23.4000	56.0000	73.0000	56.0000	58.0000	60.0000	62.0000	64.0000
18	24.8000	56.0000	73.0000	56.0000	58.0000	60.0000	62.0000	64.0000
19	26.4000	56.0000	73.0000	56.0000	58.0000	60.0000	62.0000	64.0000
20	28.4000	56.0000	73.0000	56.0000	58.0000	60.0000	62.0000	64.0000
21	30.4000	56.0000	73.0000	56.0000	58.0000	60.0000	62.0000	64.0000
22	34.4000	56.0000	73.0000	56.0000	58.0000	60.0000	62.0000	64.0000
23	38.5000	56.0000	73.0000	56.0000	58.0000	60.0000	62.0000	64.0000
24	42.5000	56.0000	73.0000	56.0000	58.0000	60.0000	62.0000	64.0000
25	49.2000	56.0000	73.0000	56.0000	58.0000	60.0000	62.0000	64.0000
26	56.2000	56.0000	73.0000	56.0000	58.0000	60.0000	62.0000	64.0000

***** CAUTION- YOUR FINAL GRID EXTENDS BEYOND THE OUTSIDE SURFACE OF YOUR INITIAL GRID AT EDGE 7 ITER NO 40
THUS AN EXTRAPOLATION TOOK PLACE TO GET THE FIRST METAL TEMP INSIDE YOUR FINAL GRID.

***** CAUTION- YOUR FINAL GRID EXTENDS BEYOND THE OUTSIDE SURFACE OF YOUR INITIAL GRID AT EDGE 11 ITER NO 40
THUS AN EXTRAPOLATION TOOK PLACE TO GET THE FIRST METAL TEMP INSIDE YOUR FINAL GRID.

JJH
07/78
620-0021-55

41

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 07/27/78

HEAD ONLY SMUD ELEMENT -0.

TEMPERATURE OF NODE PER EDGE OF THE FINAL GRID FOR ITERATION 40

*IDENTIFIES PHANTOM SEGMENTS

SEGM NO.	OUTSIDE			INSIDE		CARD NO.
1	347	332	308	269	219	401.
2	352	335	310	270	219	402.
3	358	341	314	271	219	403.
4	375	350	318	274	220	404.
5	404	369	336	286	220	405.*
6	409	379	341	288	220	406.
7	427	393	354	297	220	407.*
8	428	399	358	299	220	408.
9	440	418	378	313	220	409.*
10	443	421	380	314	220	410.
11	449	430	391	323	220	411.*
12	458	432	392	323	220	412.
13	452	439	402	331	220	413.*
14	452	440	403	332	220	414.
15	453	441	403	330	220	415.
16	450	444	396	324	220	416.

*************** NOTE THESE TEMPERATURES ARE T(ACTUAL) MINUS T(BASE) ***************

JCH
07/78
620-0011-55

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 07/27/78

HEAD ONLY SMUD ELEMENT -0.

TEMPERATURE OF NODE PER EDGE OF THE FINAL GRID FOR ITERATION 40

*IDENTIFIES PHANTOM SEGMENTS

SEGN NO.						CARD NO.
17	380	353	319	274	220	417.*
18	364	345	315	273	220	418.
19	354	338	312	271	219	419.
20	349	334	308	270	219	420.
21	348	331	307	269	219	421.
22	344	329	305	268	219	422.
23	343	329	305	267	219	423.
24	343	329	305	267	219	424.
25	343	329	305	267	219	425.
26	343	329	305	267	219	426.

*************** NOTE THESE TEMPERATURES ARE T(ACTUAL) MINUS T(BASE) ***************

620-0011-55

43

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 07/27/78

HEAD ONLY SMUD ELEMENT -0.

TEMPERATURE OF NODE PER EDGE OF THE FINAL GRID FOR ITERATION 45

*IDENTIFIES PHANTOM SEGMENTS

SEGN NO.	OUTSIDE				INSIDE	CARD NO.
1	282	274	262	244	223	401.
2	288	279	266	245	224	402.
3	298	287	270	248	224	403.
4	317	299	277	251	225	404.
5	345	313	289	258	225	405.*
6	356	325	295	260	225	406.
7	374	339	304	266	225	407.*
8	379	348	310	268	225	408.
9	398	368	327	278	225	409.*
10	403	373	330	279	225	410.
11	413	385	340	285	225	411.*
12	415	388	343	286	225	412.
13	422	398	352	291	225	413.*
14	421	400	354	291	225	414.
15	422	405	355	290	225	415.
16	429	412	349	283	225	416.

*************** NOTE THESE TEMPERATURES ARE T(ACTUAL) MINUS T(BASE) ***************

07/78
620-0011-55

44

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3   07/27/78

HEAD ONLY SMUD   ELEMENT -9.

TEMPERATURE OF NODE PER EDGE OF THE FINAL GRID FOR ITERATION 45

*IDENTIFIES PHANTOM SEGMENTS

SEGN NO.						CARD NO.
17	327	304	280	252	225	417.*
18	308	293	274	250	224	418.
19	295	285	269	247	224	419.
20	288	278	264	245	224	420.
21	282	274	261	243	223	421.
22	278	269	257	241	223	422.
23	275	268	256	241	223	423.
24	274	267	256	240	223	424.
25	272	266	255	239	223	425.
26	273	266	255	239	223	426.

*************** NOTE THESE TEMPERATURES ARE T(ACTUAL) MINUS T(BASE) **************

J.L.H.
05/78
620-0011-55
45

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3   07/27/78

SKIRT ONLY SMUD   ELEMENT -0.

CALCULATION CODE 7.

PRINTED OUTPUT ONLY

BASE TEMPERATURE 70.00

NUMBER OF INPUT TEMPERATURES 91167 GRID - 242

INPUT PER EDGE FOR INITIAL GRID

EDGE NO.	TEMP. BLOCK HEIGHT	DIST FROM ZERO LINE TO EDGE	ZERO LINE TO BLOCK BOUNDARY	RADIUS	INSIDE SURFACE ADJ. BLOCK	INSIDE SURFACE FILM COEFF.	RADIUS	OUTSIDE SURFACE ADJ. BLOCK	OUTSIDE SURFACE FILM COEFF.	MATERAL TYPE
1	2.4000	1.2000	2.4000	67.5400	0	0.0000	73.0400	0	0.0000	MAG-MOLY
2	1.4000	3.1000	3.8000	67.5400	0	0.0000	73.0400	0	0.0000	MAG-MOLY
3	2.1000	4.8500	5.9000	67.5400	0	0.0000	73.0400	0	0.0000	MAG-MOLY
4	2.2000	7.0000	8.1000	67.5400	0	0.0000	71.5800	0	0.0000	MAG-MOLY
5	2.1400	9.1700	10.2400	67.5400	0	0.0000	71.5800	0	0.0000	MAG-MOLY
6	2.2800	11.3800	12.5200	67.5400	0	0.0000	70.1000	0	0.0000	MAG-MOLY
7	1.5800	13.3100	14.1000	67.5400	0	0.0000	70.1000	0	0.0000	MAG-MOLY
8	1.5800	14.8900	15.6800	67.5400	0	0.0000	69.0400	0	0.0000	MAG-MOLY
9	2.0000	16.6800	17.6800	67.5400	0	0.0000	69.0400	0	0.0000	MAG-MOLY
10	2.0000	18.6800	19.6800	67.5400	0	0.0000	69.0400	0	0.0000	MAG-MOLY
11	3.0000	21.1800	22.6800	67.5400	0	0.0000	69.0400	0	0.0000	MAG-MOLY
12	3.0000	24.1800	25.6800	67.5400	24	.6500	69.0400	242	.1700	MAG-MOLY
13	4.0000	27.6800	29.6800	67.5400	24	.6500	69.0400	242	.1700	MAG-MOLY
14	3.0000	31.1800	32.6800	67.5400	24	.6500	69.0400	242	.1700	MAG-MOLY
15	3.1200	34.2400	35.8000	67.5400	24	.6500	69.0400	242	.1700	MAG-MOLY
16	3.9200	37.7600	39.7200	67.5400	24	.6500	69.0400	242	.1700	MAG-MOLY
17	4.0800	41.7600	43.8000	67.5400	24	.6500	69.0400	242	.1700	MAG-MOLY
18	3.9200	45.7600	47.7200	67.5400	24	.6500	69.0400	242	.1700	MAG-MOLY
19	4.0800	49.7600	51.8000	67.5400	24	.6500	69.0400	242	.1700	MAG-MOLY
20	3.9200	53.7600	55.7200	67.5400	24	.6500	69.0400	242	.1700	MAG-MOLY
21	4.0800	57.7600	59.8000	67.5400	24	.6500	69.0400	242	.1700	MAG-MOLY
22	3.9200	61.7600	63.7200	67.5400	24	.6500	69.0400	242	.1700	MAG-MOLY
23	6.0800	65.7600	68.8000	67.5400	24	.6500	69.0400	242	.1700	MAG-MOLY
24	1.9200	69.7600	70.7200	67.5400	24	.6500	69.0400	242	.1700	MAG-MOLY
25	6.0800	73.7600	76.8000	67.5400	0	0.0000	69.0400	242	.1700	MAG-MOLY
26	1.9200	77.7600	78.7200	67.5400	0	0.0000	69.0400	242	.1700	MAG-MOLY

J.L.H.
07/78
620-0011-EE
46

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 07/27/78

SKIRT ONLY SMUD ELEMENT -0.

INPUT PER EDGE FOR INITIAL GRID (CONT.)

EDGE NO.	TEMP. BLOCK HEIGHT	DIST FROM ZERO LINE TO EDGE	ZERO LINE TO BLOCK BOUNDARY	RADIUS	INSIDE SURFACE ADJ. BLOCK	INSIDE SURFACE FILM COEFF.	RADIUS	OUTSIDE SURFACE ADJ. BLOCK	OUTSIDE SURFACE FILM COEFF.	MATERAL TYPE
27	6.0800	81.7600	84.8000	67.5400	0	0.0000	69.0400	242	1.1700	MAG-MOLY
28	1.9200	85.7600	86.7200	67.5400	0	0.0000	69.0400	242	1.1700	MAG-MOLY
29	6.0800	89.7600	92.8000	67.5400	0	0.0000	69.0400	242	1.1700	MAG-MOLY
30	1.9200	93.7600	94.7200	67.5400	0	0.0000	69.0400	242	1.1700	MAG-MOLY
31	3.6600	96.5500	98.3800	67.5400	0	0.0000	69.0400	242	1.1700	MAG-MOLY

J.L.H.
07/78
620-0011-55

47

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 07/27/78

SKIRT ONLY SMUD

ELEMENT -0.

DIMENSION PER COLUMN OF THE INITIAL GRID

91167 TEMPERATURE GRID

COLUMN NO.	INSIDE RADIUS	BLOCK WIDTH	NODAL RADIUS	OUTSIDE RADIUS	LOW BLOCK NO.	HIGH BLOCK NO.
1	67.5400	.7600	67.9200	68.3000	150	180
2	68.3000	.7600	68.6900	69.0600	185	215
3	69.0600	1.0400	69.5800	70.1000	220	226
4	70.1000	1.4400	70.8200	71.5400	230	234
5	71.5400	1.5200	72.3000	73.0600	237	239

J-WH.
07/78
620-0011-55

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 07/27/78

SKIRT ONLY SMUD

ELEMENT -0.

INITIAL INTERNAL RADIUS	INITIAL GRID DISTANCE FROM ZERO LINE TO CLOSEST SURFACE	FURTHEST SURFACE	INITIAL INTERNAL RADIUS	INITIAL GRID DISTANCE FROM ZERO LINE TO CLOSEST SURFACE	FURTHEST SURFACE
67.9200	0.0000	98.3801	68.6800	0.0000	98.3801
69.5800	0.0000	14.1000	70.8200	0.0000	10.2400
72.3000	0.0000	5.9000			

T.H.H.
07/78
620.0011-55

49

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 07/27/78

SKIRT ONLY SHUD ELEMENT -0.

FINAL GRID		INITIAL GRID		FINAL GRID				
EDGE NUMBER	DISTANCE FROM ZERO LINE	INSIDE RADIUS	OUTSIDE RADIUS	INSIDE RADIUS	RB(2)	RB(3)	RB(4)	OUTSIDE RADIUS
1	3.1600	67.5400	73.0400	67.5400	68.9150	70.2900	71.6650	73.0400
2	3.7200	67.5400	73.0400	67.5400	68.9150	70.2900	71.6650	73.0400
3	4.7600	67.5400	73.0400	67.5400	68.9150	70.2900	71.6650	73.0400
4	5.9000	67.5400	73.0400	67.5400	68.9150	70.2900	71.6650	73.0400
5	5.9000	67.5400	71.5000	67.5400	68.5100	69.5200	70.5100	71.5000
6	6.8000	67.5400	73.0400	67.5400	68.5100	69.5200	70.5100	71.5000
7	7.9600	67.5400	73.0400	67.5400	68.5100	69.5200	70.5100	71.5000
8	9.0000	67.5400	73.0400	67.5400	68.5100	69.5200	70.5100	71.5000
9	10.2400	67.5400	73.0400	67.5400	68.5100	69.5200	70.5100	71.5000
10	10.2400	67.5400	70.1000	67.5400	68.1550	68.7700	69.3850	70.0000
11	11.1600	67.5400	71.5000	67.5400	68.1550	68.7700	69.3850	70.0000
12	12.3200	67.5400	71.5000	67.5400	68.1550	68.7700	69.3850	70.0000
13	13.1600	67.5400	71.5000	67.5400	68.1550	68.7700	69.3850	70.0000
14	14.0200	67.5400	71.5000	67.5400	68.1550	68.7700	69.3850	70.0000
15	14.0200	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
16	14.5200	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
17	14.9900	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
18	15.4900	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
19	15.9900	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
20	16.4800	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
21	18.4900	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
22	20.4900	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
23	24.4900	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
24	28.4800	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
25	32.4800	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
26	36.4800	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
27	40.4900	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
28	44.4800	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
29	48.4800	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
30	52.4900	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
31	56.4900	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
32	60.4900	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
33	64.4800	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
34	68.4800	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000

J.L.H.
07/78
620-0011-55

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 07/27/78

SKIRT ONLY SMUD ELEMENT -0.

FINAL GRID		INITIAL GRID		FINAL GRID				
EDGE NUMBER	DISTANCE FROM ZERO LINE	INSIDE RADIUS	OUTSIDE RADIUS	INSIDE RADIUS	RB(2)	RB(3)	RB(4)	OUTSIDE RADIUS
35	72.4800	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
36	76.4800	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
37	80.4800	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
38	84.4800	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
39	88.4800	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
40	92.4800	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000
41	96.4800	67.5400	70.1000	67.5400	67.9050	68.2700	68.6350	69.0000

J.L.H.
07/78
620-0011-55

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 07/27/78

SKIRT ONLY SMUD ELEMENT -0.

TEMPERATURE OF NODE PER EDGE OF THE FINAL GRID FOR ITERATION 40

*IDENTIFIES PHANTOM SEGMENTS

SEGM NO.	OUTSIDE				INSIDE	CARD NO.
1	452	450	448	445	444	401.
2	452	450	448	446	445	402.
3	450	448	447	445	445	403.
4	448	446	444	443	443	404.
5	445	444	444	443	443	405.*
6	442	441	440	440	440	406.
7	439	438	436	435	435	407.
8	438	434	432	431	429	408.
9	434	428	424	423	422	409.
10	424	424	423	423	422	410.*
11	416	416	416	416	416	411.
12	408	407	407	406	406	412.
13	404	402	400	399	398	413.
14	402	396	390	389	388	414.
15	390	389	389	389	388	415.*
16	383	383	382	382	382	416.

*************** NOTE THESE TEMPERATURES ARE T(ACTUAL) MINUS T(BASE) ***************

S/H

820-CCII-55

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3   07/27/78

SKIRT ONLY SMUD   ELEMENT -0.

TEMPERATURE OF NODE PER EDGE OF THE FINAL GRID FOR ITERATION 40

*IDENTIFIES PHANTOM SEGMENTS

SEGN NO.					CARD NO.
17	378	376	376	376	376 417.
18	369	369	369	369	370 418.
19	363	363	363	363	363 419.
20	357	357	357	357	357 420.
21	330	310	330	330	330 421.
22	303	303	303	303	303 422.
23	250	251	251	252	251 423.
24	211	211	212	212	212 424.
25	183	183	183	183	183 425.
26	162	162	162	162	162 426.
27	146	146	147	147	147 427.
28	135	135	135	136	136 428.
29	126	126	127	127	127 429.
30	120	120	120	120	120 430.
31	114	114	114	114	114 431.
32	108	108	108	108	109 432.
33	103	103	103	103	103 433.
34	96	96	96	96	96 434.
35	86	86	86	86	86 435.
36	78	78	78	78	78 436.

*************** NOTE THESE TEMPERATURES ARE T(ACTUAL) MINUS T(BASE) ***************

d.l.H.
07/78
620-0011-55

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 07/27/78

SKIRT ONLY SMUD ELEMENT -0.

TEMPERATURE OF NODE PER EDGE OF THE FINAL GRID FOR ITERATION 40

SEGN NO.						CARD NO.
37	72	72	72	72	72	437.
38	68	68	68	68	68	438.
39	65	65	65	65	65	439.
40	64	64	64	64	64	440.
41	63	63	63	63	63	441.

*IDENTIFIES PHANTOM SEGMENTS

*************** NOTE THESE TEMPERATURES ARE T(ACTUAL) MINUS T(BASE) ***************

JSH
07/78
020-0011-55

54

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 07/27/78

SKIRT ONLY SMUD ELEMENT -0.

TEMPERATURE OF NODE PER EDGE OF THE FINAL GRID FOR ITERATION 45

*IDENTIFIES PHANTOM SEGMENTS

SEGM NO.	OUTSIDE				INSIDE	CARD NO.
1	427	425	423	420	418	401.
2	428	426	424	422	421	402.
3	428	428	426	425	423	403.
4	430	428	426	426	425	404.
5	428	427	426	426	425	405.*
6	427	426	425	424	424	406.
7	425	424	423	422	422	407.
8	423	422	421	419	418	408.
9	421	418	415	414	412	409.
10	415	415	414	413	412	410.*
11	409	409	409	408	407	411.
12	402	401	401	400	399	412.
13	399	396	394	394	393	413.
14	395	390	385	385	384	414.
15	385	385	385	384	384	415.*
16	379	378	378	378	378	416.

*************** NOTE THESE TEMPERATURES ARE T(ACTUAL) MINUS T(BASE) ***************

55-0011-029

55

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 07/27/78

SKIRT ONLY SMUD ELEMENT -0.

TEMPERATURE OF NODE PER EDGE OF THE FINAL GRID FOR ITERATION 45

*IDENTIFIES PHANTOM SEGMENTS

SEGN NO.						CARD NO.
17	372	372	372	372	372	417.
18	368	366	366	366	366	418.
19	359	360	360	360	360	419.
20	353	353	353	353	354	420.
21	328	328	329	328	328	421.
22	303	302	302	302	302	422.
23	249	249	250	250	251	423.
24	209	209	210	210	210	424.
25	182	182	182	182	182	425.
26	161	161	161	161	161	426.
27	145	145	146	146	146	427.
28	135	135	135	135	136	428.
29	126	126	127	127	128	429.
30	119	120	120	121	121	430.
31	114	115	115	115	115	431.
32	108	108	108	108	109	432.
33	102	103	102	103	103	433.
34	96	96	96	96	97	434.
35	86	86	87	87	87	435.
36	78	78	78	78	78	436.

*************** NOTE THESE TEMPERATURES ARE T(ACTUAL) MINUS T(BASE) ***************

620-

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 07/27/78

SKIRT ONLY SMUD ELEMENT -0.

TEMPERATURE OF NODE PER EDGE OF THE FINAL GRID FOR ITERATION 45

*IDENTIFIES PHANTOM SEGMENTS

SEGN NO.						CARD NO.
37	73	72	72	72	73	437.
38	68	68	68	68	68	438.
39	65	65	65	65	66	439.
40	63	63	63	64	64	440.
41	63	63	63	63	63	441.

*************** NOTE THESE TEMPERATURES ARE T(ACTUAL) MINUS T(BASE) ***************

620-0011-55
57

The stress model of the lower head was input to Program 91206 with the interpolated temperatures from Program 91032.

In the B&W Analysis, "OTSG Lower Tubesheet Area and Tube Stress Evaluation due to the 'Rapid Cooldown' event of March 20, 1978 for Sacramento Municipal Utility District", the thermal and pressure motions at the junction of the tubesheet and lower head were calculated. These motions were input as boundary conditions at the top of the head.

The mechanical loads as calculated in Reference 1 were inpt as intermediate forces at the junction of the support skirt and lower head.

The lower head stress model was analyzed for motions at the interface of the support skirt to lower head. The following pages contain the 91206 output for the selected iterations for the lower head.

SMUD COOLDOWN INC. SUPPORT SKIRT HEAD ITERATION 40 PAGE 1 DATE 08/04/78

INPUT DATA DATE 08/04/78

TOTAL NO. OF SEGMENTS = 10

BOUNDARY CONDITIONS AT THE TOP (0) END

1. A RADIAL DEFLECTION OF .11540 INCHES
2. A ROTATION OF -.00124 RADIANS

FROM REF. 3

BOUNDARY CONDITIONS AT THE BOTTOM (N) END

1. AN AXIAL FORCE OF 0.00000 POUNDS
2. A RADIAL DEFLECTION OF 0.00000 INCHES
3. A ROTATION OF 0.00000 RADIANS

* NOTE * A SEGMENTAL GROUP MAY CONSIST OF FROM ONE TO THE TOTAL NO. OF SEGMENTS.
SEGMENT ONE IS CONSIDERED AT THE TOP OF THE GEOMETRY.
ALL LOADS ABOVE, ARE ON A TOTAL LOAD BASIS.

08/
620-0011-55

SHUD COOLDOWN INC. SUPPORT SKIRT HEAD ITERATION 40 PAGE 2 DATE 08/04/78

MID-SURFACE GEOMETRY

AT TOP BOUNDARY, MEAN RADIUS = 63.2530 Z COORDINATE = 66.6000

SEGMENTAL GEOMETRY DATA BY GROUPS

SEGMENT DATA			CENTER OF CURVATURE DATA		
BOTTOM SEG. NO.	MEAN RADIUS	Z COORD..	RADIUS TO CENTER	Z COORD.	CURVATURE IDENTIFIER
1.0	63.156	65.100	0.000	70.000	1.0
2.0	63.010	63.500	0.000	70.000	1.0
3.0	62.784	61.500	0.000	70.000	1.0
4.0	62.936	61.500	0.000	0.000	0.0
5.0	62.702	60.000	0.000	70.000	1.0
6.0	63.157	60.000	0.000	0.000	0.0
7.0	62.883	58.400	0.000	70.000	1.0
8.0	63.808	58.400	0.000	0.000	0.0
9.0	63.696	57.800	0.000	70.000	1.0
10.0	65.316	57 [illegible]	0.000	0.000	0.0
11.0	64.865	55 [illegible]	0.000	70.000	1.0
12.0	65.786	55 [illegible]	0.000	0.000	0.0
13.0	65.583	54.700	0.000	70.000	1.0
14.0	65.084	52.700	0.000	70.000	1.0
15.0	64.910	51.700	0.000	70.000	1.0
16.0	60.643	51.700	0.000	0.000	0.0
17.0	60.104	50.000	0.000	70.000	1.0
18.0	59.725	48.900	0.000	70.000	1.0
20.0	59.287	45.200	0.000	70.000	1.0
23.0	52.461	34.500	0.000	70.000	1.0
30.0	.001	6.660	0.000	70.000	1.0

J.S.H.
8/3/78
620-0011-55
60

SHUD COOLDOWN INC. SUPPORT SKIRT HEAD ITERATION 40 PAGE 3 DATE 08/04/78

NOTE- CURVATURE IDENTIFIER +1= POSITIVE CURVATURE
0= NO CURVATURE
-1= NEGATIVE CURVATURE

J.H.
08/78
620-0011-55

SMUD COOLDOWN INC. SUPPORT SKIRT HEAD ITERATION 40 PAGE 4 DATE 08/04/78

SEGMENTAL GEOMETRY BY SEGMENTS (K= SEGMENT NO.)

MEAN RADIUS

K	R(K-1)	R(K)	R(K+1)	R(K+2)	R(K+3)	R(K+4)	R(K+5)	R(K+6)	R(K+7)	R(K+8)
1	63.25	63.15	63.01	62.78	62.94	62.70	63.16	62.88	63.81	63.70
11	65.31	64.86	65.79	65.58	65.98	64.81	60.64	60.10	59.73	59.06
21	58.29	56.58	54.63	52.46	47.02	40.66	33.52	25.73	17.43	8.80
31	.00									

Z COORDINATE

K	Z(K-1)	Z(K)	Z(K+1)	Z(K+2)	Z(K+3)	Z(K+4)	Z(K+5)	Z(K+6)	Z(K+7)	Z(K+8)
1	66.60	65.10	63.50	61.60	61.60	60.00	60.00	58.40	58.40	57.80
11	57.80	55.60	55.60	54.70	52.70	51.70	51.70	50.00	48.90	47.04
21	45.20	41.51	37.94	34.50	27.56	21.43	16.26	12.12	9.11	7.27
31	6.66									

62

SHUD COOLDOWN I[illegible] . SUPPORT SKIRT HEAD ITERATION 40 PAGE 5 DATE 08/04/78

SEGMENT THICKNESS DATA BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	TOP THICK. OF TOP SEG.	BOTTOM THICK. OF BOTTOM SEG.
1.00	3.00	8.00	8.00
4.00	4.00	0.00	0.00
5.00	5.00	8.30	8.30
6.00	6.00	0.00	0.00
[illegible].00	7.00	9.20	9.20
8.[illegible]	8.00	0.00	0.00
9.00	9.00	11.02	11.02
10.00	10.00	0.00	0.00
11.00	11.00	14.20	14.20
12.00	12.00	0.00	0.00
13.00	15.00	16.00	16.00
16.00	16.00	0.00	0.00
17.00	30.00	8.00	8.00

SEGMENTAL THICKNESS BY SEGMENTS

THICKNESS AT TOP OF SEGMENT (HA)

K	HA(K)	HA(K+1)	HA(K+2)	HA(K+3)	HA(K+4)	HA(K+5)	HA(K+6)	HA(K+7)	HA(K+8)	HA(K+9)
1	8.00	8.00	8.00	0.00	8.30	0.00	9.20	0.00	11.02	0.00
11	14.20	0.00	16.00	16.00	16.00	0.00	8.00	8.00	8.00	8.00
21	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00

THICKNESS AT BOTTOM OF SEGMENT (HB)

K	HB(K)	HB(K+1)	HB(K+2)	HB(K+3)	HB(K+4)	HB(K+5)	HB(K+6)	HB(K+7)	HB(K+8)	HB(K+9)
1	8.00	8.00	8.00	0.00	8.30	0.00	9.20	0.00	11.02	0.00
11	14.20	0.00	16.00	16.00	16.00	0.00	8.00	8.00	8.00	8.00
21	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00

SHUD COOLDOWN INC. SUPPORT SKIRT HEAD ITERATION 40 PAGE A DATE 08/04/78

MATERIAL PROPERTIES BY SEGMENTS

SEG. NO.	ALPHA	MODULUS OF TENSION	MODULUS OF SHEAR	POISSON'S RATIO
1	.6749E-05	.2872E+08	.1105E+08	.3000E+00
2	.6755E-05	.2871E+08	.1104E+08	.3000E+00
3	.6764E-05	.2869E+08	.1103E+08	.3000E+00
4	.6786E-05	.2863E+08	.1101E+08	.3000E+00
5	.6810E-05	.2857E+08	.1099E+08	.3000E+00
6	.6828E-05	.2852E+08	.1097E+08	.3000E+00
7	.6845E-05	.2847E+08	.1095E+08	.3000E+00
8	.6870E-05	.2840E+08	.1092E+08	.3000E+00
9	.6893E-05	.2834E+08	.1090E+08	.3000E+00
10	.6906E-05	.2830E+08	.1088E+08	.3000E+00
11	.6918E-05	.2827E+08	.1087E+08	.3000E+00
12	.6929E-05	.2824E+08	.1086E+08	.3000E+00
13	.6941E-05	.2820E+08	.1085E+08	.3000E+00
14	.6942E-05	.2820E+08	.1085E+08	.3000E+00
15	.6915E-05	.2822E+08	.1085E+08	.3000E+00
16	.6849E-05	.2846E+08	.1093E+08	.3000E+00
17	.6767E-05	.2868E+08	.1103E+08	.3000E+00
18	.6760E-05	.2870E+08	.1104E+08	.3000E+00
19	.6751E-05	.2872E+08	.1105E+08	.3000E+00
20	.6746E-05	.2873E+08	.1105E+08	.3000E+00
21	.6743E-05	.2874E+08	.1105E+08	.3000E+00
22	.6741E-05	.2874E+08	.1106E+08	.3000E+00
23	.6741E-05	.2874E+08	.1106E+08	.3000E+00
24	.6741E-05	.2874E+08	.1106E+08	.3000E+00
25	.6741E-05	.2874E+08	.1106E+08	.3000E+00
26	.6741E-05	.2874E+08	.1106E+08	.3000E+00
27	.6741E-05	.2874E+08	.1106E+08	.3000E+00
28	.6741E-05	.2874E+08	.1106E+08	.3000E+00
29	.6741E-05	.2874E+08	.1106E+08	.3000E+00
30	.6741E-05	.2874E+08	.1106E+08	.3000E+00

64

320-0011-55
03 70
5-211

SMUD COOLDOWN INC. SUPPORT SKIRT HEAD ITERATION 40 PAGE 7 DATE 08/04/78

PRESSURE INPUT DATA BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	INTERNAL PRESSURE	EXTERNAL PRESSURE
1.0	3.0	2000.0	0.0
4.0	4.0	0.0	0.0
5.0	5.0	2000.0	0.0
6.0	6.0	0.0	0.0
7.0	7.0	2000.0	0.0
8.0	8.0	0.0	0.0
9.0	9.0	2000.0	0.0
10.0	10.0	0.0	0.0
11.0	11.0	2000.0	0.0
12.0	12.0	0.0	0.0
13.0	15.0	2000.0	0.0
16.0	16.0	0.0	0.0
17.0	30.0	2000.0	0.0

MECHANICAL LOADING ON SEGMENTAL GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	RADIAL FORCE	MOMENT	AXIAL FORCE
1.0	14.0	0.	0.	0.
15.0	15.0	0.	.108E+08	-.200E+07 ← FROM REFERENCE 1, PAGE B-12-1
16.0	30.0	0.	0.	0.

620-0011-55

65

SHUD COOLDOWN INC. SUPPORT SKIRT HEAD ITERATION 40 PAGE 8 DATE 08/04/78

STRESS CONCENTRATION FACTORS BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	INSIDE TENSION	INSIDE BENDING	OUTSIDE TENSION	OUTSIDE BENDING
1	30	1.00	1.00	1.00	1.00

SEH
08/30
620-0011-55
66

SMUD COOLDOWN INC. SUPPORT SKIRT HEAD ITERATION 40 PAGE 9 DATE 08/04/78

TEMPERATURES PER SEGMENT USED IN PRIMARY + SECONDARY ANALYSIS

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5	SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	300.	300.	300.	300.	300.	16	312.	312.	312.	312.	312.
2	304.	304.	304.	304.	304.	17	307.	307.	307.	307.	307.
3	310.	310.	310.	310.	310.	18	302.	302.	302.	302.	302.
4	326.	326.	326.	326.	326.	19	299.	299.	299.	299.	299.
5	331.	331.	331.	331.	331.	20	297.	297.	297.	297.	297.
6	342.	342.	342.	342.	342.	21	296.	296.	296.	296.	296.
7	345.	345.	345.	345.	345.	22	296.	296.	296.	296.	296.
8	360.	360.	360.	360.	360.	23	296.	296.	296.	296.	296.
9	362.	362.	362.	362.	362.	24	296.	296.	296.	296.	296.
10	370.	370.	370.	370.	370.	25	296.	296.	296.	296.	296.
11	371.	371.	371.	371.	371.	26	296.	296.	296.	296.	296.
12	377.	377.	377.	377.	377.	27	296.	296.	296.	296.	296.
13	378.	378.	378.	378.	378.	28	296.	296.	296.	296.	296.
14	378.	378.	378.	378.	378.	29	296.	296.	296.	296.	296.
15	375.	375.	375.	375.	375.	30	296.	296.	296.	296.	296.

SMUD COOLDOWN INC. SUPPORT SKIRT HEAD ITERATION 40 PAGE 10 DATE 08/04/78

PRIMARY + SECONDARY BOUNDARY AND FLEXIBILITY MATRICES

BOUNDARY FORCES DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL DEFL. (O)	ROTATION (O)	RADIAL DEFL. (N)	ROTATION (N)	SUM
AXIAL FORCE (N)	0.	0.	0.	0.	0.	0.	0.	0.	0.
RADIAL SHEAR (O)	.6274E+08	.2742E+07	-.3657E+05	0.	.4979E+08	-.6589E+07	0.	0.	.1103E+09
MOMENT (O)	.5166E+09	.2902E+08	.2256E+07	0.	.4263E+09	-.8684E+08	0.	0.	.8873E+09
RADIAL SHEAR (N)	-.4002E+06	-.2817E+05	-.1123E+04	0.	.8457E+05	-.4315E+05	0.	0.	-.3923E+06
MOMENT (N)	.9566E+05	.8719E+04	.9821E+03	0.	.5504E+05	.2274E+04	0.	0.	.1637E+06

FLEXIBILITY MATRIX DUE TO A UNIT LOAD (TOTAL LOAD BASIS)

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL SHEAR (O)	MOMENT (O)	RADIAL SHEAR (N)	MOMENT (N)
AXIAL DEFL. (N)	.1287E+00	.1188E-01	.2604E-02	.1428E-01	.2134E-08	-.2023E-09	.2213E-06	-.5268E-12
RADIAL DEFL. (O)	-.1500E+00	-.5117E-02	.2053E-02	.2134E-08	.4213E-08	-.2237E-09	.2014E-13	-.3610E-15
ROTATION (O)	.5108E-03	-.1446E-03	-.1408E-03	-.2023E-09	-.2237E-09	.2612E-10	-.3246E-14	.1760E-16
RADIAL DEFL. (N)	.2168E-05	.1625E-06	.4683E-07	.2213E-06	.2014E-13	-.3246E-14	.4390E-[illegible]	.1186E-13
ROTATION (N)	.2180E-08	-.6564E-09	-.2505E-09	-.5268E-12	-.3610E-15	.1760E-16	.1186E-13	.1686E-12

BOUNDARY DEFLECTIONS DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL DEFL. (O)	ROTATION (O)	RADIAL DEFL. (N)	ROTATION (N)	SUM
AXIAL DEFL. (N)	.6875E-01	.5568E-02	-.2677E-03	0.	.3931E-01	-.1856E-02	0.	0.	.1115E+00
RADIAL DEFL. (O)	-.1450E-14	-.1114E-15	.1745E-16	0.	.1154E+00	-.2255E-15	0.	0.	.1154E+00
ROTATION (O)	-.1778E-15	.3337E-17	-.9253E-19	0.	-.3266E-16	-.1242E-02	0.	0.	-.1242E-02
RADIAL DEFL. (N)	.4520E-20	.1340E-21	.2572E-21	0.	-.3610E-20	-.5516E-20	0.	0.	-.2223E-19
ROTATION (N)	-.1059E-21	-.6617E-23	-.8272E-24	0.	.5294E-22	.1323E-22	0.	0.	0.

J.P.H.
8
620-0011-55
69

SHUD COOLDOWN INC. SUPPORT SKIRT HEAD ITERATION 60 PAGE 11 DATE 08/04/78

FLEXIBILITY MATRIX OF ASSEMBLY AS IN PROGRAM 91060
(THIS MATRIX ONLY IS ON A PER RADIAN BASIS)

	M(O)	Q(O)	M(N)	Q(N)
ROTATION(O)	.164136E-09	.140545E-08	.110585E-15	-.203923E-13
DEFLECTION(O)	.140545E-08	.265970E-07	.226840E-14	-.126570E-12
ROTATION(N)	.110595E-15	.226840E-14	.105907E-11	.764941E-13
DEFLECTION(N)	-.203923E-13	-.126570E-12	.764941E-13	.275846E-10

NOTE- THE +1 SIGN CONVENTION IS USED IN THE MATRIX PRINTED HERE.
IF IT IS DESIRED TO USE THE -1 SIGN CONVENTION THEN THE
SIGNS MUST BE CHANGED ON ALL OF THE OFF-DIAGONAL ELEMENTS.

SMUD COOLDOWN INC. SUPPORT SKIRT HEAD ITERATION 40 PAGE 12 DATE 08/04/78

PRIMARY + SECONDARY FORCES AND MOTIONS

POSITIVE DIRECTIONS (+) ARE AS FOLLOWS

TOP OF SEGMENT NO.1	BOTTOM OF REMAINING SEGMENTS
RADIAL------ TO THE LEFT	RADIAL------ TO THE RIGHT
ROTATIONAL-- CLOCKWISE	ROTATIONAL-- COUNTERCLOCKWISE
AXIAL------- UPWARD	AXIAL------- DOWNWARD

** SIGN CONVENTIONS ARE FOR A RIGHT HAND VIEW **

SEG. NO.	LOC.	RADIAL FORCE	MOMENT	AXIAL FORCE	LOC.	RADIAL MOTION	ROTATION	AXIAL MOTION
1	TOP	.1103E+09	.8873E+09	.1995E+08	TOP	.1154E+00	-.1242E-02	0.
1	BOT.	.1013E+09	.7263E+09	.1988E+08	BOT.	-.1066E+00	.3562E-02	.5189E-02
2	BOT.	.9200E+08	.5696E+09	.1978E+08	BOT.	-.9426E-01	.5580E-02	.1161E-01
3	BOT.	.8119E+08	.3988E+09	.1962E+08	BOT.	-.7677E-01	.7392E-02	.1977E-01
4	BOT.	.8119E+08	.4018E+09	.1962E+08	BOT.	-.7644E-01	.7392E-02	.1864E-01
5	BOT.	.7239E+08	.2740E+09	.1946E+08	BOT.	-.6034E-01	.8179E-02	.2637E-01
6	BOT.	.7219E+08	.2828E+09	.1946E+08	BOT.	-.5923E-01	.8179E-02	.2256E-01
7	BOT.	.6294E+08	.1692E+09	.1927E+08	BOT.	-.4294E-01	.8896E-02	.3087E-01
8	BOT.	.6294E+08	.1870E+09	.1927E+08	BOT.	-.4075E-01	.8896E-02	.2264E-01
9	BOT.	.5837E+08	.1493E+09	.1920E+08	BOT.	-.3482E-01	.8993E-02	.2590E-01
10	BOT.	.5847E+08	.1794E+09	.1920E+08	BOT.	-.3074E-01	.8993E-02	.1135E-01
11	BOT.	.4122E+08	.6169E+08	.1890E+08	BOT.	-.1910E-01	.9154E-02	.2353E-01
12	BOT.	.4122E+08	.7910E+08	.1890E+08	BOT.	-.7717E-02	.9154E-02	.1510E-01
13	BOT.	.3356E+08	.4215E+08	.1877E+08	BOT.	.4521E-03	.9202E-02	.2024E-01
14	BOT.	.1793E+08	-.1697E+08	.1845E+08	BOT.	.1621E-01	.9273E-02	.3198E-01
15	BOT.	.1067E+08	-.4610E+08	.2028E+08	BOT.	.2609E-01	.9290E-02	.3799E-01
16	BOT.	.1067E+08	-.1306E+09	.2024E+08	BOT.	.1710E-01	.9293E-02	.7674E-01
17	BOT.	.5249E+07	-.1543E+09	.1992E+08	BOT.	.3186E-01	.8852E-02	.8666E-01
18	BOT.	.2146E+07	-.1654E+09	.1967E+08	BOT.	.4074E-01	.8517E-02	.9307E-01
19	BOT.	-.2435E+07	-.1776E+09	.1922E+08	BOT.	.5471E-01	.7498E-02	.1034E+00
20	BOT.	-.6305E+07	-.1926E+09	.1874E+08	BOT.	.6600E-01	.7215E-02	.1162E+00
21	BOT.	-.1223E+08	-.1745E+09	.1765E+08	BOT.	.8688E-01	.5793E-02	.1363E+00
22	BOT.	-.1593E+08	-.1564E+09	.1664E+08	BOT.	.9964E-01	.4407E-02	.1524E+00
23	BOT.	-.1795E+08	-.1297E+09	.1518E+08	BOT.	.1067E+00	.3165E-02	.1679E+00
24	BOT.	-.1850E+08	-.7061E+08	.1219E+08	BOT.	.1072E+00	.1144E-02	.1933E+00
25	BOT.	-.1625E+08	-.2818E+08	.9119E+07	BOT.	.9513E-01	.1751E-04	.2085E+00
26	BOT.	-.1306E+08	-.5639E+07	.6197E+07	BOT.	.7764E-01	-.4472E-03	.2169E+00
27	BOT.	-.9479E+07	.2810E+07	.3650E+07	BOT.	.5811E-01	-.5187E-03	.2214E+00
28	BOT.	-.6374E+07	.3928E+07	.1676E+07	BOT.	.3856E-01	-.3991E-03	.2237E+00
29	BOT.	-.3162E+07	.2290E+07	.4274E+06	BOT.	.1920E-01	-.2096E-03	.2250E+00
30	BOT.	-.3923E+06	.1637E+06	0.	BOT.	-.2223E-19	0.	.1115E+00

(FORCE AND MOTION OUTPUT IS IN GLOBAL DIRECTIONS R AND Z)

JSH
08/10
GZD-W-55

70

SMUD COOLDOWN INC. SUPPORT SKIRT HEAD ITERATION 40 PAGE 13 DATE 08/04/78

PRIMARY + SECONDARY STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	-159298.2	-144758.8	-.0	7292.7	-101357.9	14378.3	189784.1	-58643.6	-21.6
2	-124837.8	-129949.6	-.0	6105.8	-97863.3	11199.6	160323.9	-65725.6	-535.6
3	-87666.0	-112531.2	-.0	4930.6	-92580.9	8894.5	158884.0	-74110.2	-1026.0
5	-55743.0	-90021.7	-.0	3834.6	-90119.5	4932.2	60020.4	-82686.6	-1549.5
7	-27543.1	-84549.5	-.0	2882.2	-85955.2	2276.4	36486.1	-88808.4	-2010.6
9	-16714.3	-78533.0	-.0	2034.8	-85564.5	562.6	23810.4	-94357.2	-2375.8
11	-3916.9	-63289.4	-.0	1601.8	-77136.0	-996.0	8657.6	-96095.3	-2767.7
13	-2249.8	-58081.2	-.0	1254.2	-76114.5	-1943.2	6607.4	-93561.9	-2985.4
14	1406.8	-69516.8	.0	1599.3	-66476.1	-2614.0	2838.9	-86092.2	-3015.0
15	2577.5	-64922.8	-.0	1727.4	-62000.8	-2751.4	1859.5	-82598.7	-3017.0
17	40983.3	-24376.1	.0	5001.9	-44275.3	-4241.7	-36561.0	-65508.3	-2818.0
18	44011.6	-18336.6	-.0	5137.1	-38888.7	-4600.4	-37527.0	-60685.6	-2863.4
19	47927.1	-16175.5	-.0	5485.1	-31269.9	-4856.7	-41130.2	-53660.0	-2852.5
20	50122.9	-3314.7	.0	5425.2	-24473.4	-5053.8	-42789.6	-44630.0	-2849.2
21	51063.9	7196.7	-.0	6542.4	-12833.2	-5102.2	-42240.4	-33930.8	-2808.4
22	47996.5	13602.4	-.0	7201.2	-4005.3	-4459.5	-37493.6	-22398.6	-2715.8
23	42922.2	17155.0	-.0	7769.5	2455.6	-4382.2	-30581.8	-12685.1	-2597.8
24	29795.5	18325.7	.0	8424.0	10330.8	-3635.0	-16662.9	2612.5	-2603.2
25	18068.6	14718.0	.0	8611.8	12354.6	-2185.3	-1284.3	10485.5	-2174.2
26	10196.6	10342.8	-.0	8396.5	11609.9	-1267.0	6719.4	13413.4	-2022.0
27	5827.3	6815.2	-.0	8000.3	10004.2	-720.8	10541.6	13699.5	-1940.4
28	3816.1	4528.7	-.0	7604.4	8522.5	-455.9	11824.9	12976.2	-1906.7
29	3087.0	3312.7	-.0	7324.4	7566.0	-356.3	11390.2	12223.0	-1898.0
30	918.0	-4506.4	.0	3849.6	-4049.1	-330.8	6851.2	-3855.3	-1897.9

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

SHUD COOLDOWN INC. SUPPORT SKIRT HEAD ITERATION 40 PAGE 16 DATE 08/04/78

TEMPERATURES PER SEGMENT USED IN PEAK PRINCIPLE ANALYSIS

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5	SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	351.	335.	310.	270.	219.	16	380.	353.	319.	274.	220.
2	358.	341.	314.	271.	219.	17	364.	345.	316.	273.	220.
3	375.	350.	318.	274.	220.	18	354.	338.	312.	271.	219.
4	404.	369.	336.	286.	220.	19	369.	336.	308.	270.	219.
5	409.	379.	341.	294.	220.	20	366.	331.	307.	269.	219.
6	427.	393.	354.	297.	220.	21	364.	329.	305.	268.	219.
7	436.	390.	358.	299.	220.	22	363.	329.	305.	267.	219.
8	440.	418.	378.	313.	220.	23	363.	329.	305.	267.	219.
9	443.	421.	380.	314.	220.	24	363.	329.	305.	267.	219.
10	449.	430.	391.	321.	220.	25	363.	329.	305.	267.	219.
11	450.	432.	392.	323.	220.	26	363.	329.	305.	267.	219.
12	452.	439.	402.	331.	220.	27	363.	329.	305.	267.	219.
13	453.	440.	403.	332.	220.	28	363.	329.	305.	267.	219.
14	453.	441.	403.	330.	220.	29	363.	329.	305.	267.	219.
15	450.	444.	396.	324.	220.	30	363.	329.	305.	267.	219.

SMUD COOLDOWN INC. SUPPORT SKIRT HEAD ITERATION 40 PAGE 15 DATE 08/04/78

PEAK BOUNDARY AND FLEXABILITY MATRICES

BOUNDARY FORCES DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL DEFL. (O)	ROTATION (O)	RADIAL DEFL. (N)	ROTATION (N)	SUM
AXIAL FORCE (N)	0.	0.	0.	0.	0.	0.	0.	0.	0.
RADIAL SHEAR (O)	.6324E+09	.2762E+07	-.3657E+06	0.	.4079E+08	-.6599E+07	0.	0.	.1108E+09
MOMENT (O)	.6319E+09	.2902E+08	.2256E+07	0.	.4263E+09	-.8684E+08	0.	0.	.1003E+10
RADIAL SHEAR (N)	-.3743E+06	-.2817E+05	-.7323E+04	0.	.8657E+05	-.4315E+05	0.	0.	-.3664E+06
MOMENT (N)	.8900E+05	.8719E+04	.9421E+03	0.	.5604E+05	.2274E+04	0.	0.	.1570E+06

FLEXIBILITY MATRIX DUE TO A UNIT LOAD (TOTAL LOAD BASIS)

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL SHEAR (O)	MOMENT (O)	RADIAL SHEAR (N)	MOMENT (N)
AXIAL DEFL. (N)	.1421E+00	.1188E-01	.2604E-02	.1420E-01	.2134E-08	-.2023E-09	.2233E-06	-.5268E-12
RADIAL DEFL. (O)	-.1264E+00	-.5117E-02	.2053E-02	.2134E-08	.4233E-09	-.2237E-09	.2014E-13	-.3610E-15
ROTATION (O)	-.2361E-02	-.1446E-03	-.1408E-03	-.2023E-09	-.2237E-09	.2512E-10	-.3246E-14	.1760E-16
RADIAL DEFL. (N)	.2419E-05	.1625E-06	.4883E-07	.2233E-05	.2014E-13	-.3246E-14	.6390E-11	.1196E-13
ROTATION (N)	.1146E-08	-.6564E-09	-.2505E-09	-.5268E-12	-.3610E-15	.1760E-16	.1186E-13	.1686E-12

BOUNDARY DEFLECTIONS DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL DEFL. (O)	ROTATION (O)	RADIAL DEFL. (N)	ROTATION (N)	SUM
AXIAL DEFL. (N)	.6559E-01	.5568E-02	-.2677E-03	0.	.3931E-01	-.1856E-02	0.	0.	.1084E+00
RADIAL DEFL. (O)	-.3659E-15	-.1114E-15	-.1765E-16	0.	-.1154E+00	-.2255E-15	0.	0.	-.1154E+00
ROTATION (O)	-.9897E-16	.3337E-17	-.9253E-19	0.	-.3256E-16	-.1242E-02	0.	0.	-.1242E-02
RADIAL DEFL. (N)	.1732E-19	.1349E-21	.2572E-21	0.	-.3410E-20	-.5516E-20	0.	0.	.4129E-20
ROTATION (N)	-.1059E-21	-.6617E-23	-.8272E-24	0.	.5294E-22	.1323E-22	0.	0.	0.

JRH
09/78
620-0011-55
73

SMUD COOLDOWN INC. SUPPORT SKIRT HEAD ITERATION 60 PAGE 16 DATE 08/04/78

FLEXIBILITY MATRIX OF ASSEMBLY AS IN PROGRAM 91060
(THIS MATRIX ONLY IS ON A PER RADIAN BASIS)

	M(O)	D(O)	M(N)	D(N)
ROTATION(O)	.164136E-09	.140545E-08	.110585E-15	-.203923E-13
DEFLECTION(O)	.140545E-08	.265970E-07	.226240E-14	-.126570E-12
ROTATION(N)	.110585E-15	.226840E-14	.105907E-11	.744961E-13
DEFLECTION(N)	-.203923E-13	-.126570E-12	.744940E-13	.275946E-10

NOTE- THE +1 SIGN CONVENTION IS USED IN THE MATRIX PRINTED HERE.
IF IT IS DESIRED TO USE THE -1 SIGN CONVENTION THEN THE
SIGNS MUST BE CHANGED ON ALL OF THE OFF-DIAGONAL ELEMENTS.

JJH
08/78
620-M11-55
74

SMUD COOLDOWN INC. SUPPORT SKIRT HEAD ITERATION 40 PAGE 17 DATE 08/04/78

PEAK FORCES AND MOTIONS

POSITIVE DIRECTIONS (+) ARE AS FOLLOWS

TOP OF SEGMENT NO.1	BOTTOM OF REMAINING SEGMENTS
RADIAL------ TO THE LEFT	RADIAL------ TO THE RIGHT
ROTATIONAL-- CLOCKWISE	ROTATIONAL-- COUNTERCLOCKWISE
AXIAL------- UPWARD	AXIAL------- DOWNWARD

** SIGN CONVENTIONS ARE FOR A RIGHT HAND VIEW **

SEG. NO.	LOC.	RADIAL FORCE	MOMENT	AXIAL FORCE	LOC.	RADIAL MOTION	ROTATION	AXIAL MOTION
1	TOP	.1108E+09	.1003E+10	.1995E+08	TOP	.1154E+00	-.1242E-02	0.
1	BOT.	.1019E+09	.8407E+09	.1998E+08	BOT.	-.1065E+00	.3683E-02	.5385E-02
2	BOT.	.9253E+08	.6818E+09	.1978E+08	BOT.	-.9105E-01	.5902E-02	.1142E-01
3	BOT.	.8197E+08	.5108E+09	.1962E+08	BOT.	-.7574E-01	.7716E-02	.1992E-01
4	BOT.	.8147E+08	.5138E+09	.1962E+08	BOT.	-.7566E-01	.7716E-02	.1865E-01
5	BOT.	.7303E+08	.3846E+09	.1946E+08	BOT.	-.5880E-01	.8701E-02	.2643E-01
6	BOT.	.7303E+08	.3935E+09	.1944E+08	BOT.	-.5772E-01	.8701E-02	.2247E-01
7	BOT.	.6366E+08	.2781E+09	.1927E+08	BOT.	-.4003E-01	.9129E-02	.3065E-01
8	BOT.	.6366E+08	.2954E+09	.1927E+08	BOT.	-.3860E-01	.9123E-02	.2261E-01
9	BOT.	.5962E+08	.2545E+09	.1920E+08	BOT.	-.3253E-01	.9168E-02	.2569E-01
10	BOT.	.5962E+08	.2875E+09	.1920E+08	BOT.	-.2822E-01	.9168E-02	.1086E-01
11	BOT.	.4213E+08	.1658E+09	.1890E+08	BOT.	-.7422E-02	.[illegible]06E-02	.2309E-01
12	BOT.	.4213E+08	.1832E+09	.1890E+08	BOT.	-.4684E-02	.9106E-02	.1470E-01
13	BOT.	.3443E+08	.1441E+09	.1877E+08	BOT.	.3206E-02	.9057E-02	.1993E-01
14	BOT.	.1904E+08	.7082E+08	.1845E+08	BOT.	.2050E-01	.8621E-02	.3147E-01
15	BOT.	.1181E+09	.4780E+08	.2028E+08	BOT.	.2879E-01	.8830E-02	.3738E-01
16	BOT.	.1181E+08	-.3671E+08	.2028E+06	BOT.	.1558E-01	.8530E-02	.7421E-01
17	BOT.	.6492E+07	-.4317E+08	.1992E+08	BOT.	.3246E-01	.8421E-02	.8390E-01
18	BOT.	.3409E+07	-.7612E+08	.1967E+08	BOT.	.4118E-01	.8117E-02	.9014E-01
19	BOT.	-.1204E+07	-.9149E+08	.1922E+08	BOT.	.5450E-01	.7551E-02	.1006E+00
20	BOT.	-.5695E+07	-.9976E+08	.1874E+08	BOT.	.6621E-01	.6961E-02	.1108E+00
21	BOT.	-.1112E+08	-.1001E+09	.1765E+08	BOT.	.8525E-01	.5628E-02	.1307E+00
22	BOT.	-.1494E+08	-.8595E+08	.1644E+08	BOT.	.9708E-01	.4330E-02	.1485E+00
23	BOT.	-.1717E+08	-.6474E+08	.1518E+08	BOT.	.1051E+00	.3165E-02	.1641E+00
24	BOT.	-.1807E+08	-.1611E+08	.1219E+08	BOT.	.1041E+00	.1212E-02	.1899E+00
25	BOT.	-.1610E+08	.1741E+08	.4119E+07	BOT.	.9467E-01	.9366E-04	.2056E+00
26	BOT.	-.1394E+08	.3155E+08	.6147E+07	BOT.	.7714E-01	-.3470E-03	.2145E+00
27	BOT.	-.9725E+07	.3139E+08	.3650E+07	BOT.	.5881E-01	-.4702E-03	.2193E+00
28	BOT.	-.6428E+07	.2340E+08	.1676E+07	BOT.	.3854E-01	-.3777E-03	.2220E+00
29	BOT.	-.3195E+07	.1217E+08	.4274E+06	BOT.	.1921E-01	-.1996E-03	.2233E+00
30	BOT.	-.3664E+06	.1570E+06	0.	BOT.	.4124E-20	0.	.1084E+00

(FORCE AND MOTION OUTPUT IS IN GLOBAL DIRECTIONS R AND Z)

JSH
08/78
G20-0011-55

SHUD COOLDOWN INC. SUPPORT SKIRT HEAD ITERATION 40 PAGE 18 DATE 08/04/78

PEAK PRINCIPAL STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	-180996.6	-160282.0	-.0	5546.5	-102873.2	17373.7	223213.6	-31844.0	579.8
3	-145247.9	-145935.1	-.0	4259.0	-99324.0	14211.1	192337.7	-39189.5	63.8
3	-109909.7	-130446.8	-.0	3716.3	-93170.8	11160.1	138084.5	-45500.3	-423.6
5	-75257.5	-119340.0	-.0	2115.8	-91918.3	9066.4	100370.0	-49945.5	-893.7
7	-40741.1	-102246.5	.0	556.6	-87266.7	5426.7	66311.5	-53995.7	-1291.8
9	-22038.8	-93679.6	-.0	-1476.6	-84243.7	3719.8	47951.5	-56751.2	-1506.7
11	-2867.6	-75918.8	-.0	-2549.7	-80464.6	2201.0	28612.0	-55306.3	-1682.8
13	1614.9	-68971.2	.0	-3731.5	-79376.7	1282.7	26429.7	-52463.2	-1707.8
14	5810.8	-60618.4	.0	-3497.0	-71002.6	866.3	22305.2	-48547.0	-1744.2
15	8500.6	-55548.8	-.0	-1987.9	-65409.2	726.3	10208.1	-43365.0	-1792.3
17	23234.0	-39919.6	.0	3249.1	-65387.4	-1440.7	-6307.3	-39553.7	-2266.2
18	26745.6	-32459.4	-.0	3208.0	-40444.8	-1404.5	-9259.3	-34691.9	-2296.7
19	31054.2	-24498.7	-.0	3875.1	-32837.9	-2251.1	-13461.9	-28788.5	-2316.6
20	33592.4	-17473.8	-.0	3942.3	-26500.3	-2520.8	-15602.2	-22763.8	-2325.7
21	35342.1	-6886.9	-.0	4788.2	-15146.7	-2665.6	-14411.4	-11024.2	-2303.3
22	33419.7	-19.0	-.0	5305.1	-6572.8	-2505.6	-12773.8	-184.3	-2231.0
23	29089.8	3690.7	-.0	5870.1	-143.6	-2093.1	-6702.0	9160.4	-2127.9
24	17137.6	5430.3	-.0	6551.1	7829.9	-1234.3	8075.7	24091.2	-1947.6
25	5982.9	2287.8	.0	6778.0	10111.6	-59.0	20718.6	32028.3	-1729.6
26	-1663.0	-1808.6	-.0	6607.9	9460.1	824.1	29604.4	35157.3	-1580.9
27	-6023.5	-5209.0	-.0	6250.6	8156.5	1370.9	32505.3	35649.6	-1498.9
28	-8639.0	-7459.6	-.0	5982.4	6768.2	1642.5	33918.3	35094.8	-1453.3
29	-9888.9	-8657.5	-.0	5618.8	5853.9	1750.7	34185.0	34676.4	-1452.7
30	-10927.2	-15936.1	.0	2374.0	-5002.3	1781.6	29303.2	19330.6	-1451.6

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

SMUD COOLDOWN INCIDENT SUPPORT SKIRT HEAD ITERATION 45 PAGE 1 DATE 08/04/78

INPUT DATA DATE 08/04/78

TOTAL NO. OF SEGMENTS = 30

BOUNDARY CONDITIONS AT THE TOP (0) END

1. A RADIAL DEFLECTION OF .11540 INCHES } FROM REF. 3
2. A ROTATION OF -.00124 RADIANS }

BOUNDARY CONDITIONS AT THE BOTTOM (N) END

1. AN AXIAL FORCE OF 0.00000 POUNDS
2. A RADIAL DEFLECTION OF 0.00000 INCHES
3. A ROTATION OF 0.00000 RADIANS

* NOTE * A SEGMENTAL GROUP MAY CONSIST OF FROM ONE TO THE TOTAL NO. OF SEGMENTS.
SEGMENT ONE IS CONSIDERED AT THE TOP OF THE GEOMETRY.
ALL LOADS ABOVE, ARE ON A TOTAL LOAD BASIS.

JFH
08/80
620-0011-55
77

SMUD COOLDOWN INCIDENT SUPPORT SKIRT HEAD ITERATION 45 PAGE 2 DATE 08/04/78

MID-SURFACE GEOMETRY

AT TOP BOUNDARY, MEAN RADIUS = 63.2530 Z COORDINATE = 66.6000

SEGMENTAL GEOMETRY DATA BY GROUPS

SEGMENT DATA BOTTOM SEG. NO.	MEAN RADIUS	Z COORD..	CENTER OF CURVATURE DATA RADIUS TO CENTER	Z COORD.	CURVATURE IDENTIFIER
1.0	63.154	65.100	0.000	70.000	1.0
2.0	63.010	63.500	0.000	70.000	1.0
3.0	62.784	61.600	4.000	70.000	1.0
4.0	62.936	61.600	0.000	0.000	0.0
5.0	62.702	60.000	0.000	70.000	1.0
6.0	63.157	60.000	0.000	0.000	0.0
7.0	62.883	58.400	0.000	70.000	1.0
8.0	63.808	58.400	0.000	0.000	0.0
9.0	63.696	57.800	0.000	70.000	1.0
10.0	65.314	57.800	0.000	0.000	0.0
11.0	66.965	55.600	0.000	70.000	1.0
12.0	65.736	55.600	0.000	0.000	0.0
13.0	65.593	54.700	0.000	70.000	1.0
14.0	65.086	52.700	0.000	70.000	1.0
15.0	66.810	51.700	0.000	70.000	1.0
16.0	59.643	51.700	0.000	0.000	0.0
17.0	60.104	50.000	0.000	70.000	1.0
18.0	59.725	49.900	0.000	70.000	1.0
20.0	58.297	45.200	0.000	70.000	1.0
23.0	52.431	34.560	0.000	70.000	1.0
30.0	.001	6.660	0.000	70.000	1.0

620-0...
78

SHUD COOLDOWN INCIDENT SUPPORT SKIRT HEAD ITERATION 45 PAGE 3 . DATE 08/04/78

NOTE- CURVATURE IDENTIFIER +1= POSITIVE CURVATURE
0= NO CURVATURE
-1= NEGATIVE CURVATURE

620-0011-CC
79

SMUD COOLDOWN INCIDENT SUPPORT SKIRT HEAD ITERATION 45 PAGE 4 DATE 08/04/78

SEGMENTAL GEOMETRY BY SEGMENTS (K= SEGMENT NO.)

MEAN RADIUS

K	R(K-1)	R(K)	R(K+1)	R(K+2)	R(K+3)	R(K+4)	R(K+5)	R(K+6)	R(K+7)	R(K+8)
1	63.25	63.15	63.01	62.79	62.96	62.70	63.15	62.88	63.91	63.70
11	65.31	64.86	65.79	65.58	65.08	64.81	60.64	60.19	59.73	59.04
21	58.29	56.58	54.63	52.46	47.02	40.66	33.52	25.73	17.43	8.80
31	.00									

Z COORDINATE

K	Z(K-1)	Z(K)	Z(K+1)	Z(K+2)	Z(K+3)	Z(K+4)	Z(K+5)	Z(K+6)	Z(K+7)	Z(K+8)
1	66.60	65.10	63.50	61.60	61.60	60.00	60.00	58.40	58.40	57.80
11	57.80	55.60	55.60	54.70	52.70	51.70	51.70	50.00	48.90	47.06
21	45.20	41.51	37.94	34.50	27.56	21.43	16.26	12.12	9.11	7.27
31	6.66									

620-0011-CC
02/29
H.J.P.
80

SHUD COOLDOWN INCIDENT SUPPORT SKIRT HEAD ITERATION 45 PAGE 5 DATE 08/04/78

SEGMENT THICKNESS DATA BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	TOP THICK. OF TOP SEG.	BOTTOM THICK. OF BOTTOM SEG.
1.00	3.00	8.00	8.00
4.00	4.00	0.00	0.00
5.00	5.00	8.30	8.30
6.00	6.00	0.00	0.00
7.00	7.00	9.20	9.20
8.00	8.00	0.00	0.00
9.00	9.00	11.02	11.02
10.00	10.00	0.00	0.00
11.00	11.00	14.20	14.20
12.00	12.00	0.00	0.00
13.00	15.00	16.00	16.00
16.00	16.00	0.00	0.00
17.00	30.00	8.00	8.00

SEGMENTAL THICKNESS BY SEGMENTS

THICKNESS AT TOP OF SEGMENT (HA)

K	HA(K)	HA(K+1)	HA(K+2)	HA(K+3)	HA(K+4)	HA(K+5)	HA(K+6)	HA(K+7)	HA(K+8)	HA(K+9)
1	8.00	8.00	8.00	0.00	8.30	0.00	9.20	0.00	11.02	0.00
11	14.20	0.00	16.00	16.00	16.00	0.00	8.00	8.00	8.00	8.00
21	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00

THICKNESS AT BOTTOM OF SEGMENT (HB)

K	HB(K)	HB(K+1)	HB(K+2)	HB(K+3)	HB(K+4)	HB(K+5)	HB(K+6)	HB(K+7)	HB(K+8)	HB(K+9)
1	8.00	8.00	8.00	0.00	8.30	0.00	9.20	0.00	11.02	0.00
11	14.20	0.00	16.00	16.00	16.00	0.00	8.00	8.00	8.00	8.00
21	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00

SHUD COOLDOWN INCIDENT SUPPORT SKIRT HEAD ITERATION 45 PAGE 6 DATE 08/04/78

MATERIAL PROPERTIES BY SEGMENTS

SEG. NO.	ALPHA	MODULUS OF TENSION	MODULUS OF SHEAR	POISSON'S RATIO
1	.6657E-05	.2895E+08	.1113E+08	.3000E+00
2	.6665E-05	.2893E+08	.1113E+08	.3000E+00
3	.6677E-05	.2890E+08	.1112E+08	.3000E+00
4	.6694E-05	.2885E+08	.1110E+08	.3000E+00
5	.6715E-05	.2881E+08	.1108E+08	.3000E+00
6	.6730E-05	.2877E+08	.1107E+08	.3000E+00
7	.6745E-05	.2873E+08	.1105E+08	.3000E+00
8	.6769E-05	.2867E+08	.1103E+08	.3000E+00
9	.6789E-05	.2862E+08	.1101E+08	.3000E+00
10	.6807E-05	.2859E+08	.1099E+08	.3000E+00
11	.6816E-05	.2855E+08	.1096E+08	.3000E+00
12	.6828E-05	.2852E+08	.1097E+08	.3000E+00
13	.6835E-05	.2850E+08	.1096E+08	.3000E+00
14	.6842E-05	.2848E+08	.1095E+08	.3000E+00
15	.6837E-05	.2849E+08	.1096E+08	.3000E+00
16	.6761E-05	.2869E+08	.1104E+08	.3000E+00
17	.6686E-05	.2888E+08	.1111E+08	.3000E+00
18	.6677E-05	.2891E+08	.1112E+08	.3000E+00
19	.6662E-05	.2893E+08	.1113E+08	.3000E+00
20	.6654E-05	.2895E+08	.1114E+08	.3000E+00
21	.6647E-05	.2897E+08	.1114E+08	.3000E+00
22	.6642E-05	.2898E+08	.1115E+08	.3000E+00
23	.6641E-05	.2898E+08	.1115E+08	.3000E+00
24	.6640E-05	.2899E+08	.1115E+08	.3000E+00
25	.6639E-05	.2899E+08	.1115E+08	.3000E+00
26	.6639E-05	.2899E+08	.1115E+08	.3000E+00
27	.6639E-05	.2899E+08	.1115E+08	.3000E+00
28	.6639E-05	.2899E+08	.1115E+08	.3000E+00
29	.6639E-05	.2899E+08	.1115E+08	.3000E+00
30	.6639E-05	.2899E+08	.1115E+08	.3000E+00

08/78

620-0011-55

SMUD COOLDOWN INCIDENT SUPPORT SKIRT HEAD ITERATION 45 PAGE 7 DATE 08/04/78

PRESSURE INPUT DATA BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	INTERNAL PRESSURE	EXTERNAL PRESSURE
1.0	3.0	2000.0	0.0
4.0	4.0	0.0	0.0
5.0	5.0	2000.0	0.0
6.0	6.0	0.0	0.0
7.0	7.0	2000.0	0.0
8.0	8.0	0.0	0.0
9.0	9.0	2000.0	0.0
10.0	10.0	0.0	0.0
11.0	11.0	2000.0	0.0
12.0	12.0	0.0	0.0
13.0	15.0	2000.0	0.0
16.0	16.0	0.0	0.0
17.0	30.0	2000.0	0.0

MECHANICAL LOADING ON SEGMENTAL GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	RADIAL FORCE	MOMENT	AXIAL FORCE
1.0	14.0	0.	0.	0.
15.0	15.0	0.	-.108E+08	-.200E+07
16.0	30.0	0.	0.	0.

FROM REFERENCE 1, PAGE B-12-1

JJH
08/78
55-1100-022
83

SMUD COOLDOWN INCIDENT SUPPORT SKIRT HEAD ITERATION 45 PAGE 8 DATE 08/04/78

STRESS CONCENTRATION FACTORS BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	INSIDE TENSION	INSIDE BENDING	OUTSIDE TENSION	OUTSIDE BENDING
1	30	1.00	1.00	1.00	1.00

620-0011-55
08/28
84

SMUD COOLDOWN INCIDENT SUPPORT SKIRT HEAD ITERATION 45 PAGE 9 DATE 08/04/78

TEMPERATURES PER SEGMENT IN PRIMARY + SECONDARY ANALYSIS

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5	SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	262.	262.	262.	262.	262.	16	278.	278.	278.	278.	278.
2	267.	267.	267.	267.	267.	17	271.	271.	271.	271.	271.
3	275.	275.	275.	275.	275.	18	265.	265.	265.	265.	265.
4	286.	286.	286.	286.	286.	19	261.	261.	261.	261.	261.
5	293.	293.	293.	293.	293.	20	259.	259.	258.	258.	258.
6	302.	302.	302.	302.	302.	21	256.	254.	254.	256.	256.
7	307.	307.	307.	307.	307.	22	254.	254.	254.	254.	254.
8	321.	321.	321.	321.	321.	23	253.	253.	253.	253.	253.
9	324.	324.	324.	324.	324.	24	252.	252.	252.	252.	252.
10	332.	332.	332.	332.	332.	25	252.	252.	252.	252.	252.
11	334.	334.	334.	334.	334.	26	252.	252.	252.	252.	252.
12	341.	341.	341.	341.	341.	27	252.	252.	252.	252.	252.
13	342.	342.	342.	342.	342.	28	252.	252.	252.	252.	252.
14	343.	343.	343.	341.	343.	29	252.	252.	252.	252.	252.
15	343.	343.	343.	343.	343	30	252.	252.	252.	252.	252.

85

SMUD COOLDOWN INCIDENT SUPPORT SKIRT HEAD ITERATION 45 PAGE 10 DATE 08/04/78

PRIMARY + SECONDARY BOUNDARY AND FLEXABILITY MATRICES

BOUNDARY FORCES DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL DEFL. (O)	ROTATION (O)	RADIAL DEFL. (N)	ROTATION (N)	SUM
AXIAL FORCE (N)	0.	0.	0.	0.	0.	0.	0.	0.	0.
RADIAL SHEAR (O)	.5555E+08	.2741E+07	-.3659E+08	0.	.5021E+08	-.4627E+07	0.	0.	.1035E+09
MOMENT (O)	.4530E+09	.2902E+08	.2256E+07	0.	.4299E+09	-.8754E+08	0.	0.	.8266E+09
RADIAL SHEAR (N)	-.3562E+06	-.2918E+05	-.7324E+04	0.	.8719E+05	-.6350E+05	0.	0.	-.3680E+06
MOMENT (N)	.8309E+05	.8720E+04	.9815E+03	0.	.5650E+05	.2291E+04	0.	0.	.1516E+06

FLEXIBILITY MATRIX DUE TO A UNIT LOAD (TOTAL LOAD BASIS)

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL SHEAR (O)	MOMENT (O)	RADIAL SHEAR (N)	MOMENT (N)
AXIAL DEFL. (N)	.1121E+00	.1178E-01	.2583E-02	.1416E-01	.2117E-08	-.2007E-09	.2216E-06	-.5223E-12
RADIAL DEFL. (O)	-.1327E+00	-.5070E-02	.2036E-02	.2117E-08	.4198E-08	-.2219E-09	.1999E-13	-.3579E-15
ROTATION (O)	.5856E-03	-.1437E-03	-.1396E-03	-.2007E-09	-.2219E-09	.2591E-10	-.3219E-14	.1745E-16
RADIAL DEFL. (N)	.1897E-05	.1612E-06	.4445E-07	.2216E-06	.1999E-13	-.3219E-14	.4353E-11	.1176E-13
ROTATION (N)	.2276E-08	-.6513E-09	-.2482E-09	-.5223E-12	-.3579E-15	.1745E-16	.1176E-13	.1671E-12

BOUNDARY DEFLECTIONS DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL DEFL. (O)	ROTATION (O)	RADIAL DEFL. (N)	ROTATION (N)	SUM
AXIAL DEFL.	.5989E-01	.5522E-02	-.2655E-03	0.	.3931E-01	-.1955E-02	0.	0.	.1626E+00
RADIAL DEFL. (O)	-.1751E-14	-.1029E-15	.1207E-16	0.	.1154E+00	.2141E-15	0.	0.	.1154E+00
ROTATION (O)	-.1659E-16	.4558E-19	-.1325E-17	0.	.3688E-16	-.1242E-02	0.	0.	-.1242E-02
RADIAL DEFL. (N)	.6366E-20	.2076E-21	-.1488E-21	0.	-.1150E-19	.2070E-20	0.	0.	-.2084E-19
ROTATION (N)	.1588E-21	.6617E-23	-.8272E-24	0.	.1059E-21	0.	0.	0.	.3176E-21

JJH
08/78
CEO-…
86

SMUD COOLDOWN INCIDENT SUPPORT SKIRT HEAD ITERATION 45 PAGE 11 DATE 08/04/78

FLEXIBILITY MATRIX OF ASSEMBLY AS IN PROGRAM 91060
(THIS MATRIX ONLY IS ON A PER RADIAN BASIS)

	M(0)	Q(0)	M(N)	Q(N)
ROTATION(0)	.162827E-09	.139406E-08	.109618E-15	-.202269E-13
DEFLECTION(0)	.139406E-08	.262761E-07	.224851E-14	-.125594E-12
ROTATION(N)	.109618E-15	.224851E-14	.105013E-11	.738650E-13
DEFLECTION(N)	-.202269E-13	-.125594E-12	.738650E-13	.273519E-10

NOTE- THE +1 SIGN CONVENTION IS USED IN THE MATRIX PRINTED HERE.
IF IT IS DESIRED TO USE THE -1 SIGN CONVENTION THEN THE
SIGNS MUST BE CHANGED ON ALL OF THE OFF-DIAGONAL ELEMENTS.

JJH
08/78
620-0014-00

SMUD COOLDOWN INCIDENT SUPPORT SKIRT HEAD ITERATION 45 PAGE 12 DATE 08/04/78

PRIMARY + SECONDARY FORCES AND MOTIONS

POSITIVE DIRECTIONS (+) ARE AS FOLLOWS

TOP OF SEGMENT NO.1 — BOTTOM OF REMAINING SEGMENTS

RADIAL------ TO THE LEFT — RADIAL------ TO THE RIGHT
ROTATIONAL-- CLOCKWISE — ROTATIONAL-- COUNTERCLOCKWISE
AXIAL------- UPWARD — AXIAL------- DOWNWARD

** SIGN CONVENTIONS ARE FOR A RIGHT HAND VIEW **

SEG. NO.	LOC.	RADIAL FORCE	MOMENT	AXIAL FORCE	LOC.	RADIAL MOTION	ROTATION	AXIAL MOTION
1	TOP	.1035E+09	.8266E+09	.1995E+08	TOP	.1154E+00	-.1242E-02	0.
1	BOT.	.9596E+08	.6754E+09	.1998E+08	BOT.	-.1070E+00	.3392E-02	.6811E-02
2	BOT.	.8629E+08	.5271E+09	.1978E+08	BOT.	-.9546E-01	.5264E-02	.1041E-01
3	BOT.	.7627E+08	.3678E+09	.1962E+08	BOT.	-.7907E-01	.6011E-02	.1779E-01
4	BOT.	.7627E+08	.3708E+09	.1962E+08	BOT.	-.7879E-01	.6011E-02	.1674E-01
5	BOT.	.6781E+08	.2508E+09	.1946E+08	BOT.	-.6373E-01	.7812E-02	.2373E-01
6	BOT.	.6781E+08	.2596E+09	.1946E+08	BOT.	-.6292E-01	.7912E-02	.2018E-01
7	BOT.	.5890E+08	.1529E+09	.1927E+08	BOT.	-.4760E-01	.8281E-02	.2772E-01
8	BOT.	.5890E+08	.1707E+09	.1927E+08	BOT.	-.4563E-01	.8281E-02	.2006E-01
9	BOT.	.5506E+08	.1344E+09	.1920E+08	BOT.	-.4010E-01	.8369E-02	.2303E-01
10	BOT.	.5596E+08	.1654E+09	.1920E+08	BOT.	-.3649E-01	.8363E-02	.9486E-02
11	BOT.	.3833E+08	.5504E+08	.1890E+08	BOT.	-.1725E-01	.8521E-02	.2060E-01
12	BOT.	.3833E+08	.7245E+08	.1890E+08	BOT.	-.1513E-01	.8521E-02	.1275E-01
13	BOT.	.3115E+08	.3790E+08	.1877E+08	BOT.	-.7511E-02	.8561E-02	.1745E-01
14	BOT.	.1515E+08	-.1703E+08	.1865E+08	BOT.	.9042E-02	.8627E-02	.2821E-01
15	BOT.	.9169E+07	-.4457E+08	.2020E+08	BOT.	.1712E-01	.8651E-02	.3374E-01
16	BOT.	.9169E+07	-.1291E+09	.2020E+08	BOT.	.8181E-02	.8651E-02	.6479E-01
17	BOT.	.4033E+07	-.1504E+09	.1992E+08	BOT.	.2212E-01	.8214E-02	.7808E-01
18	BOT.	.1085E+07	-.1603E+09	.1967E+08	BOT.	.3642E-01	.7690E-02	.8468E-01
19	BOT.	-.1285E+07	-.1707E+09	.1922E+08	BOT.	.4333E-01	.7297E-02	.9438E-01
20	BOT.	-.6922E+07	-.1744E+09	.1874E+08	BOT.	.5444E-01	.6674E-02	.1038E+00
21	BOT.	-.1244E+08	-.1670E+09	.1765E+08	BOT.	.7205E-01	.5292E-02	.1218E+00
22	BOT.	-.1585E+08	-.1449E+09	.1644E+08	BOT.	.8608E-01	.4000E-02	.1378E+00
23	BOT.	-.1764E+08	-.1209E+09	.1518E+08	BOT.	.9151E-01	.2859E-02	.1515E+00
24	BOT.	-.1807E+08	-.6481E+08	.1219E+08	BOT.	.9230E-01	.9204E-03	.1774E+00
25	BOT.	-.1737E+08	-.2527E+08	.9119E+07	BOT.	.9177E-01	-.2910E-04	.1941E+00
26	BOT.	-.1278E+08	-.4620E+07	.6197E+07	BOT.	.6642E-01	-.4341E-03	.1928E+00
27	BOT.	-.9516E+07	.2410E+07	.3650E+07	BOT.	.4967E-01	-.4496E-03	.1962E+00
28	BOT.	-.6294E+07	.3749E+07	.1676E+07	BOT.	.3289E-01	-.3718E-03	.1979E+00
29	BOT.	-.3132E+07	.2144E+07	.4274E+06	BOT.	.1630E-01	-.1931E-03	.1987E+00
30	BOT.	-.3480E+06	.1516E+06	0.	BOT.	-.2084E-19	.3174E-21	.1026E+00

(FORCE AND MOTION OUTPUT IS IN GLOBAL DIRECTIONS R AND Z)

SHUD COOLDOWN INCIDENT SUPPORT SKIRT HEAD ITERATION 45 PAGE 13 DATE 08/04/78

PRIMARY + SECONDARY STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	-147682.0	-134780.9	-.0	7195.1	-94452.1	13323.6	176936.6	-54774.7	-160.1
2	-113381.0	-121115.2	.0	6098.8	-91415.3	10338.2	139935.7	-62651.7	-644.3
3	-80448.5	-105149.7	-.0	4985.0	-86861.1	7419.7	98173.7	-69997.4	-1166.8
5	-50644.6	-92202.9	-.0	3947.3	-84251.4	6460.0	63656.2	-77687.8	-1595.5
7	-24552.9	-78913.7	-.0	3014.0	-80451.4	1988.6	33450.8	-83628.3	-2025.6
9	-14889.8	-73604.9	-.0	2167.1	-80460.3	412.9	21303.4	-88855.7	-2365.3
11	-3327.0	-59715.3	-.0	1704.4	-72858.8	-1014.5	8161.1	-85918.9	-2730.3
13	-1875.7	-55010.8	-.0	1356.9	-70183.7	-1910.5	6328.4	-88575.9	-2935.5
14	1530.8	-47259.9	-.0	1680.8	-63336.1	-2333.1	2463.7	-82774.3	-2966.8
15	2602.4	-43225.8	-.0	1815.9	-59554.4	-2644.5	1974.7	-79127.9	-2970.1
17	40235.1	-22466.2	.0	5149.9	-41509.3	-4155.7	-33423.4	-61879.2	-2790.0
18	42952.0	-16689.7	.0	5284.5	-36258.7	-4476.6	-34052.5	-57050.7	-2809.4
19	45406.7	-8761.8	.0	5620.0	-28708.4	-4609.6	-39149.0	-50015.5	-2813.8
20	48747.1	-2216.8	.0	5944.9	-22201.1	-4962.9	-40449.5	-43293.3	-2804.9
21	48695.2	7745.8	-.0	6621.9	-11061.6	-4878.2	-39498.7	-30727.3	-2761.3
22	45511.9	13627.6	-.0	7237.9	-2021.7	-4617.3	-36509.3	-14492.9	-2668.6
23	40515.7	16750.5	-.0	7764.6	3106.1	-4145.4	-27957.0	-10740.8	-2554.4
24	27406.7	17658.1	.0	8350.1	10468.4	-3235.0	-12581.3	3571.2	-2368.8
25	16895.6	14090.2	-.0	8495.9	12137.6	-2055.7	-290.7	10467.3	-2153.8
26	9645.7	9952.4	-.0	8273.5	11122.3	-1204.0	7044.0	11204.5	-2013.5
27	5674.4	6674.5	-.0	7890.7	9768.2	-705.6	10466.4	13310.7	-1930.8
28	3886.6	4577.5	-.0	7514.7	8367.3	-459.3	11553.9	12590.0	-1910.3
29	3261.8	3492.9	.0	7250.8	7470.9	-384.0	11643.4	11850.9	-1903.5
30	1385.8	-3317.2	-.0	4163.7	-2864.5	-364.0	7016.5	-2576.3	-1904.1

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

J.F.
08/25
620-0011-55
59

SMUD COOLDOWN INCIDENT SUPPORT SKIRT HEAD ITERATION 45 PAGE 14 DATE 08/04/78

TEMPERATURES PER SEGMENT USED IN PEAK PRINCIPLE ANALYSIS

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5	SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	288.	279.	266.	245.	224.	16	327.	304.	280.	252.	225.
2	298.	287.	270.	248.	224.	17	308.	293.	274.	250.	224.
3	317.	299.	277.	251.	225.	18	295.	285.	269.	247.	224.
4	346.	313.	289.	258.	225.	19	296.	278.	264.	245.	224.
5	356.	325.	295.	260.	225.	20	297.	274.	261.	243.	223.
6	374.	339.	304.	265.	225.	21	276.	269.	257.	241.	223.
7	379.	364.	310.	269.	225.	22	275.	268.	256.	241.	223.
8	398.	368.	327.	278.	225.	23	274.	267.	256.	240.	223.
9	403.	373.	330.	279.	225.	24	272.	266.	255.	239.	223.
10	413.	385.	340.	285.	225.	25	273.	266.	255.	239.	223.
11	415.	389.	343.	286.	225.	26	273.	266.	255.	239.	223.
12	421.	398.	352.	291.	225.	27	273.	266.	255.	239.	223.
13	421.	400.	354.	291.	225.	28	273.	266.	255.	239.	223.
14	422.	405.	355.	290.	225.	29	273.	266.	255.	239.	223.
15	429.	412.	349.	283.	225.	30	273.	266.	255.	239.	223.

620-0011-55

90

SMUD COOLDOWN INCIDENT SUPPORT SKIRT HEAD ITERATION 45 PAGE 15 DATE 08/04/78

PEAK BOUNDARY AND FLEXABILITY MATRICES

BOUNDARY FORCES DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL DEFL. (O)	ROTATION (O)	RADIAL DEFL. (N)	ROTATION (N)	SUM
AXIAL FORCE (N)	0.	0.	0.	0.	0.	0.	0.	0.	0.
RADIAL SHEAR (O)	.5605E+08	.2741E+07	-.3659E+06	0.	.5021E+08	-.6627E+07	0.	0.	.1040E+09
MOMENT (O)	.5317E+09	.2902E+08	.2256E+07	0.	.4290E+09	-.8754E+08	0.	0.	.9053E+09
RADIAL SHEAR (N)	-.3271E+06	-.2818E+05	-.7324E+04	0.	.8719E+05	-.4350E+05	0.	0.	-.3189E+06
MOMENT (N)	.7439E+05	.8720E+04	.9815E+03	0.	.5650E+05	.2291E+04	0.	0.	.1429E+06

FLEXIBILITY MATRIX DUE TO A UNIT LOAD (TOTAL LOAD BASIS)

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL SHEAR (O)	MOMENT (O)	RADIAL SHEAR (N)	MOMENT (N)
AXIAL DEFL. (N)	.1171E+00	.1178E-01	.2583E-02	.1416E-01	.2117E-08	-.2007E-09	.2214E-06	-.5223E-12
RADIAL DEFL. (O)	-.1173E+00	-.5070E-02	.2036E-02	.2117E-08	.4198E-08	-.2219E-09	.1999E-13	-.3570E-15
ROTATION (O)	-.1342E-02	-.1437E-03	-.1396E-03	-.2007E-09	-.2219E-09	.2591E-10	-.3219E-14	.1745E-16
RADIAL DEFL. (N)	.2014E-05	.1612E-06	.4665E-07	.2214E-06	.1999E-13	-.3219E-14	.4353E-11	.1176E-13
ROTATION (N)	.2196E-08	-.6513E-09	-.2482E-09	-.5223E-12	-.3570E-15	.1745E-16	.1176E-13	.1671E-12

BOUNDARY DEFLECTIONS DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL DEFL. (O)	ROTATION (O)	RADIAL DEFL. (N)	ROTATION (N)	SUM
AXIAL DEFL. (N)	.5664E-01	.5522E-02	-.2655E-03	0.	.3931[illegible]	-.1855E-02	0.	0.	.9935E-01
RADIAL DEFL. (O)	-.2416E-14	-.1029E-15	.1207E-16	0.	.1154E+00	-.2141E-15	0.	0.	.1154E+00
ROTATION (O)	.7803E-16	.4558E-19	-.1125E-17	0.	.3680E-16	-.1242E-02	0.	0.	-.1242E-02
RADIAL DEFL. (N)	-.6111E-20	.2076E-21	-.1888E-21	0.	-.1150E-19	.2070E-20	0.	0.	-.6220E-23
ROTATION (N)	.1059E-21	.6617E-23	-.8272E-24	0.	.1059E-21	0.	0.	0.	.1059E-21

91

JJH 08/78

SHUD COOLDOWN INCIDENT SUPPORT SKIRT HEAD ITERATION 45 PAGE 16 DATE 08/04/78

FLEXIBILITY MATRIX OF ASSEMBLY AS IN PROGRAM 91060
(THIS MATRIX ONLY IS ON A PER RADIAN BASIS)

	M(O)	Q(O)	M(N)	Q(N)
ROTATION(O)	.162827E-09	.139406E-08	.109614E-15	-.202269E-13
DEFLECTION(O)	.139406E-08	.263176E-07	.224951E-14	-.125594E-12
ROTATION(N)	.109619E-15	-.224951E-16	.105013E-11	.738650E-13
DEFLECTION(N)	-.202269E-13	-.125594E-12	.738650E-13	.273516E-10

NOTE- THE +1 SIGN CONVENTION IS USED IN THE MATRIX PRINTED HERE.
IF IT IS DESIRED TO USE THE -1 SIGN CONVENTION THEN THE
SIGNS MUST BE CHANGED ON ALL OF THE OFF-DIAGONAL ELEMENTS.

SMUD COOLDOWN INCIDENT SUPPORT SKIRT HEAD ITERATION 45 PAGE 17 DATE 08/04/78

PEAK FORCES AND MOTIONS

POSITIVE DIRECTIONS (+) ARE AS FOLLOWS

TOP OF SEGMENT NO.1	BOTTOM OF REMAINING SEGMENTS
RADIAL------ TO THE LEFT	RADIAL------ TO THE RIGHT
ROTATIONAL-- CLOCKWISE	ROTATIONAL-- COUNTERCLOCKWISE
AXIAL------- UPWARD	AXIAL------- DOWNWARD

** SIGN CONVENTIONS ARE FOR A RIGHT HAND VIEW **

SEG. NO.	LOC.	RADIAL FORCE	MOMENT	AXIAL FORCE	LOC.	RADIAL MOTION	ROTATION	AXIAL MOTION
1	TOP	.1040E+09	.9053E+09	.1995E+08	TOP	.1156E+00	-.1242E-02	0.
1	BOT.	.9558E+08	.7532E+09	.1988E+08	BOT.	-.1069E+00	.3509E-02	.4806E-02
2	BOT.	.8683E+08	.6060E+09	.1979E+08	BOT.	-.9504E-01	.5673E-02	.1041E-01
3	BOT.	.7686E+08	.4434E+09	.1962E+08	BOT.	-.7808E-01	.7235E-02	.1745E-01
4	BOT.	.7686E+08	.4464E+09	.1962E+08	BOT.	-.7779E-01	.7235E-02	.1675E-01
5	BOT.	.6844E+08	.3251E+09	.1966E+08	BOT.	-.6218E-01	.8113E-02	.2179E-01
6	BOT.	.6846E+08	.3339E+09	.1966E+08	BOT.	-.6126E-01	.8113E-02	.2009E-01
7	BOT.	.5964E+08	.2256E+09	.1927E+08	BOT.	-.4556E-01	.8515E-02	.2769E-01
8	BOT.	.5964E+08	.2635E+09	.1927E+08	BOT.	-.4356E-01	.8515E-02	.1981E-01
9	BOT.	.5584E+08	.2064E+09	.1920E+08	BOT.	-.3700E-01	.8547E-02	.2280E-01
10	BOT.	.5594E+08	.2375E+09	.1920E+08	BOT.	-.3421E-01	.8547E-02	.8066E-02
11	BOT.	.3931E+08	.1232E+09	.1890E+08	BOT.	-.1478E-01	.8479E-02	.2010E-01
12	BOT.	.3931E+08	.1406E+09	.1890E+08	BOT.	-.1259E-01	.8479E-02	.1229E-01
13	BOT.	.3221E+08	.1060E+09	.1877E+08	BOT.	-.5039E-02	.8429E-02	.3697E-01
14	BOT.	.1238E+08	.4390E+08	.1845E+08	BOT.	.1109E-01	.8288E-02	.2762E-01
15	BOT.	.1046E+08	.1341E+08	.2028E+08	BOT.	.1679E-01	.8193E-02	.3304E-01
16	BOT.	.1045E+08	-.7110E+08	.2028E+08	BOT.	.9436E-02	[illegible]	.6720E-01
17	BOT.	.5387E+07	-.9520E+08	.1942E+08	BOT.	.2300E-01	.7774E-02	.7602E-01
18	BOT.	.2462E+07	-.1068E+09	.1957E+08	BOT.	.3096E-01	.7476E-02	.8165E-01
19	BOT.	-.1094E+07	-.1203E+09	.1922E+08	BOT.	.4117E-01	.6929E-02	.9114E-01
20	BOT.	-.5550E+07	-.1271E+09	.1874E+08	BOT.	.5146E-01	.6364E-02	.1003E+00
21	BOT.	-.1117E+08	-.1256E+09	.1765E+08	BOT.	.7147E-01	.5111E-02	.1180E+00
22	BOT.	-.1475E+08	-.1088E+09	.1646E+08	BOT.	.8116E-01	.3917E-02	.1338E+00
23	BOT.	-.1677E+08	-.8966E+08	.1519E+08	BOT.	.8976E-01	.2437E-02	.1476E+00
24	BOT.	-.1756E+08	-.4093E+08	.1213E+08	BOT.	.9095E-01	.1060E-02	.1697E+00
25	BOT.	-.1567E+08	-.6452E+07	.9119E+07	BOT.	.8099E-01	.5589E-04	.1831E+00
26	BOT.	-.1275E+08	.1039E+08	.6147E+07	BOT.	.6605E-01	-.3694E-03	.1906E+00
27	BOT.	-.9564E+07	.1445E+08	.3650E+07	BOT.	.4954E-01	-.4443E-03	.1961E+00
28	BOT.	-.6354E+07	.1188E+08	.1676E+07	BOT.	.3286E-01	-.3467E-03	.1961E+00
29	BOT.	-.3169E+07	.6198E+07	.4274E+06	BOT.	.1636E-01	-.1826E-03	.1971E+00
30	BOT.	-.3189E+06	.1429E+06	0.	BOT.	-.6220E-20	.1059E-21	.9935E-01

(FORCE AND MOTION OUTPUT IS IN GLOBAL DIRECTIONS R AND Z)

620-0??-55

SMUD COOLDOWN INCIDENT SUPPORT SKIRT HEAD ITERATION 45 PAGE 18 DATE 08/04/78

PEAK PRINCIPAL STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	-163419.6	-144070.1	-.0	6470.8	-94916.5	15232.2	107852.8	-40642.5	185.1
2	-130917.3	-131114.6	.0	5719.4	-91630.0	12279.8	150659.6	-47447.6	-208.2
3	-96394.0	-117020.9	-.0	4870.0	-86323.4	9638.2	117026.7	-53195.1	-756.4
5	-66039.8	-107619.8	-.0	3865.9	-83307.6	6593.7	81636.3	-57669.8	-1222.2
7	-35417.9	-94326.5	-.0	2940.0	-79471.1	4276.9	48212.4	-61361.9	-1621.6
9	-20259.6	-88500.7	-.0	1547.9	-80010.3	2923.6	33504.7	-63827.6	-1875.1
11	-3787.5	-73282.1	.0	584.6	-72968.6	1814.5	16366.0	-62215.7	-2120.8
13	508.8	-67267.1	-.0	-457.1	-71053.0	1229.8	16066.0	-60110.6	-2213.2
14	5231.6	-59325.1	.0	63.9	-64226.2	922.3	9725.5	-54221.8	-2247.3
15	6979.4	-56654.8	-.0	1882.8	-58055.6	908.1	5777.2	-51509.4	-2304.4
17	28614.5	-32577.6	.0	4689.8	-41368.0	-2412.6	-17741.9	-46872.5	-2687.3
18	31954.2	-25350.0	.0	4609.9	-36512.5	-2852.6	-20718.3	-43653.4	-2517.1
19	35911.8	-16744.2	.0	5007.8	-29209.6	-3176.9	-24662.3	-37906.3	-2538.4
20	38137.4	-10100.4	.0	5312.5	-22470.9	-3638.1	-26652.5	-32091.6	-2565.8
21	39591.0	306.8	-.0	6085.1	-12114.1	-3563.5	-24906.0	-21178.7	-2523.7
22	37327.0	6415.1	-.0	6785.2	-4027.5	-3426.5	-23119.3	-11114.6	-2453.3
23	33179.1	9658.2	-.0	7081.3	1721.6	-3046.8	-17581.7	-2570.1	-2356.2
24	22099.7	11639.4	.0	7694.2	8901.0	-2235.9	-3821.7	11028.9	-2191.6
25	11588.9	8382.4	-.0	7906.5	11075.3	-1143.1	7774.3	18177.8	-1992.3
26	4595.8	4572.7	-.0	7735.4	10525.1	-326.6	14451.7	20933.3	-1856.9
27	647.4	1448.7	-.0	7397.6	9158.6	162.3	18451.7	21301.5	-1782.8
28	-1205.9	-690.9	-.0	7054.2	7867.6	405.5	19601.8	20731.7	-1751.3
29	-1898.3	-1694.2	-.0	6809.7	7023.0	500.2	19805.4	20099.6	-1762.5
30	-3630.2	-7893.5	-.0	3940.8	-2417.3	526.2	15651.8	6788.5	-1741.8

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

94

The motions at the interface of the support skirt and lower head were imposed on the support skirt stress model along with the interpolated temperature distribution and mechanical loads using the 91206 program.

The motions are the peak motions that were calculated previously by the 91206 program for the stress model of the lower head. The motions at the bottom of segment 15 of the lower head model are the boundary conditions for the upper (0) end of the support skirt stress model. The peak motions for iterations 40 and 45 are found on pages 75 and 93 respectively.

The 91206 program calculates primary plus secondary and peak stresses. The following pages contain the stress output for the iterations selected.

JLH
08/78
620-0011-55

SMUD COOLDOWN INC. SUPPORT SKIRT ITERATION 10. PAGE 1 DATE 08/04/78

INPUT DATA DATE 08/04/78

TOTAL NO. OF SEGMENTS = 37

BOUNDARY CONDITIONS AT THE TOP (0) END

1. A RADIAL DEFLECTION OF -.02879 INCHES } REF. PAGE 75
2. A ROTATION OF -.00884 RADIANS

BOUNDARY CONDITIONS AT THE BOTTOM (N) END

1. AN AXIAL FORCE OF -2000000.00000 POUNDS FROM REF. 1, PAGE B-12-1
2. A RADIAL DEFLECTION OF 0.00000 INCHES
3. A ROTATION OF 0.00000 RADIANS

* NOTE * A SEGMENTAL GROUP MAY CONSIST OF FROM ONE TO THE TOTAL NO. OF SEGMENTS.
SEGMENT ONE IS CONSIDERED AT THE TOP OF THE GEOMETRY.
ALL LOADS ABOVE. ARE ON A TOTAL LOAD BASIS.

96
55-1100-229
8/30
M-?

SHUD COOLDOWN INC. SUPPORT SKIRT ITERATION 10. PAGE 2 DATE 08/04/78

MID-SURFACE GEOMETRY

AT TOP BOUNDARY, MEAN RADIUS = 70.3200 Z COORDINATE = 94.4000

SEGMENTAL GEOMETRY DATA BY GROUPS

SEGMENT DATA BOTTOM SEG. NO.	MEAN RADIUS	Z COORD..	CENTER OF CURVATURE DATA RADIUS TO CENTER	Z COORD.	CURVATURE IDENTIFIER
1.0	70.220	93.860	0.000	0.000	0.0
2.0	70.070	92.800	0.000	0.000	0.0
3.0	69.890	91.800	0.000	0.000	0.0
4.0	69.700	90.660	0.000	0.000	0.0
5.0	69.500	89.600	0.000	0.000	0.0
6.0	69.300	88.530	0.000	0.000	0.0
7.0	69.100	87.500	0.000	0.000	0.0
8.0	68.900	86.330	0.000	0.000	0.0
9.0	68.720	85.200	0.000	0.000	0.0
10.0	68.600	84.400	0.000	0.000	0.0
11.0	68.460	83.660	0.000	0.000	0.0
12.0	68.380	83.020	0.000	0.000	0.0
13.0	68.310	82.520	0.000	0.000	0.0
14.0	68.260	82.020	0.000	0.000	0.0
16.0	68.260	81.020	0.000	0.000	0.0
18.0	68.260	77.000	0.000	0.000	0.0
37.0	68.260	1.000	0.000	0.000	0.0

NOTE- CURVATURE IDENTIFIER +1= POSITIVE CURVATURE
0= NO CURVATURE
-1= NEGATIVE CURVATURE

SHUD COOLDOWN INC. SUPPORT SKIRT ITERATION 48. PAGE 3 DATE 08/04/78

SEGMENTAL GEOMETRY BY SEGMENTS (K= SEGMENT NO.)

MEAN RADIUS

K	R(K-1)	R(K)	R(K+1)	R(K+2)	R(K+3)	R(K+4)	R(K+5)	R(K+6)	R(K+7)	R(K+8)
1	70.32	70.22	70.07	69.89	69.70	69.50	69.30	69.10	68.90	68.72
11	68.60	68.46	68.38	68.31	68.26	68.26	68.26	68.26	68.26	68.26
21	68.26	68.26	68.26	68.26	68.26	68.26	68.26	68.26	68.26	68.26
31	68.26	68.26	68.26	68.26	68.26	68.26	68.26	68.26		

Z COORDINATE

K	Z(K-1)	Z(K)	Z(K+1)	Z(K+2)	Z(K+3)	Z(K+4)	Z(K+5)	Z(K+6)	Z(K+7)	Z(K+8)
1	94.40	93.86	92.80	91.80	90.65	89.60	88.53	87.50	86.33	85.20
11	84.40	83.66	83.02	82.52	82.02	81.52	81.02	79.01	77.00	73.00
21	69.00	65.00	61.00	57.00	53.00	49.00	45.00	41.00	37.00	33.00
31	29.00	25.00	21.00	17.00	13.00	9.00	5.00	1.00		

620-011-55

98

SHUD COOLDOWN INC. SUPPORT SKIRT ITERATION 40. PAGE 6 DATE 08/04/78

SEGMENT THICKNESS DATA BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	TOP THICK. OF TOP SEG.	BOTTOM THICK. OF BOTTOM SEG.
1.00	14.00	5.65	1.50
15.00	37.00	1.50	1.50

SEGMENTAL THICKNESS BY SEGMENTS

THICKNESS AT TOP OF SEGMENT (HA)

K	HA(K)	HA(K+1)	HA(K+2)	HA(K+3)	HA(K+4)	HA(K+5)	HA(K+6)	HA(K+7)	HA(K+8)	HA(K+9)
1	5.65	5.35	5.06	4.76	4.46	4.17	3.87	3.58	3.28	2.98
11	2.69	2.39	2.09	1.80	1.50	1.50	1.50	1.50	1.50	1.50
21	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
31	1.50	1.50	1.50	1.50	1.50	1.50	1.50			

THICKNESS AT BOTTOM OF SEGMENT (HB)

K	HB(K)	HB(K+1)	HB(K+2)	HB(K+3)	HB(K+4)	HB(K+5)	HB(K+6)	HB(K+7)	HB(K+8)	HB(K+9)
1	5.35	5.06	4.76	4.46	4.17	3.87	3.58	3.28	2.98	2.69
11	2.39	2.09	1.80	1.50	1.50	1.50	1.50	1.50	1.50	1.50
21	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
31	1.50	1.50	1.50	1.50	1.50	1.50	1.50			

08/30
620-0011-029
99

SMUD COOLDOWN INC. SUPPORT SKIRT ITERATION 40. PAGE 5 DATE 08/04/78

MATERIAL PROPERTIES BY SEGMENTS

SEG. NO.	ALPHA	MODULUS OF TENSION	MODULUS OF SHEAR	POISSON'S RATIO
1	.7034E-05	.2792E+08	.1074E+08	.3000E+00
2	.7033E-05	.2793E+08	.1074E+08	.3000E+00
3	.7029E-05	.2794E+08	.1075E+08	.3000E+00
4	.7021E-05	.2796E+08	.1075E+08	.3000E+00
5	.7013E-05	.2799E+08	.1076E+08	.3000E+00
6	.7005E-05	.2801E+08	.1077E+08	.3000E+00
7	.6993E-05	.2805E+08	.1079E+08	.3000E+00
8	.6976E-05	.2810E+08	.1081E+08	.3000E+00
9	.6959E-05	.2815E+08	.1083E+08	.3000E+00
10	.6943E-05	.2820E+08	.1085E+08	.3000E+00
11	.6925E-05	.2825E+08	.1086E+08	.3000E+00
12	.6907E-05	.2830E+08	.1088E+08	.3000E+00
13	.6893E-05	.2834E+08	.1090E+08	.3000E+00
14	.6879E-05	.2839E+08	.1091E+08	.3000E+00
15	.6866E-05	.2842E+08	.1093E+08	.3000E+00
16	.6854E-05	.2845E+08	.1094E+08	.3000E+00
17	.6820E-05	.2854E+08	.1098E+08	.3000E+00
18	.6765E-05	.2859E+08	.1103E+08	.3000E+00
19	.6683E-05	.2889E+08	.1111E+08	.3000E+00
20	.6590E-05	.2910E+08	.1119E+08	.3000E+00
21	.6521E-05	.2924E+08	.1125E+08	.3000E+00
22	.6470E-05	.2934E+08	.1129E+08	.3000E+00
23	.6433E-05	.2941E+08	.1131E+08	.3000E+00
24	.6405E-05	.2946E+08	.1133E+08	.3000E+00
25	.6385E-05	.2950E+08	.1135E+08	.3000E+00
26	.6370E-05	.2953E+08	.1136E+08	.3000E+00
27	.6356E-05	.2955E+08	.1137E+08	.3000E+00
28	.6344E-05	.2957E+08	.1137E+08	.3000E+00
29	.6333E-05	.2959E+08	.1138E+08	.3000E+00
30	.6321E-05	.2961E+08	.1139E+08	.3000E+00
31	.6303E-05	.2964E+08	.1140E+08	.3000E+00
32	.6295E-05	.2967E+08	.1141E+08	.3000E+00
33	.6270E-05	.2969E+08	.1142E+08	.3000E+00
34	.6260E-05	.2970E+08	.1142E+08	.3000E+00
35	.6253E-05	.2971E+08	.1143E+08	.3000E+00
36	.6249E-05	.2972E+08	.1143E+08	.3000E+00
37	.6247E-05	.2972E+08	.1143E+08	.3000E+00

620-0411-ER
100

SMUD COOLDOWN INC. SUPPORT SKIRT ITERATION [illegible]0. PAGE 6 DATE 08/0[illegible]/78

PRESSURE INPUT DATA BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	INTERNAL PRESSURE	EXTERNAL PRESSURE
1.0	37.0	0.0	0.0

MECHANICAL LOADINGS ON SEGMENTAL GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	RADIAL FORCE	MOMENT	AXIAL FORCE
1.0	37.0	0.	0.	0.

STRESS CONCENTRATION FACTORS BY GROUPS

FROM REF. 1, SECTION B-13

TOP SEG. NO.	BOTTOM SEG. NO.	INSIDE TENSION	INSIDE BENDING	OUTSIDE TENSION	OUTSIDE BENDING
1	1	2.10	1.72	1.20	1.05
2	2	1.86	1.58	1.13	1.03
3	3	1.61	1.44	1.06	1.01
4	11	1.00	1.00	1.00	1.00
12	16	1.00	1.00	1.04	1.04
17	37	1.00	1.00	1.00	1.00

JFH 08/78

620-00-55

101

SMUD COOLDOWN INC. SUPPORT SKIRT ITERATION 40. PAGE 7 DATE 08/04/78

TEMPERATURES PER SEGMENT USED IN PRIMARY + SECONDARY ANALYSIS

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	448.	448.	448.	448.	448.
2	447.	447.	447.	447.	447.
3	445.	445.	445.	445.	445.
4	441.	441.	441.	441.	441.
5	437.	437.	437.	437.	437.
6	432.	432.	432.	432.	432.
7	426.	426.	426.	426.	426.
8	416.	416.	416.	416.	416.
9	407.	407.	407.	407.	407.
10	401.	401.	401.	401.	401.
11	393.	393.	393.	393.	393.
12	382.	382.	382.	382.	382.
13	376.	376.	376.	376.	376.
14	369.	369.	369.	369.	369.
15	363.	363.	363.	363.	363.
16	357.	357.	357.	357.	357.
17	330.	330.	330.	330.	330.
18	303.	303.	303.	303.	303.

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
19	250.	250.	250.	250.	250.
20	212.	212.	212.	212.	212.
21	183.	183.	183.	183.	183.
22	162.	162.	162.	162.	162.
23	147.	147.	147.	147.	147.
24	135.	135.	135.	135.	135.
25	127.	127.	127.	127.	127.
26	120.	120.	120.	120.	120.
27	114.	114.	114.	114.	114.
28	108.	108.	108.	108.	108.
29	103.	103.	103.	103.	103.
30	96.	96.	96.	96.	96.
31	86.	86.	86.	86.	88.
32	78.	78.	78.	78.	78.
33	72.	72.	72.	72.	72.
34	68.	68.	68.	68.	68.
35	65.	65.	65.	65.	65.
36	64.	64.	64.	64.	64.
37	63.	63.	63.	63.	63.

102

SMUD COOLDOWN INC. SUPPORT SKIRT ITERATION 40. PAGE 8 DATE 08/04/78

PRIMARY + SECONDARY BOUNDARY AND FLEXABILITY MATRICES

BOUNDARY FORCES DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL DEFL. (O)	ROTATION (O)	RADIAL DEFL. (N)	ROTATION (N)	SUM
AXIAL FORCE (N)	0.	0.	0.	-.2000E+07	0.	0.	0.	0.	-.2000E+07
RADIAL SHEAR (O)	.2521E+08	0.	0.	.2338E+06	-.3523E+07	-.6535E+07	0.	0.	.1539E+08
MOMENT (O)	.1376E+09	0.	0.	-.1614E+07	-.2128E+08	-.6787E+08	0.	0.	.4684E+08
RADIAL SHEAR (N)	-.8516E+06	0.	0.	-.6800E+05	.3723E+02	.2074E+03	0.	0.	-.9194E+06
MOMENT (N)	.3460E+07	0.	0.	.2714E+06	-.2204E+03	-.8192E+03	0.	0.	.3730E+07

FLEXIBILITY MATRIX DUE TO A UNIT LOAD (TOTAL LOAD BASIS)

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL SHEAR (O)	MOMENT (O)	RADIAL SHEAR (N)	MOMENT (N)
AXIAL DEFL. (N)	.9939E-01	0.	0.	.5389E-08	.3802E-08	-.4711E-09	-.1050E-08	.5551E-11
RADIAL DEFL. (O)	-.2338E+00	0.	0.	.3802E-08	.1953E-07	-.1881E-08	-.9781E-12	-.9818E-13
ROTATION (O)	.4584E-02	0.	0.	-.4711E-09	-.1881E-08	.3113E-09	.1894E-12	.9200E-14
RADIAL DEFL. (N)	.2580E-01	0.	0.	-.1050E-08	-.9781E-12	.1894E-12	.6212E-07	.7833E-08
ROTATION (N)	-.2604E-03	0.	0.	.5551E-11	-.9818E-13	.9200E-14	.7833E-08	.2004E-08

BOUNDARY DEFLECTIONS DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL DEFL. (O)	ROTATION (O)	RADIAL DEFL. (N)	ROTATION (N)	SUM
AXIAL DEFL. (N)	.1313E+00	0.	0.	-.9056E-02	-.3369E-02	.7135E-02	0.	0.	.1260E+00
RADIAL DEFL. (O)	-.4430E-14	0.	0.	-.6916E-16	-.2879E-01	-.2937E-15	0.	0.	-.2879E-01
ROTATION (O)	-.2629E-15	0.	0.	.6936E-17	-.9412E-17	-.8839E-02	0.	0.	-.8839E-02
RADIAL DEFL. (N)	0.	0.	0.	0.	0.	-.1355E-18	0.	0.	.2220E-15
ROTATION (N)	.8327E-16	0.	0.	.1041E-16	-.5082E-20	-.1355E-19	0.	0.	.8327E-16

SMUD COOLDOWN INC. SUPPORT SKIRT ITERATION 40. PAGE 9 DATE 08/04/78

FLEXIBILITY MATRIX OF ASSEMBLY AS IN PROGRAM 91060
(THIS MATRIX ONLY IS ON A PER RADIAN BASIS)

	M(O)	Q(O)	M(N)	Q(N)
ROTATION(O)	.195593E-08	.118170E-07	.578025E-13	.119020E-11
DEFLECTION(O)	.118170E-07	.122741E-06	.616864E-12	.614566E-11
ROTATION(N)	.578025E-13	.616864E-12	.125995E-07	.492164E-07
DEFLECTION(N)	.119020E-11	.614566E-11	.492164E-07	.390335E-06

NOTE-- THE +1 SIGN CONVENTION IS USED IN THE MATRIX PRINTED HERE.
IF IT IS DESIRED TO USE THE -1 SIGN CONVENTION THEN THE
SIGNS MUST BE CHANGED ON ALL OF THE OFF-DIAGONAL ELEMENTS.

620-0011-55

SMUD COOLDOWN INC. SUPPORT SKIRT ITERATION 40. PAGE 10 DATE 08/04/78

PRIMARY + SECONDARY FORCES AND MOTIONS

POSITIVE DIRECTIONS (+) ARE AS FOLLOWS

TOP OF SEGMENT NO.1	BOTTOM OF REMAINING SEGMENTS
RADIAL------ TO THE LEFT	RADIAL------ TO THE RIGHT
ROTATIONAL-- CLOCKWISE	ROTATIONAL-- COUNTERCLOCKWISE
AXIAL------- UPWARD	AXIAL------- DOWNWARD

** SIGN CONVENTIONS ARE FOR A RIGHT HAND VIEW **

SEG. NO.	LOC.	RADIAL FORCE	MOMENT	AXIAL FORCE	LOC.	RADIAL MOTION	* ROTATION	AXIAL MOTION
1	TOP	.1539E+08	.4684E+08	-.2000E+07	TOP	-.2879E-01	-.8839E-02	0.
1	BOT.	.1395E+08	.3912E+08	-.2000E+07	BOT.	.3356E-01	.8980E-02	.3067E-02
2	BOT.	.1139E+08	.2602E+08	-.2000E+07	BOT.	.4326E-01	.9225E-02	.8636E-02
3	BOT.	.9225E+07	.1610E+08	-.2000E+07	BOT.	.5240E-01	.9411E-02	.1422E-01
4	BOT.	.7071E+07	.7234E+07	-.2000E+07	BOT.	.6300E-01	.9559E-02	.2037E-01
5	BOT.	.5336E+07	.1094E+07	-.2000E+07	BOT.	.7280E-01	.9632E-02	.2623E-01
6	BOT.	.3840E+07	-.3380E+07	-.2000E+07	BOT.	.8268E-01	.9636E-02	.3203E-01
7	BOT.	.2630E+07	-.6279E+07	-.2000E+07	BOT.	.9208E-01	.9568E-02	.3756E-01
8	BOT.	.1520E+07	-.8268E+07	-.2000E+07	BOT.	.1027E+00	.9394E-02	.4340E-01
9	BOT.	.8841E+05	-.9123E+07	-.2000E+07	BOT.	.1126E+00	.9117E-02	.4869E-01
10	BOT.	.2237E+06	-.9232E+07	-.2000E+07	BOT.	.1195E+00	.8833E-02	.5223E-01
11	BOT.	-.1095E+06	-.8982E+07	-.2000E+07	BOT.	.1254E+00	.8464E-02	.5564E-01
12	BOT.	-.3233E+06	-.8676E+07	-.2000E+07	BOT.	.1304E+00	.8013E-02	.5812E-01
13	BOT.	-.4469E+06	-.8339E+07	-.2000E+07	BOT.	.1341E+00	.7488E-02	.6003E-01
14	BOT.	-.5367E+06	-.7930E+07	-.2000E+07	BOT.	.1375E+00	.6657E-02	.6170E-01
15	BOT.	-.6053E+06	-.7794E+07	-.2000E+07	BOT.	.1405E+00	.5617E-02	.6297E-01
16	BOT.	-.6625E+06	-.7[illegible]7E+07	-.2000E+07	BOT.	.1430E+00	.4517E-02	.6421E-01
17	BOT.	-.7901E+06	-.[illegible]03E+07	-.2000E+07	BOT.	.1483E+00	.1076E-02	.6884E-01
18	BOT.	-.7919E+06	-.[illegible]7E+07	-.2000E+07	BOT.	.1474E+00	-.1623E-02	.7292E-01
19	BOT.	-.5847E+06	-.1[illegible]87E+07	-.2000E+07	BOT.	.1335E+00	-.4583E-02	.7964E-01
20	BOT.	-.3050E+06	.2760E+06	-.2000E+07	BOT.	.1132E+00	-.5129E-02	.8500E-01
21	BOT.	-.9287E+05	.1037E+07	-.2000E+07	BOT.	.9375E-01	-.4391E-02	.8949E-01
22	BOT.	.2671E+05	.1137E+07	-.2000E+07	BOT.	.7842E-01	-.3242E-02	.9341E-01
23	BOT.	.7095E+05	.9191E+06	-.2000E+07	BOT.	.6769E-01	-.2179E-02	.9691E-01
24	BOT.	.7323E+05	.6210E+06	-.2000E+07	BOT.	.6069E-01	-.1396E-02	.1001E+00
25	BOT.	.5777E+05	.3535E+06	-.2000E+07	BOT.	.5621E-01	-.9081E-03	.1030E+00
26	BOT.	.3771E+05	.1624E+06	-.2000E+07	BOT.	.5318E-01	-.6564E-03	.1058E+00
27	BOT.	.2216E+05	.4393E+05	-.2000E+07	BOT.	.5081E-01	-.5616E-03	.1084E+00
28	BOT.	.1368E+05	-.2578E+05	-.2000E+07	BOT.	.4860E-01	-.5606E-03	.1108E+00
29	BOT.	.8630E+04	-.7137E+05	-.2000E+07	BOT.	.4626E-01	-.6173E-03	.1130E+00
30	BOT.	.6888E+04	-.1004E+06	-.2000E+07	BOT.	.4362E-01	-.7109E-03	.1151E+00
31	BOT.	.2035E+05	-.1482E+06	-.2000E+07	BOT.	.4055E-01	-.8388E-03	.1170E+00
32	BOT.	.4375E+05	-.2780E+06	-.2000E+07	BOT.	.3683E-01	-.1054E-02	.1186E+00

620-0011-55
0240
105

SMUD COOLDOWN INC. SUPPORT SKIRT ITERATION 40. PAGE 11 DATE 08/04/78

33	ROT.	.4791E+05	-.4742E+06	-.2000E+07	ROT.	.3194E-01	-.1440E-02	.1201E+00
34	ROT.	-.7243E+04	-.5936E+06	-.2000E+07	ROT.	.2511E-01	-.2000E-02	.1215E+00
35	ROT.	-.1606E+06	-.2746E+06	-.2000E+07	ROT.	.1596E-01	-.2491E-02	.1229E+00
36	ROT.	-.4772E+06	.9650E+06	-.2000E+07	ROT.	.5872E-02	-.2241E-02	.1244E+00
37	ROT.	-.9194E+06	.3730E-07	-.2000E+07	ROT.	.2220E-15	.8327E-16	.1260E+00

(FORCE AND MOTION OUTPUT IS IN GLOBAL DIRECTIONS R AND Z)

V4
5/9/78
320-0011-55
106

SHUD COOLDOWN INC. SUPPORT SKIRT ITERATION 40. PAGE 12 DATE 08/04/78

PRIMARY + SECONDARY STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	-20797.8	-75636.4	-1.5	-1675.5	-75248.8	-34.4	17429.2	-74985.8	-1.5
2	-15839.4	-70856.2	-1.9	-1438.6	-71086.2	-34.6	12936.0	-71438.3	-1.9
3	-11787.0	-65583.0	-7.6	-1621.8	-66968.4	-70.9	8538.4	-68497.3	-7.6
4	-6927.6	-59534.6	-10.7	-1563.2	-61798.9	-89.3	3805.4	-64206.7	-10.7
5	-2834.8	-53707.9	-14.4	-1633.1	-56951.1	-112.3	-417.5	-60344.0	-14.4
6	1185.4	-47989.7	-16.4	-1635.0	-52002.0	-124.1	-4414.4	-56159.6	-16.4
7	4873.7	-41952.1	-18.0	-1670.2	-46706.5	-133.1	-8187.1	-51601.4	-18.0
8	8791.2	-34891.6	-18.5	-1679.0	-40249.0	-134.9	-12118.2	-45735.1	-18.5
9	12363.2	-28131.4	-18.9	-1746.7	-34120.1	-136.3	-15801.8	-40227.8	-18.9
10	15726.4	-23211.2	-19.0	-1879.5	-29907.5	-136.0	-19448.8	-36115.6	-19.0
11	19650.7	-17883.5	-19.5	-2045.5	-25678.9	-138.7	-23703.6	-33585.7	-19.5
12	24946.0	-12508.7	-19.5	-2329.4	-21487.0	-138.1	-29565.4	-30571.2	-19.5
13	32775.2	-7375.6	-20.7	-2672.4	-18650.3	-145.9	-30078.3	-30036.8	-20.7
14	45160.4	-1011.1	-22.6	-3218.6	-15890.0	-158.7	-51552.2	-30889.5	-22.6
15	44639.5	1137.3	-23.4	-3320.1	-13376.3	-163.9	-51219.3	-27999.5	-23.4
16	42667.0	2846.0	-22.4	-3311.5	-11045.5	-157.2	-49240.6	-25041.6	-22.4
17	33598.9	7877.4	-19.7	-3235.8	-3186.1	-138.1	-40099.2	-14322.5	-19.7
18	23540.7	10157.8	-15.0	-3230.9	2187.8	-104.7	-29963.1	-5830.5	-15.0
19	5700.5	9915.4	-8.1	-3145.9	7370.2	-56.8	-11962.2	4827.7	-8.1
20	-5329.8	5962.9	-1.3	-3097.8	6729.2	-9.1	-856.3	7497.0	-1.3
21	-9591.5	2269.8	2.3	-3078.3	4368.0	15.9	3743.2	6488.1	2.3
22	-10337.3	-154.4	3.4	-3076.8	2043.1	23.6	4176.7	4258.1	3.4
23	-8843.5	-1301.5	3.1	-3083.7	425.7	21.5	2668.6	2164.2	3.1
24	-6920.8	-1357.5	2.2	-3092.2	-216.2	15.7	770.2	931.5	2.2
25	-5230.6	-1192.3	1.9	-3099.6	-563.0	9.7	-972.8	68.0	1.9
26	-4061.0	-773.8	.7	-3104.8	-500.8	4.9	-2171.0	-227.3	.7
27	-3316.1	-411.7	.3	-3108.0	-354.3	1.8	-2900.9	-297.3	.3
28	-2899.5	-78.7	-.0	-3109.8	-143.4	-.0	-3320.3	-209.1	-.0
29	-2622.4	-32.7	-.3	-3111.8	-181.1	-1.8	-3599.3	-331.0	-.3
30	-2451.0	218.0	-.3	-3111.7	21.1	-1.9	-3771.9	-177.6	-.3
31	-2187.9	870.6	-.4	-3112.9	602.9	-2.5	-4037.3	333.0	-.4
32	-1399.5	1026.7	-.6	-3116.3	521.7	-4.2	-4812.4	11.8	-.6
33	-140.8	437.5	-1.1	-3121.9	-458.9	-7.8	-6101.5	-1363.8	-1.1
34	653.4	-1492.8	-1.7	-3125.4	-2661.9	-11.6	-6911.3	-3841.3	-1.7
35	-1028.1	-5339.3	-1.5	-3117.9	-6049.9	-10.9	-5203.3	-6764.6	-1.5
36	-8481.2	-11640.7	.5	-3085.3	-10200.5	3.2	2234.8	-8741.1	.5
37	-25263.8	-18941.3	6.1	-3010.8	-12478.3	42.6	19241.0	-5946.0	6.1

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

SMUD COOLDOWN INC. SUPPORT SKIRT ITERATION 40. PAGE 13 DATE 08/04/78

TEMPERATURES PER SEGMENT USED IN PEAK PRINCIPLE ANALYSIS

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5	SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	452.	450.	448.	446.	445.	19	250.	250.	250.	250.	250.
2	450.	448.	447.	445.	445.	20	212.	212.	212.	212.	212.
3	448.	446.	444.	443.	443.	21	183.	183.	183.	183.	183.
4	442.	441.	440.	440.	440.	22	162.	162.	162.	162.	162.
5	439.	438.	436.	435.	435.	23	147.	147.	147.	147.	147.
6	436.	434.	432.	431.	429.	24	135.	135.	135.	135.	135.
7	434.	428.	424.	423.	422.	25	127.	127.	127.	127.	127.
8	416.	416.	416.	416.	416.	26	120.	120.	120.	120.	120.
9	408.	407.	407.	406.	406.	27	114.	114.	114.	114.	114.
10	404.	402.	400.	399.	398.	28	108.	108.	109.	108.	109.
11	402.	396.	390.	389.	388.	29	103.	103.	103.	103.	103.
12	383.	383.	382.	382.	382.	30	96.	96.	96.	96.	96.
13	376.	376.	376.	375.	376.	31	86.	86.	86.	86.	86.
14	369.	369.	369.	369.	369.	32	78.	78.	78.	78.	78.
15	363.	363.	363.	363.	363.	33	72.	72.	72.	72.	72.
16	357.	357.	357.	357.	357.	34	68.	68.	68.	68.	68.
17	330.	330.	330.	330.	330.	35	65.	65.	65.	65.	65.
18	303.	303.	303.	303.	303.	36	64.	64.	64.	64.	64.
						37	63.	63.	63.	63.	63.

620-0011-55
108

SMUD COOLDOWN INC. SUPPORT SKIRT ITERATION 40. PAGE 14 DATE 08/04/78

PEAK BOUNDARY AND FLEXABILITY MATRICES

BOUNDARY FORCES DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL DEFL. (O)	ROTATION (O)	RADIAL DEFL. (N)	ROTATION (N)	SUM
AXIAL FORCE (N)	0.	0.	0.	-.2000E+07	0.	0.	0.	0.	-.2000E+07
RADIAL SHEAR (O)	.2525E+08	0.	0.	.2338E+06	-.3523E+07	-.6535E+07	0.	0.	.1563E+08
MOMENT (O)	.1392E+09	0.	0.	-.1614E+07	-.3128E+08	-.6787E+08	0.	0.	.4742E+08
RADIAL SHEAR (N)	-.8516E+06	0.	0.	-.6800E+05	.3723E+02	.2074E+03	0.	0.	-.9194E+06
MOMENT (N)	.3460E+07	0.	0.	.2714E+06	-.2204E+03	-.8192E+03	0.	0.	.3730E+07

FLEXIBILITY MATRIX DUE TO A UNIT LOAD (TOTAL LOAD BASIS)

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL SHEAR (O)	MOMENT (O)	RADIAL SHEAR (N)	MOMENT (N)
AXIAL DEFL. (N)	.9947E-01	0.	0.	.5389E-08	.3802E-08	-.4711E-09	-.1050E-08	.5551E-11
RADIAL DEFL. (O)	-.2334E+00	0.	0.	.3802E-08	.1953E-07	-.1881E-08	-.9781E-12	-.9818E-13
ROTATION (O)	.4473E-02	0.	0.	-.4711E-09	-.1881E-08	.3113E-09	.1494E-12	.9200E-14
RADIAL DEFL. (N)	.2580E-01	0.	0.	-.1050E-08	-.9781E-12	.1494E-12	.6213E-07	.7833E-08
ROTATION (N)	-.2604E-03	0.	0.	.5551E-11	-.9818E-13	.9200E-14	.7833E-08	.2004E-08

BOUNDARY DEFLECTIONS DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL DEFL. (O)	ROTATION (O)	RADIAL DEFL. (N)	ROTATION (N)	SUM
AXIAL DEFL. (N)	.1313E+00	0.	0.	-.9056E-02	-.3365E-02	.7135E-02	0.	0.	.1260E+00
RADIAL DEFL. (O)	-.4130E-14	0.	0.	-.6916E-16	-.2879E-01	-.2937E-15	0.	0.	-.2879E-01
ROTATION (O)	.1439E-15	0.	0.	.6936E-17	-.9412E-17	-.8839E-02	0.	0.	-.8839E-02
RADIAL DEFL. (N)	.2220E-15	0.	0.	0.	0.	.1355E-18	0.	0.	.2220E-15
ROTATION (N)	.5551E-16	0.	0.	.1041E-16	-.5082E-20	-.1355E-19	0.	0.	.1110E-15

08/08

620-...-55

109

SHUD COOLDOWN INC. SUPPORT SKIRT ITERATION 49. PAGE 15 DATE 08/04/78

FLEXIBILITY MATRIX OF ASSEMBLY AS IN PROGRAM 91060
(THIS MATRIX ONLY IS ON A PER RADIAN BASIS)

	M(O)	Q(O)	M(N)	Q(N)
ROTATION(O)	.195593E-08	.118170E-07	.578025E-13	.119020E-11
DEFLECTION(O)	.118170E-07	.122741E-06	.616864E-12	.614566E-11
ROTATION(N)	.578025E-13	.616864E-12	.125495E-07	.492164E-07
DEFLECTION(N)	.119020E-11	.614566E-11	.492164E-07	.390335E-06

NOTE- THE +1 SIGN CONVENTION IS USED IN THE MATRIX PRINTED HERE.
IF IT IS DESIRED TO USE THE -1 SIGN CONVENTION THEN THE
SIGNS MUST BE CHANGED ON ALL OF THE OFF-DIAGONAL ELEMENTS.

820-0011-55

SMUD COOLDOWN INC. SUPPORT SKIRT ITERATION 40. PAGE 16 DATE 08/04/78

PEAK FORCES AND MOTIONS

POSITIVE DIRECTIONS (+) ARE AS FOLLOWS

TOP OF SEGMENT NO.1	BOTTOM OF REMAINING SEGMENTS
RADIAL------ TO THE LEFT	RADIAL------ TO THE RIGHT
ROTATIONAL-- CLOCKWISE	ROTATIONAL-- COUNTERCLOCKWISE
AXIAL------- UPWARD	AXIAL------- DOWNWARD

** SIGN CONVENTIONS ARE FOR A RIGHT HAND VIEW **

SEG. NO.	LOC.	RADIAL FORCE	MOMENT	AXIAL FORCE	LOC.	RADIAL MOTION	ROTATION	AXIAL MOTION
1	TOP	.1543E+08	.4742E+08	-.2000E+07	TOP	-.2979E-01	-.8839E-02	0.
1	BOT.	.1398E+08	.3968E+08	-.2000E+07	BOT.	.3356E-01	.8974E-02	.3066E-02
2	BOT.	.1143E+08	.2654E+08	-.2000E+07	BOT.	.4325E-01	.9210E-02	.8633E-02
3	BOT.	.9264E+07	.1658E+08	-.2000E+07	BOT.	.5238E-01	.9389E-02	.1421E-01
4	BOT.	.7110E+07	.7661E+07	-.2000E+07	BOT.	.6295E-01	.9533E-02	.2036E-01
5	BOT.	.5374E+07	.1478E+07	-.2000E+07	BOT.	.7272E-01	.9603E-02	.2621E-01
6	BOT.	.3877E+07	-.3018E+07	-.2000E+07	BOT.	.8257E-01	.9599E-02	.3201E-01
7	BOT.	.2665E+07	-.4977E+07	-.2000E+07	BOT.	.9103E-01	.9514E-02	.3753E-01
8	BOT.	.1554E+07	-.8008E+07	-.2000E+07	BOT.	.1074E+00	.9330E-02	.4336E-01
9	BOT.	.7160E+06	-.8900E+07	-.2000E+07	BOT.	.1123E+00	.9058E-02	.4884E-01
10	BOT.	.2539E+06	-.9035E+07	-.2000E+07	BOT.	.1191E+00	.8771E-02	.5218E-01
11	BOT.	-.8109E+05	-.8808E+07	-.2000E+07	BOT.	.1250E+00	.8382E-02	.5558E-01
12	BOT.	-.2455E+06	-.8520E+07	-.2000E+07	BOT.	.1300E+00	.7919E-02	.5805E-01
13	BOT.	-.4213E+06	-.8196E+07	-.2000E+07	BOT.	.1336E+00	.7402E-02	.5995E-01
14	BOT.	-.5121E+06	-.7850E+07	-.2000E+07	BOT.	.1369E+00	.6586E-02	.6162E-01
15	BOT.	-.5818E+06	-.7586E+07	-.2000E+07	BOT.	.1399E+00	.5561E-02	.6290E-01
16	BOT.	-.6402E+06	-.7280E+07	-.2000E+07	BOT.	.1424E+00	.4577E-02	.6414E-01
17	BOT.	-.7724E+06	-.5836E+07	-.2000E+07	BOT.	.1477E+00	.1082E-02	.6877E-01
18	BOT.	-.7789E+06	-.4262E+07	-.2000E+07	BOT.	.1458E+00	-.1591E-02	.7285E-01
19	BOT.	-.5790E+06	-.1498E+07	-.2000E+07	BOT.	.1331E+00	-.4536E-02	.7958E-01
20	BOT.	-.3038E+06	[illegible]	-.2000E+07	BOT.	.1130E+00	-.5091E-02	.8404E-01
21	BOT.	-.9363E+05	.1023E+07	-.2000E+07	BOT.	.9368E-01	-.4368E-02	.8944E-01
22	BOT.	.2546E+05	.1127E+07	-.2000E+07	BOT.	.7842E-01	-.3231E-02	.9336E-01
23	BOT.	.6992E+05	.9137E+06	-.2000E+07	BOT.	.6771E-01	-.2177E-02	.9688E-01
24	BOT.	.7259E+05	.6190E+06	-.2000E+07	BOT.	.6071E-01	-.1397E-02	.1001E+00
25	BOT.	.5747E+05	.3533E+06	-.2000E+07	BOT.	.5623E-01	-.9101E-03	.1030E+00
26	BOT.	.3763E+05	.1630E+06	-.2000E+07	BOT.	.5319E-01	-.6582E-03	.1057E+00
27	BOT.	.2218E+05	.6446E+05	-.2000E+07	BOT.	.5081E-01	-.5627E-03	.1083E+00
28	BOT.	.1373E+05	-.2531E+05	-.2000E+07	BOT.	.4860E-01	-.5611E-03	.1107E+00
29	BOT.	.8677E+04	-.7110E+05	-.2000E+07	BOT.	.4626E-01	-.6174E-03	.1130E+00
30	BOT.	.6918E+04	-.1003E+06	-.2000E+07	BOT.	.4362E-01	-.7109E-03	.1151E+00
31	BOT.	.2036E+05	-.1482E+06	-.2000E+07	BOT.	.4055E-01	-.8387E-03	.1169E+00
32	BOT.	.4376E+05	-.2781E+06	-.2000E+07	BOT.	.3683E-01	-.1054E-02	.1186E+00

620-0011-55

111

SHUD COOLDOWN INC. SUPPORT SKIRT ITERATION 40. PAGE 17 DATE 08/04/78

33	BOT.	.4790E+05	-.4742E+06	-.2000E+07	BOT.	.3194E-01	-.1440E-02	.1200E+00
34	BOT.	-.7245E+04	-.5836E+06	-.2000E+07	BOT.	.2511E-01	-.2000E-05	.1214E+00
35	BOT.	-.1696E+06	-.2746E+06	-.2000E+07	BOT.	.1596E-01	-.2491E-02	.1228E+00
36	BOT.	-.4772E+06	.9650E+06	-.2000E+07	BOT.	.5872E-02	-.2241E-02	.1243E+00
37	BOT.	-.9194E+06	.3730E+07	-.2000E+07	BOT.	.2220E-15	.1110E-15	.1260E+00

(FORCE AND MOTION OUTPUT IS IN GLOBAL DIRECTIONS R AND Z)

SAH
05/78
620-0011-55

112

SHUD COOLDOWN INC. SUPPORT SKIRT ITERATION 40. PAGE 18 DATE 08/04/78

PEAK PRINCIPAL STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	-22392.5	-76755.6	2.7	-1644.2	-75704.2	2.6	29407.8	-70199.3	2.7
2	-16869.6	-71714.4	1.5	-1508.6	-71127.6	-9.1	20012.3	-68558.4	1.5
3	-12447.2	-66413.9	-4.9	-1451.4	-66798.2	-47.6	11971.2	-66842.8	-4.9
4	-7369.8	-59972.9	-8.7	-1415.1	-61677.4	-73.3	3954.6	-64075.2	-8.7
5	-3129.8	-54308.8	-12.8	-1488.3	-56836.3	-97.1	-397.0	-60058.6	-12.8
6	775.0	-48858.6	-13.9	-1510.5	-51929.7	-104.6	-4061.4	-55412.8	-13.9
7	3747.7	-43956.4	-13.9	-1194.7	-46276.0	-107.7	-8355.9	-50952.7	-13.9
8	8478.0	-35078.5	-15.9	-1674.6	-40334.1	-119.9	-11805.6	-45725.7	-15.9
9	11891.0	-28628.8	-18.3	-1847.1	-34316.2	-131.8	-15550.8	-40116.5	-18.3
10	15209.3	-24184.1	-17.6	-1736.5	-29961.2	-122.9	-19197.6	-36217.5	-17.9
11	18522.5	-20275.3	-16.7	-1331.0	-25128.2	-118.9	-23964.6	-32914.7	-16.7
12	45500.6	-6062.2	-17.5	-2204.3	-21553.8	-122.7	-29203.5	-30566.8	-17.5
13	59700.1	1169.9	-20.3	-2673.2	-18850.2	-142.1	-37475.7	-30054.0	-20.3
14	82302.0	10772.5	-22.2	-3219.0	-16196.3	-156.2	-50740.6	-30868.1	-22.2
15	81786.2	12769.6	-23.0	-3316.9	-13604.1	-161.4	-50479.8	-28009.8	-23.0
16	77844.5	13993.5	-22.1	-3308.6	-11282.9	-155.0	-48572.6	-25082.0	-22.4
17	33190.2	7508.5	-19.5	-3273.1	-3435.9	-136.4	-39687.9	-14652.6	-19.5
18	23324.2	9864.1	-14.8	-3229.8	1955.9	-103.7	-29744.9	-6000.3	-14.8
19	5721.8	9765.9	-8.1	-3146.0	7217.0	-56.6	-11984.1	4660.7	-8.1
20	-5232.9	5910.8	-1.4	-3098.3	6638.2	-9.3	-953.1	7384.7	-1.9
21	-9808.4	2269.3	2.7	-3078.7	4319.5	15.6	1649.4	6430.7	2.3
22	-10274.0	-116.1	3.3	-3077.1	2042.5	23.4	4113.0	4238.4	3.3
23	-8810.7	-1282.0	3.0	-3083.8	435.4	21.3	2635.5	2164.2	3.0
24	-6909.1	-1343.7	2.2	-3092.3	-205.7	15.6	718.5	938.7	2.2
25	-5230.2	-1184.7	1.4	-3099.6	-555.5	9.7	-973.2	76.4	1.4
26	-4064.8	-770.9	.7	-3104.8	-496.7	4.9	-2167.1	-221.8	.7
27	-3320.2	-411.4	.3	-3108.0	-352.7	1.8	-2896.8	-294.5	.3
28	-2902.4	-79.4	-.0	-3109.8	-143.2	-.8	-3317.4	-208.8	-.0
29	-2624.0	-33.6	-.3	-3111.0	-181.5	-1.8	-3597.7	-330.9	-.3
30	-2451.7	217.4	-.3	-3111.7	29.6	-1.9	-3771.3	-377.9	-.3
31	-2189.0	870.2	-.4	-3112.9	602.6	-2.5	-4017.2	332.6	-.4
32	-1399.4	1026.6	-.6	-3116.3	521.5	-4.2	-4832.6	11.5	-.6
33	-189.6	4376.5	-1.1	-3121.9	-459.0	-7.8	-6101.7	-1363.9	-1.1
34	683.6	-1492.8	-1.7	-3125.4	-2662.0	-11.6	-6911.5	-3841.4	-1.1
35	-1028.0	-5339.2	-1.5	-3117.9	-6049.9	-10.9	-5203.4	-6764.6	-1.5
36	-8401.2	-11640.7	.5	-3085.3	-10200.5	3.2	2274.7	-8741.1	.5
37	-25283.8	-18941.3	6.1	-3010.8	-12478.3	42.6	19241.1	-5946.0	6.1

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

620-0011-55

113

SMUD COOLDOWN INC. SUPPORT SKIRT ITERATION 45 PAGE 1 DATE 08/04/78

INPUT DATA DATE 08/04/78

TOTAL NO. OF SEGMENTS = 37

BOUNDARY CONDITIONS AT THE TOP (O) END

1. A RADIAL DEFLECTION OF	-.01879 INCHES	REF. PAGE 93
2. A ROTATION OF	-.00820 RADIANS	

BOUNDARY CONDITIONS AT THE BOTTOM (N) END

1. AN AXIAL FORCE OF	-2000000.00000 POUNDS	FROM REF. 1, PAGE B-12-1
2. A RADIAL DEFLECTION OF	0.00000 INCHES	
3. A ROTATION OF	0.00000 RADIANS	

* NOTE * A SEGMENTAL GROUP MAY CONSIST OF FROM ONE TO THE TOTAL NO. OF SEGMENTS.
SEGMENT ONE IS CONSIDERED AT THE TOP OF THE GEOMETRY.
ALL LOADS ABOVE, ARE ON A TOTAL LOAD BASIS.

114
HEB

SMUD COOLDOWN INC. SUPPORT SKIRT ITERATION 45 PAGE 2 DATE 08/04/78

MID-SURFACE GEOMETRY

AT TOP BOUNDARY, MEAN RADIUS = 70.3200 Z COORDINATE = 94.4000

SEGMENTAL GEOMETRY DATA BY GROUPS

SEGMENT DATA			CENTER OF CURVATURE DATA		
BOTTOM SEG. NO.	MEAN RADIUS	Z COORD..	RADIUS TO CENTER	Z COORD.	CURVATURE IDENTIFIER
1.0	70.220	93.860	0.000	0.000	0.0
2.0	70.070	92.800	0.000	0.000	0.0
3.0	69.890	91.800	0.000	0.000	0.0
4.0	69.700	90.660	0.000	0.000	0.0
5.0	69.500	89.600	0.000	0.000	0.0
6.0	69.300	88.530	0.000	0.000	0.0
7.0	69.100	87.500	0.000	0.000	0.0
8.0	68.900	86.330	0.000	0.000	0.0
9.0	68.720	85.200	0.000	0.000	0.0
10.0	68.600	84.400	0.000	0.000	0.0
11.0	68.460	83.650	0.000	0.000	0.0
12.0	68.380	83.020	0.000	0.000	0.0
13.0	68.310	82.520	0.000	0.000	0.0
14.0	68.260	82.020	0.000	0.000	0.0
16.0	68.260	81.020	0.000	0.000	0.0
18.0	68.260	77.000	0.000	0.000	0.0
37.0	68.260	1.000	0.000	0.000	0.0

NOTE- CURVATURE IDENTIFIER +1= POSITIVE CURVATURE
0= NO CURVATURE
-1= NEGATIVE CURVATURE

SMUD COOLDOWN INC. SUPPORT SKIRT ITERATION 45 PAGE 3 DATE 08/04/78

SEGMENTAL GEOMETRY BY SEGMENTS (K= SEGMENT NO.)

MEAN RADIUS

K	R(K-1)	R(K)	R(K+1)	R(K+2)	R(K+3)	R(K+4)	R(K+5)	R(K+6)	R(K+7)	R(K+8)
1	70.32	70.22	70.07	69.89	69.70	69.50	69.30	69.10	68.90	68.72
11	68.60	68.46	68.38	68.31	68.26	68.26	68.26	68.26	68.26	68.26
21	68.26	68.26	68.26	68.26	68.26	68.26	68.26	68.26	68.26	68.26
31	68.26	68.26	68.26	68.26	68.26	68.26	68.26	68.26		

Z COORDINATE

K	Z(K-1)	Z(K)	Z(K+1)	Z(K+2)	Z(K+3)	Z(K+4)	Z(K+5)	Z(K+6)	Z(K+7)	Z(K+8)
1	94.49	93.86	92.80	91.80	90.86	89.60	88.53	87.50	86.33	85.20
11	84.49	83.66	83.02	82.52	82.02	81.52	81.02	79.01	77.00	73.00
21	69.00	65.00	61.00	57.00	53.00	49.00	45.00	41.00	37.00	33.00
31	29.00	25.00	21.00	17.00	13.00	9.00	5.00	1.00		

1020-M11-55
30/30

116

SHUD COOLDOWN INC. SUPPORT SKIRT ITERATION 45 PAGE 4 DATE 08/04/78

SEGMENT THICKNESS DATA BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	TOP THICK. OF TOP SEG.	BOTTOM THICK. OF BOTTOM SEG.
1.00	14.00	5.65	1.50
15.00	37.00	1.50	1.50

SEGMENTAL THICKNESS BY SEGMENTS

THICKNESS AT TOP OF SEGMENT (HA)

K	HA(K)	HA(K+1)	HA(K+2)	HA(K+3)	HA(K+4)	HA(K+5)	HA(K+6)	HA(K+7)	HA(K+8)	HA(K+9)
1	5.65	5.35	5.06	4.76	4.46	4.17	3.87	3.58	3.28	2.98
11	2.69	2.39	2.09	1.80	1.50	1.50	1.50	1.50	1.50	1.50
21	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
31	1.50	1.50	1.50	1.50	1.50	1.50	1.50			

THICKNESS AT BOTTOM OF SEGMENT (HB)

K	HB(K)	HB(K+1)	HB(K+2)	HB(K+3)	HB(K+4)	HB(K+5)	HB(K+6)	HB(K+7)	HB(K+8)	HB(K+9)
1	5.35	5.06	4.76	4.46	4.17	3.87	3.58	3.28	2.98	2.69
11	2.39	2.09	1.80	1.50	1.50	1.50	1.50	1.50	1.50	1.50
21	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
31	1.50	1.50	1.50	1.50	1.50	1.50	1.50			

117

SHUD COOLDOWN INC. SUPPORT SKIRT **** **** ****91206 REV 3 5-8-75 08/04/78 13.13.12 PAGE 27 H01CCV3

SHUD COOLDOWN INC. SUPPORT SKIRT ITERATION 45 PAGE 8 DATE 08/04/78

MATERIAL PROPERTIES BY SEGMENTS

SEG. NO.	ALPHA	MODULUS OF TENSION	MODULUS OF SHEAR	POISSON<S RATIO
1	$69864E-05	.2808E+08	.1080E+08	.3000E+00
2	$69887E-05	.2807E+08	.1079E+08	.3000E+00
3	$69899E-05	.2806E+08	.1079E+08	.3000E+00
4	$69888E-05	.2806E+08	.1079E+08	.3000E+00
5	$69895E-05	.2807E+08	.1080E+08	.3000E+00
6	$69891E-05	.2809E+08	.1080E+08	.3000E+00
7	$69772E-05	.2811E+08	.1081E+08	.3000E+00
8	$69960E-05	.2815E+08	.1083E+08	.3000E+00
9	$69946E-05	.2819E+08	.1084E+08	.3000E+00
10	$69930E-05	.2823E+08	.1086E+08	.3000E+00
11	$69914E-05	.2828E+08	.1088E+08	.3000E+00
12	$69898E-05	.2833E+08	.1089E+08	.3000E+00
13	$69884E-05	.2836E+08	.1091E+08	.3000E+00
14	$69872E-05	.2840E+08	.1092E+08	.3000E+00
15	$69860E-05	.2843E+08	.1094E+08	.3000E+00
16	$69847E-05	.2847E+08	.1095E+08	.3000E+00
17	$69814E-05	.2856E+08	.1098E+08	.3000E+00
18	$69762E-05	.2869E+08	.1104E+08	.3000E+00
19	$69682E-05	.2889E+08	.1111E+08	.3000E+00
20	$69588E-05	.2910E+08	.1119E+08	.3000E+00
21	$69518E-05	.2925E+08	.1125E+08	.3000E+00
22	$69468E-05	.2935E+08	.1129E+08	.3000E+00
23	$69431E-05	.2942E+08	.1131E+08	.3000E+00
24	$69404E-05	.2947E+08	.1133E+08	.3000E+00
25	$69385E-05	.2950E+08	.1135E+08	.3000E+00
26	$69370E-05	.2953E+08	.1136E+08	.3000E+00
27	$69357E-05	.2955E+08	.1136E+08	.3000E+00
28	$69345E-05	.2957E+08	.1137E+08	.3000E+00
29	$69333E-05	.2959E+08	.1138E+08	.3000E+00
30	$69321E-05	.2961E+08	.1139E+08	.3000E+00
31	$69304E-05	.2964E+08	.1140E+08	.3000E+00
32	$69286E-05	.2966E+08	.1141E+08	.3000E+00
33	$69270E-05	.2969E+08	.1142E+08	.3000E+00
34	$69260E-05	.2970E+08	.1142E+08	.3000E+00
35	$69253E-05	.2971E+08	.1143E+08	.3000E+00
36	$69248E-05	.2972E+08	.1143E+08	.3000E+00
37	$69246E-05	.2972E+08	.1143E+08	.3000E+00

SMUD COOLDOWN INC. SUPPORT SKIRT ITERATION 45 PAGE 6 DATE 08/04/78

PRESSURE INPUT DATA BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	INTERNAL PRESSURE	EXTERNAL PRESSURE
1.0	37.0	0.0	0.0

MECHANICAL LOADING ON SEGMENTAL GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	RADIAL FORCE	MOMENT	AXIAL FORCE
1.0	37.0	0.	0.	0.

STRESS CONCENTRATION FACTORS BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	INSIDE TENSION	INSIDE BENDING	OUTSIDE TENSION	OUTSIDE BENDING
1	1	2.10	1.72	1.20	1.05
2	2	1.86	1.56	1.13	1.03
3	3	1.61	1.44	1.06	1.01
4	11	1.00	1.00	1.00	1.00
12	16	1.00	1.30	1.04	1.04
17	37	1.00	1.00	1.00	1.00

FROM REF. 1, SECTION B-13

SMUD COOLDOWN INC. SUPPORT SKIRT ITERATION 45 PAGE 7 DATE 08/04/78

TEMPERATURES PER SEGMENT USED IN PRIMARY + SECONDARY ANALYSIS

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5	SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	424.	424.	424.	424.	424.	19	250.	250.	250.	250.	250.
2	426.	426.	426.	426.	426.	20	210.	210.	210.	210.	210.
3	427.	427.	427.	427.	427.	21	182.	182.	182.	182.	182.
4	425.	425.	425.	425.	425.	22	161.	161.	161.	161.	161.
5	423.	423.	423.	423.	423.	23	146.	146.	146.	143.	146.
6	421.	421.	421.	421.	421.	24	135.	135.	135.	135.	135.
7	416.	416.	416.	416.	416.	25	127.	127.	127.	127.	127.
8	409.	409.	409.	409.	409.	26	120.	120.	120.	120.	120.
9	401.	401.	401.	401.	401.	27	115.	115.	115.	115.	115.
10	395.	395.	395.	395.	395.	28	108.	108.	108.	108.	108.
11	387.	387.	387.	387.	387.	29	103.	103.	103.	103.	103.
12	378.	378.	378.	378.	378.	30	96.	96.	96.	96.	96.
13	372.	372.	372.	372.	372.	31	87.	87.	87.	87.	87.
14	366.	366.	366.	366.	366.	32	78.	78.	78.	78.	78.
15	360.	360.	360.	360.	360.	33	72.	72.	72.	72.	72.
16	351.	351.	351.	351.	351.	34	68.	68.	68.	68.	68.
17	328.	328.	328.	328.	328.	35	65.	65.	65.	65.	65.
18	302.	302.	302.	302.	302.	36	63.	63.	63.	63.	63.
						37	63.	63.	63.	63.	63.

SHUD COOLDOWN INC. SUPPORT SKIRT ITERATION 45 PAGE 8 DATE 08/04/78

PRIMARY + SECONDARY BOUNDARY AND FLEXABILITY MATRICES

BOUNDARY FORCES DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL DEFL. (O)	ROTATION (O)	RADIAL DEFL. (N)	ROTATION (N)	SUM
AXIAL FORCE (N)	0.	0.	0.	-.2000E+07	0.	0.	0.	0.	-.2000E+07
RADIAL SHEAR (O)	.2442E+08	0.	0.	.2337E+06	-.2306E+07	-.6075E+07	0.	0.	.1627E+08
MOMENT (O)	.1349E+09	0.	0.	-.1616E+07	-.1392E+08	-.6308E+08	0.	0.	.5631E+08
RADIAL SHEAR (N)	-.8483E+06	0.	0.	-.6800E+05	.2633E+02	.1926E+03	0.	0.	-.9161E+06
MOMENT (N)	.3453E+07	0.	0.	.2714E+06	-.1440E+03	-.7606E+03	0.	0.	.3724E+07

FLEXIBILITY MATRIX DUE TO A UNIT LOAD (TOTAL LOAD BASIS)

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL SHEAR (O)	MOMENT (O)	RADIAL SHEAR (N)	MOMENT (N)
AXIAL DEFL. (N)	.9941E-01	0.	0.	.5386E-08	.3789E-08	-.4699E-09	-.1049E-08	.5556E-11
RADIAL DEFL. (O)	-.2223E+00	0.	0.	.3789E-08	.1946E-07	-.1875E-08	-.9760E-12	-.9789E-13
ROTATION (O)	.3878E-02	0.	0.	-.4699E-09	-.1875E-08	.3105E-09	.1892E-12	.9184E-14
RADIAL DEFL. (N)	.2565E-01	0.	0.	-.1049E-08	-.9760E-12	.1892E-12	.6212E-07	.7833E-08
ROTATION (N)	-.2734E-03	0.	0.	.5556E-11	-.9789E-13	.9184E-14	.7833E-08	.2004E-08

BOUNDARY DEFLECTIONS DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL DEFL. (O)	ROTATION (O)	RADIAL DEFL. (N)	ROTATION (N)	SUM
AXIAL DEFL. (N)	.1294E+00	0.	0.	-.9954E-02	-.2196E-02	.6624E-02	0.	0.	.1248E+00
RADIAL DEFL. (O)	-.7380E-15	0.	0.	-.5772E-[illegible]	-.1879E-01	.3845E-15	0.	0.	-.1879E-01
ROTATION (O)	-.4055E-15	0.	0.	.6140E-17	-.1694E-18	-.6199E-02	0.	0.	-.6199E-02
RADIAL DEFL. (N)	.3331E-15	0.	0.	.4163E-16	-.2711E-19	-.2711E-19	0.	0.	.4441E-15
ROTATION (N)	-.5551E-16	0.	0.	0.	.1694E-20	.6776E-20	0.	0.	-.2776E-16

SHUD COOLDOWN INC. SUPPORT SKIRT ITERATION 45 PAGE 4 DATE 08/04/78

FLEXIBILITY MATRIX OF ASSEMBLY AS IN PROGRAM 91060
(THIS MATRIX ONLY IS ON A PER RADIAN BASIS)

	M(O)	Q(O)	M(N)	Q(N)
ROTATION(O)	.195122E-08	.117787E-07	.577050E-13	.118895E-11
DEFLECTION(O)	.117787E-07	.122291E-06	.615055E-12	.613224E-11
ROTATION(N)	.577050E-13	.615055E-12	.125090E-07	.492143E-07
DEFLECTION(N)	.118895E-11	.613224E-11	.492143E-07	.390318E-06

NOTE- THE +1 SIGN CONVENTION IS USED IN THE MATRIX PRINTED HERE. IF IT IS DESIRED TO USE THE -1 SIGN CONVENTION THEN THE SIGNS MUST BE CHANGED ON ALL OF THE OFF-DIAGONAL ELEMENTS.

620-0011-55

122

SHUD COOLDOWN INC. SUPPORT SKIRT ITERATION 45 PAGE 18 DATE 08/04/78

PRIMARY + SECONDARY FORCES AND MOTIONS

POSITIVE DIRECTIONS (+) ARE AS FOLLOWS

TOP OF SEGMENT NO.1	BOTTOM OF REMAINING SEGMENTS
RADIAL------ TO THE LEFT	RADIAL------ TO THE RIGHT
ROTATIONAL-- CLOCKWISE	ROTATIONAL-- COUNTERCLOCKWISE
AXIAL------- UPWARD	AXIAL------- DOWNWARD

** SIGN CONVENTIONS ARE FOR A RIGHT HAND VIEW **

SEG. NO.	LOC.	RADIAL FORCE	MOMENT	AXIAL FORCE	LOC.	RADIAL MOTION	ROTATION	AXIAL MOTION
1	TOP	.1627E+08	.5631E+08	-.2000E+07	TOP	-.1879E-01	-.8199E-02	0.
1	BOT.	.1484E+08	.4811E+08	-.2000E+07	BOT.	.2326E-01	.8366E-02	.2894E-02
2	BOT.	.1230E+08	.3404E+08	-.2000E+07	BOT.	.3241E-01	.8666E-02	.8185E-02
3	BOT.	.1012E+08	.2321E+08	-.2000E+07	BOT.	.4109E-01	.8908E-02	.1153E-01
4	BOT.	.7930E+07	.1333E+08	-.2000E+07	BOT.	.5123E-01	.9124E-02	.1948E-01
5	BOT.	.6141E+07	.6298E+07	-.2000E+07	BOT.	.6068E-01	.9265E-02	.2515E-01
6	BOT.	.4580E+07	.9930E+06	-.2000E+07	BOT.	.7027E-01	.9341E-02	.3081E-01
7	BOT.	.3300E+07	-.2636E+07	-.2000E+07	BOT.	.7946E-01	.9346E-02	.3624E-01
8	BOT.	.2105E+07	-.5364E+07	-.2000E+07	BOT.	.8990E-01	.9259E-02	.4201E-01
9	BOT.	.1183E+07	-.6812E+07	-.2000E+07	BOT.	.9981E-01	.9071E-02	.4728E-01
10	BOT.	.6650E+06	-.7318E+07	-.2000E+07	BOT.	.1067E+00	.8855E-02	.5082E-01
11	BOT.	.2822E+06	-.7377E+07	-.2000E+07	BOT.	.1127E+00	.8560E-02	.5424E-01
12	BOT.	.2978E+05	-.7310E+07	-.2000E+07	BOT.	.1178E+00	.8187E-02	.5674E-01
13	BOT.	-.1205E+06	-.7143E+07	-.2000E+07	BOT.	.1216E+00	.7742E-02	.5967E-01
14	BOT.	-.2332E+06	-.6952E+07	-.2000E+07	BOT.	.1252E+00	.7026E-02	.6037E-01
15	BOT.	-.3227E+06	-.6812E+07	-.2000E+07	BOT.	.1284E+00	.6115E-02	.6166E-01
16	BOT.	-.3997E+06	-.6631E+07	-.2000E+07	BOT.	.1312E+00	.5226E-02	.6291E-01
17	BOT.	-.6021E+05	-.5600E+07	-.2000E+07	BOT.	.1382E+00	.1964E-02	.6757E-01
18	BOT.	-.6709E+05	-.4303E+07	-.2000E+07	BOT.	.1302E+00	-.6507E-03	.7170E-01
19	BOT.	-.5597E+05	-.1767E+07	-.2000E+07	BOT.	.1289E+00	-.3799E-02	.7851E-01
20	BOT.	-.3215E+05	-.2331E+06	-.2000E+07	BOT.	.1112E+00	-.4647E-02	.8388E-01
21	BOT.	-.1167E+06	.8437E+06	-.2000E+07	BOT.	.9311E-01	-.4155E-02	.8834E-01
22	BOT.	.5717E+04	.1036E+07	-.2000E+07	BOT.	.7839E-01	-.3156E-02	.9222E-01
23	BOT.	.5994E+05	.8844E+06	-.2000E+07	BOT.	.6783E-01	-.2160E-02	.9568E-01
24	BOT.	.6937E+05	.6126E+06	-.2000E+07	BOT.	.6085E-01	-.1397E-02	.9885E-01
25	BOT.	.5691E+05	.3554E+06	-.2000E+07	BOT.	.5616E-01	-.9112E-03	.1018E+00
26	BOT.	.3921E+05	.1618E+06	-.2000E+07	BOT.	.5332E-01	-.6581E-03	.1045E+00
27	BOT.	.2177E+05	.3949E+05	-.2000E+07	BOT.	.5094E-01	-.5664E-03	.1071E+00
28	BOT.	.1198E+05	-.2401E+05	-.2000E+07	BOT.	.4870E-01	-.5671E-03	.1095E+00
29	BOT.	.8898E+04	-.6654E+05	-.2000E+07	BOT.	.4635E-01	-.6198E-03	.1118E+00
30	BOT.	.8509E+04	-.9992E+05	-.2000E+07	BOT.	.4371E-01	-.7103E-03	.1139E+00
31	BOT.	.2059E+05	-.1526E+06	-.2000E+07	BOT.	.4063E-01	-.8407E-03	.1158E+00
32	BOT.	.4294E+05	-.2800E+06	-.2000E+07	BOT.	.3689E-01	-.1059E-02	.1174E+00

08/08
53-1100-029
123

SMUD COOLDOWN INC. SUPPORT SKIRT ITERATION 45 PAGE 11 DATE 08/04/78

33	BOT.	.4754E+05	-.4742E+06	-.2000E+07	BOT.	.3198E-01	-.1447E-02	.1188E+00
34	BOT.	-.7562E+04	-.5970E+06	-.2000E+07	BOT.	.2512E-01	-.2006E-02	.1202E+00
35	BOT.	-.1693E+06	-.2715E+06	-.2000E+07	BOT.	.1596E-01	-.2494E-02	.1217E+00
36	BOT.	-.4761E+06	.9699E+06	-.2000E+07	BOT.	.5866E-02	-.2240E-02	.1232E+00
37	BOT.	-.9161E+06	.3724E+07	-.2000E+07	BOT.	.4441E-15	-.2776E-16	.1248E+00

(FORCE AND MOTION OUTPUT IS IN GLOBAL DIRECTIONS R AND Z)

SHUD COOLDOWN INC. SUPPORT SKIRT ITERATION 45 PAGE 12 DATE 08/04/78

PRIMARY + SECONDARY STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	-25059.5	-76221.1	6.3	-1680.8	-74429.4	20.3	21666.1	-72729.9	6.3
2	-20104.9	-72239.2	5.4	-1433.9	-71134.5	16.4	17204.0	-70117.8	5.4
3	-16097.0	-67746.8	-1.0	-1639.8	-67821.5	-24.6	12798.1	-68008.3	-1.0
4	-11150.9	-62312.4	-4.7	-1581.8	-63374.8	-47.8	7978.0	-64474.0	-4.7
5	-7001.7	-57014.4	-9.0	-1666.3	-59059.6	-75.4	3671.2	-61230.6	-9.0
6	-2889.7	-51713.1	-11.9	-1671.4	-54578.9	-91.2	-442.8	-57569.5	-11.9
7	874.9	-46123.7	-13.7	-1712.5	-49775.1	-104.0	-4282.6	-53549.1	-13.7
8	4991.2	-39552.5	-14.8	-1713.2	-43886.3	-109.6	-8395.1	-48334.5	-14.8
9	8716.1	-33051.6	-15.7	-1777.1	-38085.8	-114.5	-12242.9	-43216.8	-15.7
10	11998.7	-28281.9	-16.2	-1907.9	-33980.6	-116.5	-15784.2	-39779.1	-16.2
11	15688.7	-21120.3	-16.9	-2090.0	-29849.7	-120.6	-19936.5	-36679.1	-16.9
12	20587.8	-18027.1	-16.9	-2352.3	-25806.6	-120.0	-25258.7	-33680.2	-16.9
13	27619.7	-13156.4	-18.1	-2704.9	-22988.3	-127.5	-32993.6	-32910.3	-18.1
14	38801.9	-7304.2	-19.8	-3238.3	-20364.3	-139.2	-45239.0	-33531.6	-19.8
15	39100.9	-4811.7	-20.7	-3295.5	-17727.0	-145.0	-45646.9	-30741.7	-20.7
16	37982.3	-2555.8	-20.1	-3290.6	-15098.9	-161.3	-44519.5	-27737.4	-20.1
17	31787.6	3580.6	-18.3	-3265.8	-6992.0	-128.3	-38275.0	-17637.5	-18.3
18	23634.0	6995.8	-14.6	-3230.5	-1047.1	-102.5	-30057.6	-9141.2	-14.6
19	7615.5	8630.1	-8.7	-3154.6	5484.1	-60.9	-13894.5	2334.2	-8.7
20	-3532.2	6108.5	-2.2	-3105.8	6321.0	-15.3	-2666.9	6549.0	-2.2
21	-8689.8	7570.9	1.6	-3083.6	4304.5	11.0	2522.9	6057.8	1.6
22	-9721.3	213.3	2.9	-3079.5	2228.4	20.6	3556.7	4260.4	2.9
23	-8649.1	-917.2	2.9	-3084.5	756.2	20.2	2473.3	2441.1	2.9
24	-6881.2	-1295.0	2.2	-3092.4	-164.9	15.3	690.6	971.1	2.2
25	-5248.7	-1087.2	1.4	-3099.5	-451.0	9.7	-954.5	188.1	1.4
26	-4061.4	-760.2	.7	-3104.8	-496.8	5.0	-2170.6	-212.9	.7
27	-3284.6	-512.5	.2	-3108.1	-466.1	1.7	-2932.6	-420.2	.2
28	-2908.9	-40.1	-.0	-3109.7	-101.4	-.1	-3310.8	-163.6	-.0
29	-2656.3	16.5	-.3	-3110.8	-120.6	-1.1	-3545.2	-359.8	-.3
30	-2456.2	228.7	-.3	-3111.7	33.5	-1.8	-3766.8	-163.5	-.3
31	-2156.9	797.2	-.4	-3113.0	519.1	-2.6	-4068.5	238.5	-.4
32	-1386.2	1056.8	-.6	-3116.4	548.1	-4.3	-4845.8	34.6	-.6
33	-141.6	432.4	-1.1	-3121.9	-463.9	-7.8	-6100.7	-1368.6	-1.1
34	653.8	-1498.2	-1.3	-3125.4	-2654.3	-11.6	-6901.6	-3830.6	-1.3
35	-1046.1	-5367.9	-1.5	-3117.8	-6073.5	-10.8	-5185.2	-6783.1	-1.5
36	-8429.3	-11536.0	.5	-3085.2	-10085.8	3.3	2263.1	-8616.2	.5
37	-25228.1	-18929.8	6.1	-3011.0	-12477.4	42.6	19205.0	-5955.9	6.1

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

JFN
05/78
620-0011-55

125

SMUD COOLDOWN INC. SUPPORT SKIRT ITERATION 45 PAGE 13 DATE 08/04/78

TEMPERATURES PER SEGMENT USED IN PEAK PRINCIPLE ANALYSIS

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5	SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	428.	426.	424.	422.	421.	19	249.	249.	250.	250.	251.
2	428.	428.	426.	422.	423.	20	209.	209.	210.	210.	210.
3	430.	428.	426.	426.	435.	21	182.	182.	182.	182.	182.
4	427.	426.	425.	424.	426.	22	161.	161.	161.	161.	161.
5	425.	424.	423.	422.	422.	23	145.	145.	146.	146.	146.
6	423.	422.	421.	419.	418.	24	135.	135.	135.	135.	136.
7	421.	419.	415.	414.	412.	25	126.	126.	127.	127.	128.
8	409.	409.	409.	408.	407.	26	119.	120.	120.	121.	121.
9	402.	401.	401.	400.	399.	27	114.	115.	115.	115.	115.
10	398.	396.	394.	394.	393.	28	108.	108.	108.	108.	108.
11	395.	390.	385.	385.	384.	29	102.	103.	103.	103.	103.
12	379.	378.	378.	378.	378.	30	96.	96.	96.	96.	97.
13	372.	372.	372.	372.	377.	31	86.	86.	87.	87.	87.
14	366.	366.	366.	366.	366.	32	78.	78.	78.	78.	78.
15	359.	360.	360.	360.	360.	33	72.	72.	72.	72.	73.
16	353.	353.	353.	353.	353.	34	68.	68.	68.	68.	68.
17	328.	328.	328.	328.	328.	35	65.	65.	65.	65.	66.
18	302.	302.	302.	302.	302.	36	63.	63.	63.	64.	64.
						37	63.	63.	63.	63.	63.

SMUD COOLDOWN INC. SUPPORT SKIRT ITERATION 45 PAGE 14 DATE 08/04/78

PEAK BOUNDARY AND FLEXABILITY MATRICES

BOUNDARY FORCES DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL DEFL. (O)	ROTATION (O)	RADIAL DEFL. (N)	ROTATION (N)	SUM
AXIAL FORCE (N)	0.	0.	0.	-.2000E+07	0.	0.	0.	0.	-.2000E+07
RADIAL SHEAR (O)	.2446E+08	0.	0.	.2337E+06	-.2306E+07	-.6075E+07	0.	0.	.1631E+08
MOMENT (O)	.1355E+09	0.	0.	-.1616E+07	-.1392E+08	-.6308E+08	0.	0.	.5605E+08
RADIAL SHEAR (N)	-.8490E+06	0.	0.	-.6900E+05	.2433E+02	.1926E+03	0.	0.	-.9157E+06
MOMENT (N)	.3436E+07	0.	0.	.2714E+06	-.1440E+03	-.7606E+03	0.	0.	.3706E+07

FLEXIBILITY MATRIX DUE TO A UNIT LOAD (TOTAL LOAD BASIS)

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL SHEAR (O)	MOMENT (O)	RADIAL SHEAR (N)	MOMENT (N)
AXIAL DEFL. (N)	.9947E-01	0.	0.	.5386E-08	.3789E-08	-.4699E-09	-.1049E-08	-.5556E-11
RADIAL DEFL. (O)	-.2221E+00	0.	0.	.3789E-08	.1946E-07	-.1875E-08	-.9760E-12	-.9789E-13
ROTATION (O)	.3780E-02	0.	0.	-.4699E-09	-.1875E-08	.3105E-09	.1892E-12	.9184E-14
RADIAL DEFL. (N)	.2576E-01	0.	0.	-.1049E-08	-.9760E-12	.1892E-12	.6212E-07	.7833E-08
ROTATION (N)	-.2409E-03	0.	0.	.5556E-11	-.9789E-13	.9184E-14	.7833E-08	.2004E-08

BOUNDARY DEFLECTIONS DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL DEFL. (O)	ROTATION (O)	RADIAL DEFL. (N)	ROTATION (N)	SUM
AXIAL DEFL. (N)	.1294E+00	0.	0.	-.9054E-02	-.2196E-02	.6624E-02	0.	0.	.1248E+00
RADIAL DEFL. (O)	-.5005E-14	0.	0.	-.5772E-16	-.1879E-01	.3845E-15	0.	0.	-.1879E-01
ROTATION (O)	.2294E-15	0.	0.	.6140E-17	-.1694E-18	-.8199E-02	0.	0.	-.8199E-02
RADIAL DEFL. (N)	.3331E-15	0.	0.	.4163E-16	-.2711E-19	-.2711E-19	0.	0.	.4441E-15
ROTATION (N)	0.	0.	0.	0.	.1694E-20	.6776E-20	0.	0.	-.5551E-16

127

SHUD COOLDOWN INC. SUPPORT SKIRT ITERATION 45 PAGE 15 DATE 08/04/78

FLEXIBILITY MATRIX OF ASSEMBLY AS IN PROGRAM 91060
(THIS MATRIX ONLY IS ON A PER RADIAN BASIS)

	M(O)	Q(O)	M(N)	Q(N)
ROTATION(O)	.195122E-08	.117787E-07	.577050E-13	.118895E-11
DEFLECTION(O)	.117787E-07	.122291E-06	.615055E-12	.613224E-11
ROTATION(N)	.577050E-13	.615055E-12	.125890E-07	.492143E-07
DEFLECTION(N)	.118895E-11	.613224E-11	.492143E-07	.390318E-05

NOTE- THE +1 SIGN CONVENTION IS USED IN THE MATRIX PRINTED HERE.
IF IT IS DESIRED TO USE THE -1 SIGN CONVENTION THEN THE
SIGNS MUST BE CHANGED ON ALL OF THE OFF-DIAGONAL ELEMENTS.

JCT/1
05/78
620-0011-55

128

SHUD COOLDOWN INC. SUPPORT SKIRT ITERATION 45 PAGE 16 DATE 08/04/78

PEAK FORCES AND MOTIONS

POSITIVE DIRECTIONS (+) ARE AS FOLLOWS

TOP OF SEGMENT NO.1	BOTTOM OF REMAINING SEGMENTS
RADIAL------ TO THE LEFT	RADIAL------ TO THE RIGHT
ROTATIONAL-- CLOCKWISE	ROTATIONAL-- COUNTERCLOCKWISE
AXIAL------- UPWARD	AXIAL------- DOWNWARD

** SIGN CONVENTIONS ARE FOR A RIGHT HAND VIEW **

SEG. NO.	LOC.	RADIAL FORCE	MOMENT	AXIAL FORCE	LOC.	RADIAL MOTION	ROTATION	AXIAL MOTION
1	TOP	.1631E+08	.5685E+08	-.2000E+07	TOP	-.1879E-01	-.8199E-02	0.
1	BOT.	.1498E+08	.4867E+08	-.2000E+07	BOT.	.2326E-01	.8359E-02	.2894E-02
2	BOT.	.1234E+08	.3452E+08	-.2000E+07	BOT.	.3240E-01	.8651E-02	.8184E-02
3	BOT.	.1016E+08	.2366E+08	-.2000E+07	BOT.	.4107E-01	.8887E-02	.1353E-01
4	BOT.	.7967E+07	.1372E+08	-.2000E+07	BOT.	.5118E-01	.9099E-02	.1945E-01
5	BOT.	.6177E+07	.6652E+07	-.2000E+07	BOT.	.6060E-01	.9235E-02	.2514E-01
6	BOT.	.4616E+07	.1306E+07	-.2000E+07	BOT.	.7016E-01	.9306E-02	.3079E-01
7	BOT.	.3335E+07	-.2362E+07	-.2000E+07	BOT.	.7931E-01	.9298E-02	.3622E-01
8	BOT.	.2138E+07	-.5130E+07	-.2000E+07	BOT.	.8969E-01	.9202E-02	.4197E-01
9	BOT.	.1214E+07	-.6635E+07	-.2000E+07	BOT.	.9954E-01	.9013E-02	.4723E-01
10	BOT.	.6940E+06	-.7146E+07	-.2000E+07	BOT.	.1063E+00	.8794E-02	.5077E-01
11	BOT.	.3094E+06	-.7226E+07	-.2000E+07	BOT.	.1123E+00	.8486E-02	.5419E-01
12	BOT.	.5545E+05	-.7176E+07	-.2000E+07	BOT.	.1174E+00	.8106E-02	.5669E-01
13	BOT.	-.9593E+05	-.7022E+07	-.2000E+07	BOT.	.1212E+00	.7660E-02	.5861E-01
14	BOT.	-.2096E+06	-.6843E+07	-.2000E+07	BOT.	.1247E+00	.6964E-02	.6030E-01
15	BOT.	-.3001E+06	-.6715E+07	-.2000E+07	BOT.	.1279E+00	.6067E-02	.6159E-01
16	BOT.	-.3781E+06	-.6545E+07	-.2000E+07	BOT.	.1307E+00	.5191E-02	.6284E-01
17	BOT.	-.5849E+06	-.5552E+07	-.2000E+07	BOT.	.1378E+00	.1965E-02	.6751E-01
18	BOT.	-.6580E+06	-.4246E+07	-.2000E+07	BOT.	.1386E+00	-.5419E-02	.7165E-01
19	BOT.	-.5540E+06	-.1786E+07	-.2000E+07	BOT.	.1285E+00	-.3762E-02	.7846E-01
20	BOT.	-.3204E+06	-.3411E+05	-.2000E+07	BOT.	.1109E+00	-.4597E-02	.8383E-01
21	BOT.	-.1176E+06	.8124E+06	-.2000E+07	BOT.	.9307E-01	-.4121E-02	.8829E-01
22	BOT.	.4845E+04	.1009E+07	-.2000E+07	BOT.	.7842E-01	-.3152E-02	.9217E-01
23	BOT.	.5965E+05	.8593E+06	-.2000E+07	BOT.	.6784E-01	-.2165E-02	.9564E-01
24	BOT.	.6951E+05	.5879E+06	-.2000E+07	BOT.	.6084E-01	-.1405E-02	.9890E-01
25	BOT.	.5712E+05	.3297E+06	-.2000E+07	BOT.	.5632E-01	-.9184E-03	.1017E+00
26	BOT.	.3855E+05	.1366E+06	-.2000E+07	BOT.	.5328E-01	-.6474E-03	.1045E+00
27	BOT.	.2033E+05	.1892E+05	-.2000E+07	BOT.	.5095E-01	-.5521E-03	.1071E+00
28	BOT.	.1099E+05	-.3943E+05	-.2000E+07	BOT.	.4875E-01	-.5658E-03	.1095E+00
29	BOT.	.8444E+04	-.7928E+05	-.2000E+07	BOT.	.4638E-01	-.6276E-03	.1117E+00
30	BOT.	.8287E+04	-.1113E+06	-.2000E+07	BOT.	.4370E-01	-.7201E-03	.1138E+00
31	BOT.	.2039E+05	-.1633E+06	-.2000E+07	BOT.	.4060E-01	-.8398E-03	.1157E+00
32	BOT.	.4262E+05	-.2895E+06	-.2000E+07	BOT.	.3689E-01	-.1052E-02	.1173E+00

620-0311-5.5

SHUD COOLDOWN INC. SUPPORT SKIRT ITERATION 45 PAGE 17 DATE 08/04/78

33	ROT.	.4751E+05	-.4828E+06	-.2000E+07	ROT.	.3199E-01	-.1644E-02	.1188E+00
34	ROT.	-.7109E+04	-.5916E+06	-.2000E+07	ROT.	.2515E-01	-.2006E-02	.1202E+00
35	ROT.	-.1684E+06	-.2837E+06	-.2000E+07	ROT.	.1597E-01	-.2501E-02	.1216E+00
36	ROT.	-.4753E+05	.9531E+06	-.2000E+07	ROT.	.5853E-02	-.2240E-02	.1231E+00
37	ROT.	-.9157E+06	.3706E+07	-.2000E+07	ROT.	.4441E-15	-.5551E-16	.1248E+00

(FORCE AND MOTION OUTPUT IS IN GLOBAL DIRECTIONS R AND Z)

J.L.H.
08/78
620-0011-55
130

SMUD COOLDOWN INC. SUPPORT SKIRT ITERATION 45 PAGE 18 DATE 08/04/78

PEAK PRINCIPAL STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	-26892.3	-77397.8	10.8	-1649.1	-74385.1	57.0	36673.8	-67022.7	10.8
2	-20813.1	-72752.4	8.7	-1348.3	-71090.5	44.5	27176.2	-66127.0	8.7
3	-16829.6	-68551.8	1.8	-1379.5	-67574.3	-4.8	18328.5	-65676.3	1.8
4	-11462.4	-62788.2	-2.5	-1555.7	-63319.2	-32.2	8059.3	-64238.2	-2.5
5	-7324.4	-57505.5	-7.5	-1642.1	-59955.5	-60.8	3756.7	-61003.3	-7.5
6	-3089.7	-52275.7	-9.8	-1790.9	-54728.4	-74.9	-206.4	-57012.6	-9.8
7	343.2	-47317.7	-10.8	-1446.0	-49579.0	-83.5	-4063.0	-52765.0	-10.8
8	4837.4	-39782.3	-12.5	-1853.1	-44108.7	-95.1	-7968.9	-47990.6	-12.5
9	8349.2	-33551.7	-14.5	-1898.5	-38306.5	-108.1	-11840.8	-42883.3	-14.6
10	11431.7	-20189.5	-14.7	-1644.2	-33859.6	-108.6	-15529.6	-39459.1	-14.7
11	14665.9	-25059.6	-14.5	-1308.6	-29325.4	-106.1	-19946.9	-36187.1	-14.5
12	37296.2	-12768.7	-15.2	-2328.1	-25044.5	-109.7	-26910.6	-33720.8	-15.2
13	50302.3	-5862.1	-17.6	-2706.1	-23176.6	-125.5	-32479.6	-32951.5	-17.2
14	70739.2	2885.5	-19.5	-3239.1	-20566.2	-137.1	-44576.0	-33534.4	-19.5
15	71531.9	5704.7	-20.5	-3114.4	-17949.6	-141.0	-44903.3	-30785.2	-20.5
16	69350.5	7461.6	-20.0	-3288.2	-15318.7	-139.4	-41978.6	-27798.3	-20.0
17	31495.7	3264.6	-18.1	-3264.4	-7223.9	-127.0	-37981.9	-17785.0	-18.1
18	23530.7	6745.8	-14.5	-3229.9	-1269.1	-101.9	-29953.6	-9335.4	-14.5
19	7650.1	8610.0	-8.9	-3253.0	5230.3	-62.1	-16126.3	1843.8	-8.9
20	-3381.8	6175.9	-2.5	-3225.9	6115.2	-18.0	-2182.7	6347.3	-2.5
21	-8492.8	2619.0	1.4	-3085.1	4283.8	9.3	2324.0	5977.8	1.4
22	-9552.0	276.1	2.9	-3080.2	2240.6	20.0	3386.1	4221.5	2.9
23	-8549.6	-764.1	2.8	-3202.2	655.6	18.7	2408.9	2355.6	2.8
24	-6769.8	-1241.7	2.0	-3072.6	-138.4	13.8	350.0	701.3	2.0
25	-5189.3	-949.6	1.1	-3195.8	-548.3	8.1	-1210.4	-146.9	1.1
26	-3717.8	-468.1	.3	-3010.4	-430.2	2.4	-2214.7	-393.4	.3
27	-2771.7	-247.0	-.1	-3130.1	-498.8	.2	-3020.5	-462.9	-.1
28	-1814.5	9.4	-.3	-3110.2	-80.0	-.4	-3406.1	-170.4	-.3
29	-2394.4	272.5	-.3	-3131.9	-136.8	-1.4	-3601.6	-280.4	-.3
30	2427.6	558.5	-.5	-3091.1	61.3	-2.1	-4021.8	-405.8	-.5
31	-2144.6	903.4	-.5	-3228.9	401.0	-3.8	-4065.6	161.1	-.5
32	-1326.9	1073.4	-.7	-3117.2	546.4	-5.5	-4905.9	15.3	-.7
33	-129.5	465.1	-1.2	-3101.3	-478.2	-8.0	-6337.8	-1596.4	-1.2
34	712.0	-1461.1	-1.8	-3125.7	-2644.6	-11.8	-6960.4	-3838.4	-1.8
35	-1012.1	-5332.8	-1.7	-3097.4	-6042.0	-11.0	-8443.8	-7021.2	-1.7
36	-8419.2	-11479.4	.3	-2970.6	-9988.0	2.0	2217.0	-8751.6	.3
37	-25117.9	-18897.0	6.0	-3012.0	-12478.2	41.3	19093.6	-5989.6	6.0

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

620-0011-55
181

The primary plus secondary stress intensity was calculated at the most highly stressed point and combined with the worst case stress intensity during heatup from the Stress Report (Ref. 1) to calculate the range of stress intensity. The range of primary plus secondary stress intensity was found to be greater than the allowable, therefore it was necessary to perform a Simplified Elastic-Plastic Fatigue Analysis.

The usage factor for the one (1) cycle of "Rapid Cooldown" was calculated by the same method as the primary plus secondary stress intensity and combined with the usage factor from the Stress Report (Ref. 1) for a total cumulative usage factor.

The following pages contain the fatigue analysis.

JLH
08/78
620-0011-55

THE MAXIMUM (OR MINIMUM) STRESS INTENSITY RESULTING FROM HEAT UP AS CALCULATED IN THE SUPPORT SKIRT STRESS REPORT WILL BE COMBINED WITH THE COOLDOWN INCIDENT STRESS INTENSITY TO FIND THE RANGE OF STRESS INTENSITIES.

FROM THE STRESS REPORT THE MAXIMUM STRESS INTENSITY OCCURRING DURING HEAT UP WAS $\sigma_H - \sigma_L = 74.4$ KSI (PRIMARY PLUS SECONDARY) JUNCTURE 1 INSIDE. PAGE B-16-2 & B-17-2.

FROM THE COOLDOWN INCIDENT STRESS EVALUATION THE MINIMUM STRESS INTENSITY WAS $\sigma_H - \sigma_L = -72.7 - 21.7 = -94.4$ KSI (PRIMARY PLUS SECONDARY, JUNCTURE 1, INSIDE.

THE RANGE OF PRIMARY PLUS SECONDARY STRESS INTENSITY IS

$$74.4 + 94.4 = 168.8 \text{ KSI}$$

THE MAXIMUM PEAK STRESS INTENSITY OCCURRING DURING HEAT UP FROM THE STRESS REPORT WAS $\sigma_H - \sigma_L = 86.7$ AT JUNCT 1, IN, PAGE B-16-2

FROM THE COOLDOWN INCIDENT STRESS EVALUATION, THE MINIMUM PEAK STRESS INTENSITY WAS $\sigma_H - \sigma_L = -67.0 - 36.7 = -103.7$ KSI JCT 1, IN.

THE RANGE OF PEAK STRESS INTENSITY IS

$$86.7 + 103.7 = 190.4 \text{ KSI}$$

REF. USAS B31.7 NUCLEAR POWER PIPING CODE, DRAFT USA STANDARD FEB., 1968 PARAGRAPH F-105.2.7

$$S_{ALT} = \tfrac{1}{2} K_f K_E S_{rij}^{(n)}$$

WHERE $K_f = K_t + A (K_t - 1)$

AND $K_t = S_{rij}^{(P)} / S_{rij}^{(n)}$

$S_{rij}^{(P)}$ = PEAK STRESS INTENSITY RANGE = 190.4 KSI

$S_{rij}^{(n)}$ = PRIMARY PLUS SECONDARY STRESS INTENSITY RANGE = 168.8 KSI

THE "A" FACTOR IS A FUNCTION OF $S_{rij}^{(n)} / 3 S_m$

REF. FIG. 201(b) APPENDIX D OF B 31.7

$$S_{rij}^{(n)} / 3 S_m = 168.8 / 80.1 = 2.11$$

BABCOCK & WILCOX		REVISION
DEPARTMENT	DATE 08/07/78 BY J.L.H.	
	CHECKED DATE BY	
	JOB NO. 620-0011-55	SHEET 123 OF

FROM FIG. 2-1(b)* IN APPENDIX D OF B31.7 THE "A" FACTOR IS FOUND BY EXTRAPOLATING THE "A" CURVE FOR 2¼ Cr-Mo TO BE 3.5

* A CURVE IS NOT AVAILABLE FOR A-508 CL 2 MATERIAL SO THE APPROXIMATION IS MADE BY EXTRAPOLATING THE MOST CONSERVATIVE CURVE AVAILABLE (THE (b) CURVE).

$$K_t = S_{rij}^{(P)} / S_{rij}^{(n)} = 190.4/168.3 = 1.13$$

$$K_f = K_t + A(K_t - 1) = 1.13 + 3.5(1.13 - 1.0) = 1.585$$

K_E (ELASTIC-PLASTIC CORRECTION FACTOR) IS A FUNCTION OF A RATIO OF THE AVERAGE (THRU THICKNESS) PRIMARY PLUS SECONDARY MEMBRANE STRESS INTENSITY RANGE AND THE AVERAGE (THRU THICKNESS) PRIMARY PLUS SECONDARY BENDING STRESS INTENSITY RANGE.

PRIMARY PLUS SECONDARY MEMBRANE STRESSES (MIDPLANE)

	σ_L	σ_H	σ_R
ITEM 45 "COOLDOWN"	-1.7	-74.4	0.
ITEM 2025 STRESS RESULT	-.5	-.5	37.3

PRIMARY PLUS SECONDARY MEMBRANE STRESS INTENSITIES (MIDPLANE)

	$\sigma_L - \sigma_R$	$\sigma_R - \sigma_H$	$\sigma_H - \sigma_L$
ITEM 45 "COOLDOWN"	-1.7	74.4	-72.7
ITEM 2025 STRESS RESULT	0.	-37.3	37.8
PRIMARY PLUS SECONDARY MEMBRANE STRESS INTENSITY RANGE (S_{rm})	1.7	112.2	110.5

BABCOCK & WILCOX

DEPARTMENT

DATE [illegible] BY [illegible]

CHECKED DATE BY

JOB NO. [illegible]

REVISION

SHEET 24 OF

PRIMARY PLUS SECONDARY PRINCIPLE BENDING STRESSES
INSIDE - MIDPLANE

	σ_L	σ_H	σ_R
ITER 45 "COOLDOWN"	23.4	1.7	0.
ITER 2028 STRESS REPORT	-50.4	.4	-13.8

PRIMARY PLUS SECONDARY BENDING STRESS INTENSITIES
INSIDE - MIDPLANE

	$\sigma_L - \sigma_R$	$\sigma_R - \sigma_H$	$\sigma_H - \sigma_L$
ITER 45 "COOLDOWN"	23.4	-1.7	-21.7
ITER 2028 STRESS REPORT	-50.8	14.2	36.6
Q_B PRIMARY PLUS SECONDARY BENDING STRESS INTENSITY RANGE	74.2	15.9	58.3

FOR THE $\sigma_H - \sigma_L$ STRESS INTENSITIES THE PARAMETER FOR THE K_E CORRECTION FACTOR IS

$$\frac{Q_M}{Q_M + Q_B} = \frac{110.5}{110.5 + 58.3} = .65$$

FROM FIGURE F-105(a) APPENDIX F OF B31.7 $K_E = 1.9$

$$S_{ALT} = \tfrac{1}{2} K_f K_E S_{rij}^{(n)}$$

$$S_{ALT} = \tfrac{1}{2}(1.58)(1.9)(168.8) = 253.4 \text{ KSI}$$

$$S'_{ALT} = (30.\times10^6 / 28.8\times10^6)(253.4) = 264. \text{ KSI}$$

N ALLOWABLE CYCLES FROM SECTION III N-415(a) IS 52 CYCLES
N REQUIRED IS 1 CYCLE

USAGE FACTOR = 1/52 = .02 (COOLDOWN, 1 CYCLE)

USAGE FACTOR FROM STRESS REPORT IS 0.89 (240 CYCLES HEAT UP & COOLDOWN)

COMBINED TOTAL USAGE FACTOR = 0.89 + 0.02 = 0.91

BABCOCK & WILCOX	REVISION
DEPARTMENT DATE 08/08/78 BY J.L.H.	
CHECKED DATE BY	
JOB NO. 620-0011-55	SHEET 136 OF

OTSG LOWER TUBESHEET AREA AND TUBE
STRESS EVALUATION DUE TO THE
'RAPID COOLDOWN' EVENT OF MARCH 20, 1978

FOR

SACRAMENTO MUNICIPAL UTILITY DISTRICT

B&W CONTRACT: 620-0011-55
CUSTOMER ORDER NO: 3075

BY: Lyall C. White - Engr. Assoc. 6-6-78

APPROVED BY: John D. Brew - Sn. Engr. Supervisor 6-9-78

B & W DOCUMENT NUMBER

33 0274 00

Component Engineering
Mt. Vernon Works
Mt. Vernon, Indiana

DISCUSSION

The geometry and materials were established by Report No. 4 of the OTSG Stress Report for Sacramento Municipal Utility District.

The Transient Condition is given in the transmitted data shown in the Appendix. The analyzed 'Rapid Cooldown' was taken from this information.

To determine the thermal effects of the analyzed transient, a thermal model was developed, film coefficients were calculated, and B&W Program 91167 'Implicit and Explicit Temperature Distribution' was run. This program determined the temperature distribution versus time for the overall geometry. (The tubesheet was not included in this model; however, its temperature distribution was determined later in the report.)

From this 'Time vs. Temperature' information, the critical times for further analysis were selected based on: 1) maximum radial and axial gradients in the model and 2) maximum temperature difference between average tube temperature and average shell temperature (causes maximum tube loads).

The overall geometry was divided into classic analytical parts called interaction elements.

At the critical times for analysis, the temperatures for each interaction element were interpolated (by B&W Program 91032 'Temperature Interpolation Grid Change Program') to the format used by B&W Program 91206 'Save-SS-II'. This interpolation was required since the 91206 B&W Program is used to determine the free-body thermal motions and stresses resulting from the temperature effects of the transients analyzed.

The temperatures through the thickness of the tubesheet were determined using equations pertaining to a 'Not Very Long Rod Protruding From A Heat Source' from Ref. 6.

The preceding thermal motions were input, along with the appropriate pressures and other data, into B&W Program 91249 'Tubesheet Area Interaction Analysis' to determine interaction stresses, tube loads, ligament stresses, etc.

To evaluate the interaction junctures, the appropriate stress concentration factors were input, along with the sum of the free-body thermal and 91249 interaction stresses, into B&W Program 91076 'Stress Summary Program'. This program calculates stress intensities and ranges for both primary plus secondary and peak classifications. These values are then used in meeting the stress and fatigue requirements of the design code.

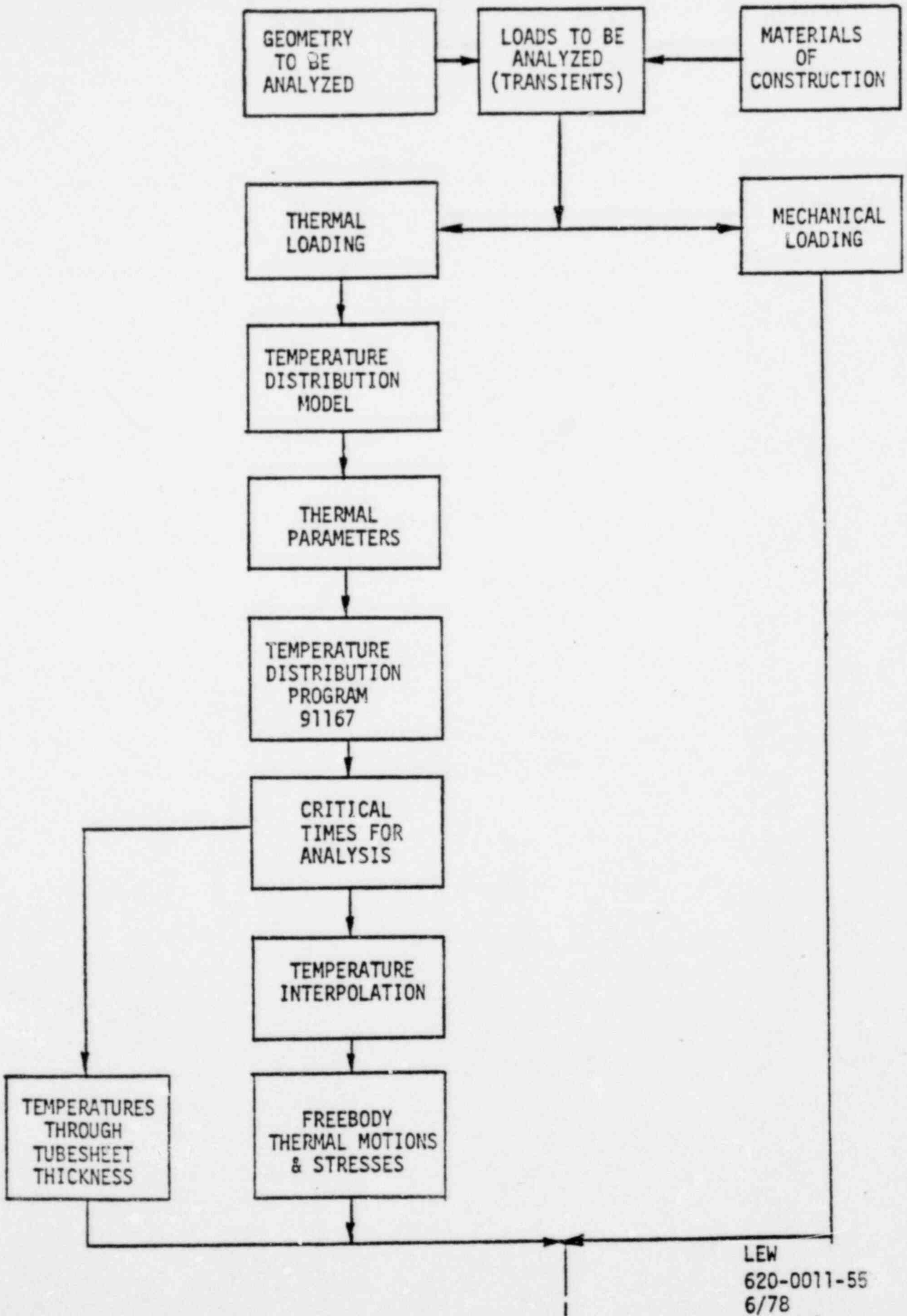
The critical interaction junctures (head-to-tubesheet and shell-to-tubesheet) were also evaluated for increased fatigue usage factor due to the 'Rapid Cooldown'.

The stress requirements applicable to the tubes were satisfied based on stresses resulting from the tube loads output by Program 91249.

As an aid in visualizing the analytical steps just explained, a flow chart of the analysis has been included on the following two pages.

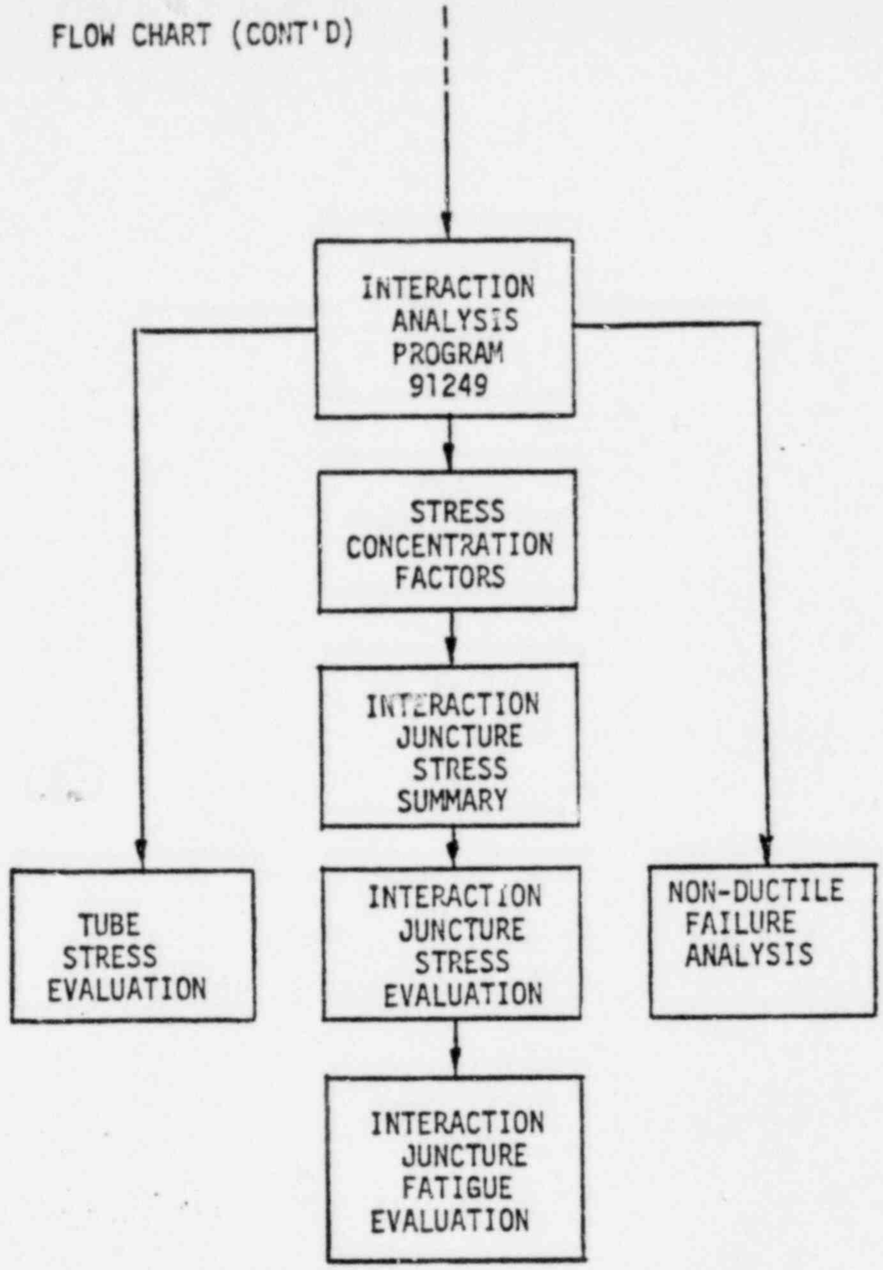
A final check was made to assure that non-ductile failure would not occur for a postulated base metal defect.

ANALYSIS FLOW CHART



LEW
620-0011-55
6/78

FLOW CHART (CONT'D)



RESULTS:

A) Interaction Junctures

1) Head-To-Tubesheet

a) Max. Pri. + Sec. Stress Intensity Range = 79 KSI < 3 S_m = 80.1 KSI (Page 161)

b) Max. cumulative usage factor = 0.034 < 1.0 max. allowable (Page 166)

2) Shell-To-Tubesheet

a) Max. Pri. + Sec. Stress Intensity Range = 33 KSI < 3 S_m = 80.1 KSI (Page 160)

b) Max. cumulative usage factor = 0.0 < 1.0 max. allowable (Page 164)

B) Tubes

Max. Tube Stress = 26.0 KSI < yield strength = 30.3 KSI (Page 173)

C) Check for assurance that non-ductile failure, due to postulated defect, will not occur:

Temperature at which non-ductile failure could occur ≈ 220°F (Page 177)

Actual temperature of metal in area of postulated defect = 308°F (Page 177)

CONCLUSIONS:

This analysis of lower tubesheet area and tubes shows that the stresses and usage factors, including the effects of the 'Rapid cool-down', are still well within the code allowables and the structural adequacy of these areas has not been impaired.

REFERENCES:

1. ASME Code, Section III, 1965 Edition, with Addenda through Summer 1967.
2. "Stress Report for Once-Thru Steam Generator", for Sacramento Municipal Utility District, B&W Contract No. 620-0011-55, Customer Order No. 3075, Report Section No. 4, entitled 'Stress Analysis of Upper and Lower Tubesheets'.
3. BAW-10046 Topical Report, May 1976, entitled 'Methods of Compliance with Fracture Toughness and Operational Requirements of 10CFR50, Appendix G.
4. ASME Code, Section III, 1977 Edition, Appendix G.
5. Babcock & Wilcox, NPGD, Engineering Calculations, Heat Transfer Manual 2A3-N, Sections 2A35221 and 2A35222.
6. 'Heat Transfer', Volume 1, by Max Jakob, copyright 1949, John Wiley & Sons, Inc., Publishers, New York.
7. B&W Computer Program 91167, 'Explicit and Implicit Transient Temperature Distribution', Revision 2, dated 7/73.
8. B&W Computer Program 91032, 'Temperature Interpolation and Free-body Thermal Motions and Stresses', Revision 3, 9/73.
9. B&W Computer Program 91206, 'Save SS-2', Rev. 0, 2/69.
10. B&W Computer Program 91249, 'Tubesheet Area Interaction Analysis for Once-Through Steam Generators, Rev. 2, 8/75.
11. B&W Computer Program 91076, 'Calculation and Tabulation of Stress Intensities, Maximum and Minimum Stresses, Stress Range, Mean and Alternating Stresses, Rev. 0, 8/66.
12. B&W Computer Program 91425, 'Materials Standard'.
13. B&W letter from J. M. Burnett, RCS Components to Distribution, Subject: SMUD Cooldown Incident, dated 4/4/78.
14. B&W letter from J. M. Burnett - RCS Components to Distribution, Subject: SMUD Cooldown Incident, dated 4/7/78.
15. B&W letter from J. M. Burnett - RCS Components to Distribution, Subject: SMUD Cooldown Incident, dated 4/20/78.
16. B&W letter from P. A. Sherburne to C. W. Bruny, Subject: SMUD Cooldown Incident, dated 5/11/78.

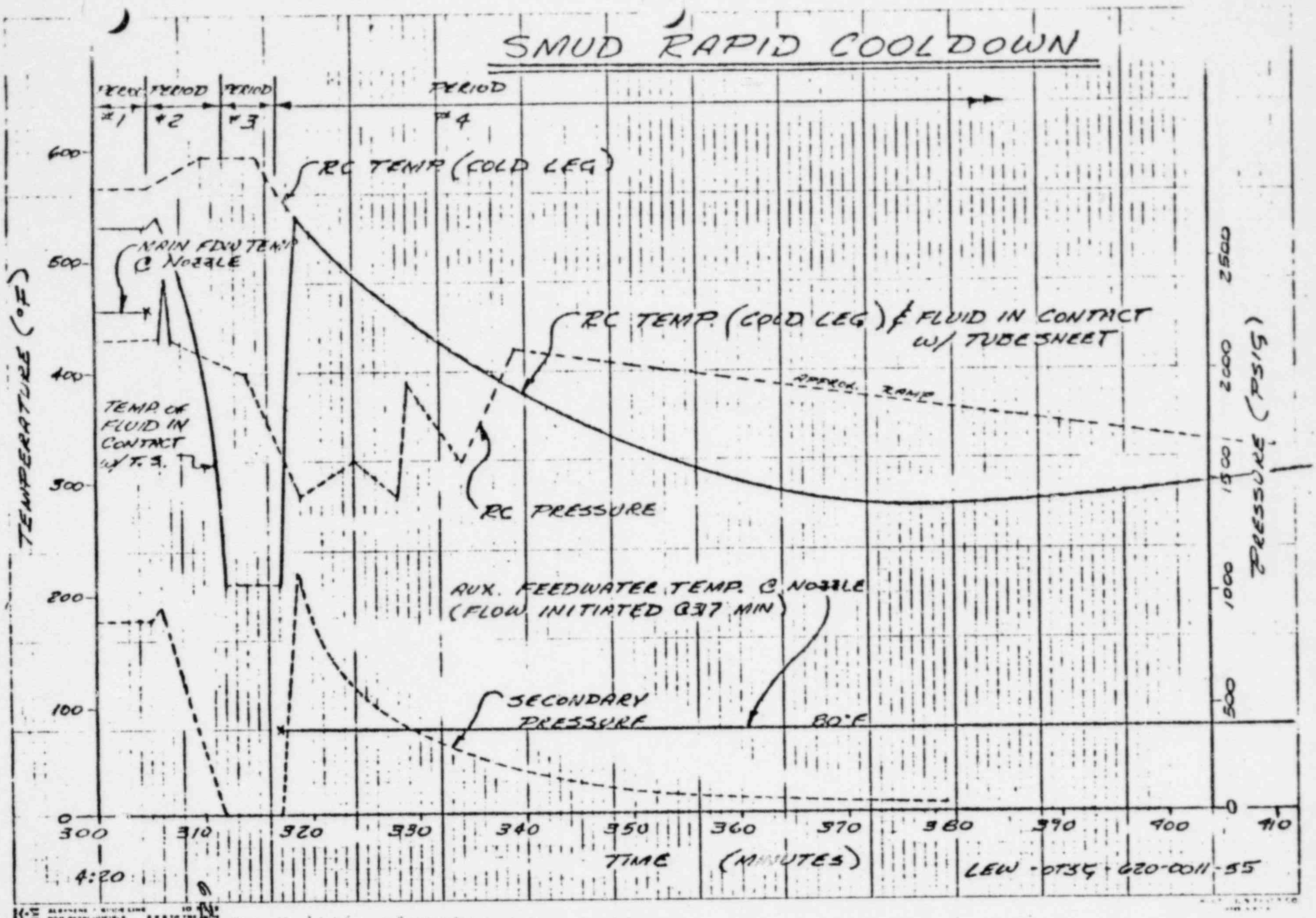
GEOMETRY TO BE ANALYZED

The Geometry Analyzed here is the same as was used in the original analysis, and will not be presented here again. Refer to Reference 2 for complete description of Geometry Analyzed.

LOADS TO BE ANALYZED

The subject for investigation is the 'Rapid Cooldown' present in the information contained in the appendix of this analysis.

The following pages contain sketches and a discussion of the transient that is analyzed.



LEW
620-0011-55
6/78
9A of A

DISCUSSION OF ANALYZED TRANSIENT

A) Primary Parameters -
The reactor coolant cold leg temperature and pressure are shown on the figure on page 9. . These conditions are applicable to fluid blocks 193 and 192*

B) Secondary Parameters -
Period #1 - The steam generator is operating at 100% steady state conditions.

Period #2 - The loss of Non Nuclear Instrumentation (NNI) causes a reactor trip and loss of main feedwater. Thus, fluid 191*conducts heat by natural convection and it is essentially saturated water. During this period, the water level in the OTSG is decreasing but this does not affect the lower tubesheet area until Period #3.

Period #3 - During this period the steam generator has boiled 'dry' and the pressure has decreased to essentially zero. Therefore, the heat conduction during this period will be by natural convection of steam.

Period #4 - At the beginning of this period. The auxiliary feedwater flow is started. The temperature of this feedwater is 80^{o}F. However, it should be visualized that the water exiting the auxiliary feedwater header comes into contact with the tube bundle. Before reaching the lower tubesheet this water runs down the outside of the hot (>500^{o}F) tubes. It is reasonably assumed that after running down the outside of the tubes for an approximate distance of 50 feet, the water is heated to the saturation temperature.

As the auxiliary feedwater flow continues, the water level in the generator increases until the OTSG is full.

Since the water is 'pooled' in the lower tubesheet area, the heat conduction for this period will be by natural convection of a saturated fluid.

*See Pages 14 and 15 for location of Fluid Blocks.

MATERIALS OF CONSTRUCTION

Tubesheet	- A-508 CL 2 (Mag Moly)
Head	- SA 533 GR B CL 1 (Mag Moly)
Shell	- SA 212 GR B (Carbon Steel)
Tubes	- SB 163 (Inconel)

THERMAL LOADING

The Thermal Loads are represented by the fluid transients shown on page 9, and they will be analyzed in detail in the following Thermal Analysis.

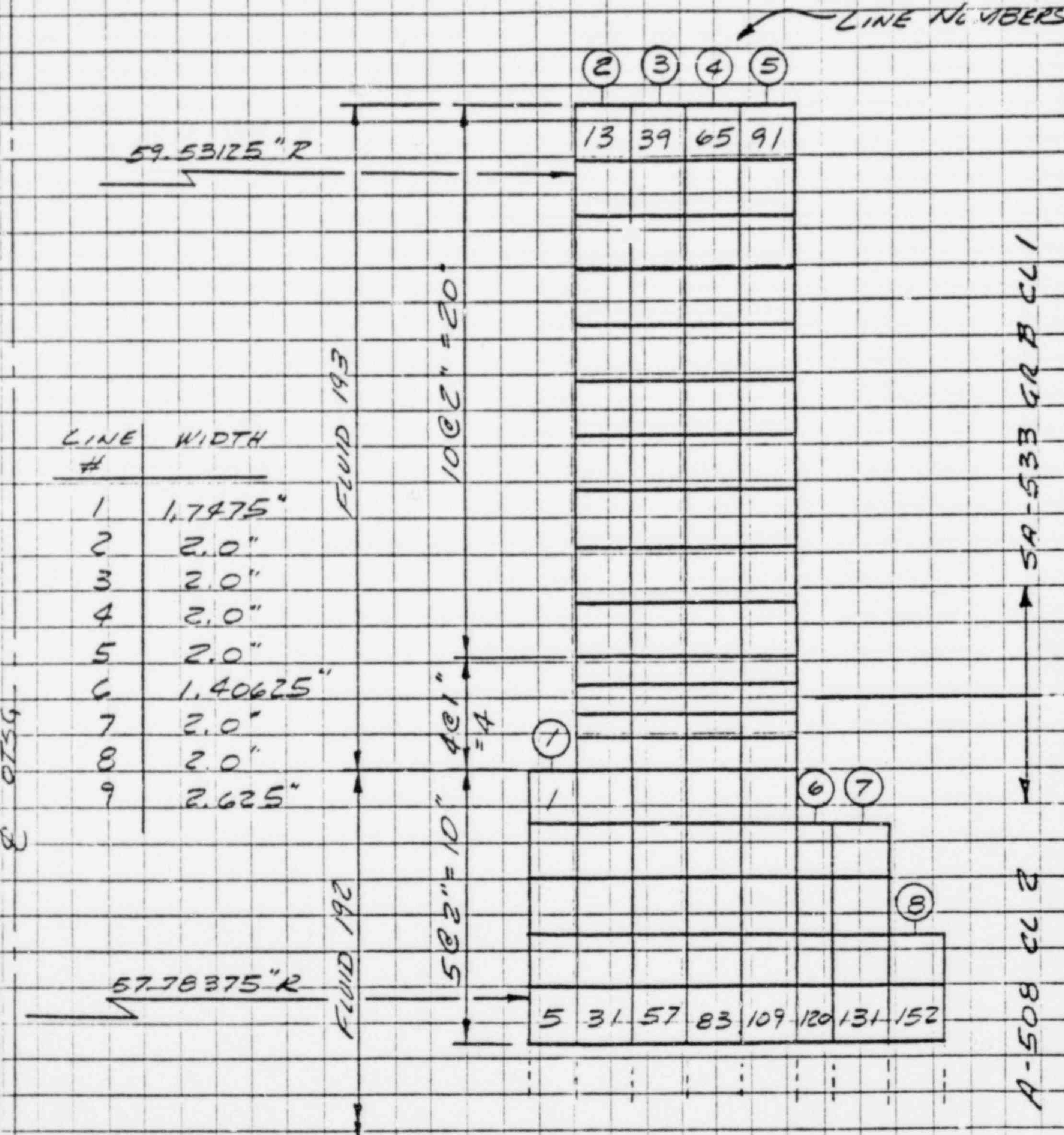
TEMPERATURE DISTRIBUTION MODEL

The following pages show the temperature distribution model as extracted from Reference 2. This model is used by Program 91167 to determine the temperature distribution versus time for the lower tubesheet interaction area.

It should be noted that the perforated portion of the tubesheet is not included in the model since its temperature distribution will be determined later by a different method.

BMS 247-1

UPPER PORTION OF PROGRAM 91167
THERMAL MODEL



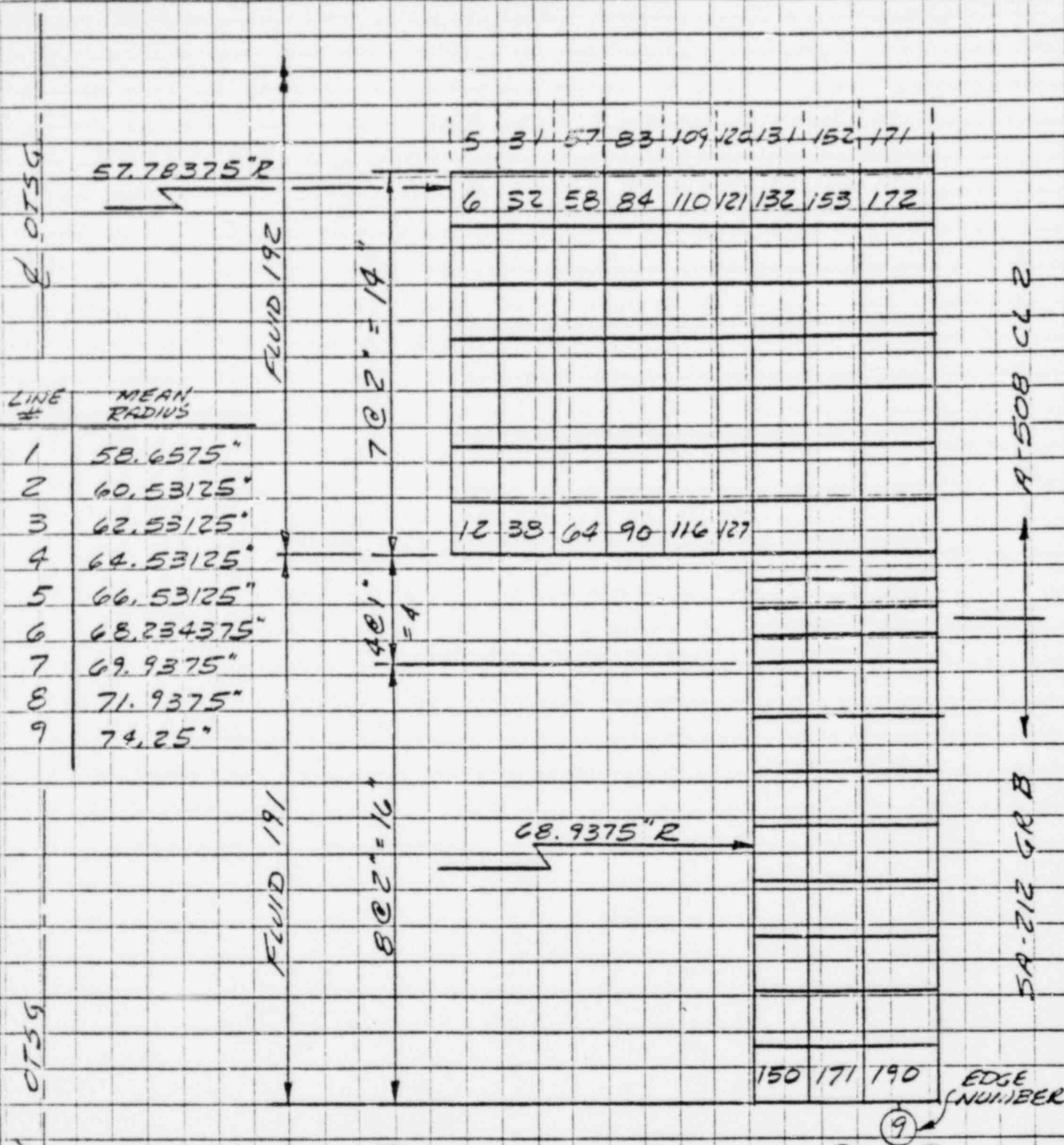
LINE #	WIDTH
1	1.7475"
2	2.0"
3	2.0"
4	2.0"
5	2.0"
6	1.40625"
7	2.0"
8	2.0"
9	2.625"

BABCOCK & WILCOX
DEPARTMENT Mt. V-Comp Energ DATE 6/78 BY LEW
PROGRAM 91167 MODEL CHECKED DATE BY
JOB NO. 620-0011-55

REVISION

SHEET 14 OF

BMS 247-1



LINE #	MEAN RADIUS
1	58.6575"
2	60.53125"
3	62.53125"
4	64.53125"
5	66.53125"
6	68.234375"
7	69.9375"
8	71.9375"
9	74.25"

LOWER PORTION OF PROGRAM 91167 THERMAL MODEL

BABCOCK & WILCOX
DEPARTMENT NT. V-COMP. ENGRG. DATE 6/78 BY LEW
PROGRAM 91167 MODEL CHECKED DATE BY
JOB NO. 620-0011-55

REVISION

SHEET 15 OF

THERMAL PARAMETERS

The Thermal Parameters, with the exception of Heat Transfer Film Boundary Coefficients, are determined internally in Program 91167.

The following pages show the calculation of the film coefficients using equation contained in B&W Engineering Standards.
However, when conditions were similar to those analyzed in the original analysis (Reference 2), the coefficients of the original analysis were extracted and used here.

FILM COEFFICIENTS

FLUID 191 - LWR SHELL AND LWR TUBESHEET

TIME PERIOD #1 - 0.0 - 305.0 MIN. (100% S.S.)

PARAMETERS:

FLOW = 6.12×10^6 #/HR

FLUID = MAIN FEEDWATER

TEMPERATURE = 455°F @ FDW NOZZLE (SATURATION TEMP. BY THE TIME IT CONTACTS LWR TUBESHEET = 531°)

PRESSURE = 890 PSI

FROM REF. 2, 'TUBESHEET ANALYSIS', PG. B-3-11,

h_{191} = 285 BTU/HR-FT^2-°F

TIME PERIOD #2A - 305.0 - 308.0 MIN.

PARAMETERS:

FLOW = 0 #/HR (NO FDW FLOW)

FLUID = SATURATED WATER

TEMP. = 515°F (AVG. TEMP. FOR TIME PERIOD)

PRESSURE = 820 PSIG (AVG. FOR TIME PERIOD)

CALC. $[Gr_L Pr]_m$

$Gr_L = K_{50} L^3 \Delta T$ (REF. 5, PG. 5)

BABCOCK & WILCOX

DEPARTMENT NUCL-COMP. ENGR. DATE 6/78 BY LEW

FILM COEFFICIENTS CHECKED DATE BY

JOB NO. 620-0011-55

REVISION

SHEET 17 OF

$K_{50} = 2(10)^{10}$

$L = 3.11$ FT (EQ. CIRCLE DIA.) $\times 0.9 = 2.80$ FT

$\Delta T = 25$ °F

$Gr_L = [2(10)^{10}](2.80)^3(25) = 1.1\,(10^{13})$

$P_R = 0.77$ (FIG. NC22)

$\therefore [Gr_L P_R]_m = (1.1\times10^{13})(0.77) = 8.5\,(10)^{12}$

CORRELATION - FLAT PLATE - HORIZ. - TURB. REGION

REF. 5, PG. 7

$\bar{h} = [\Delta T]^{1/3} K_{46} K_L = [25]^{1/3}(0.17)(915)$

$\bar{h} = 455$ BTU/HR-FT^2-°F

TIME PERIOD #2B - 308.0+ TO 310.0 MIN.

PARAMETERS:

FLOW = 0 #/HR

FLUID = SATURATED WATER

TEMP. = 450 °F (AVG. TEMP. FOR TIME PERIOD)

PRESSURE = 450 PSIG (AVG. FOR TIME PERIOD)

TEMP. OF THE T.S. ASSUMED AS 500°F.

$\Delta T = 500° - 450° = 50°$

SAME CORRELATION AS #2A APPLIES.

$$\bar{h} = [\Delta T]^{1/3} K_{46} K_6 = [50]^{1/3} (0.17)(860)$$

$\bar{h}$ = 538 BTU/HR-FT²-°F

TIME PERIOD #2C - 310.0+ TO 312.0 MIN.

PARAMETERS:
FLOW = 0 #/HR
FLUID = SATURATED WATER
TEMP. = 305°F (AVG. TEMP. FOR TIME PERIOD)
PRESSURE = 150 PSIG (AVG. FOR TIME PERIOD)

TEMP. OF THE T.S. ASSUMED AS 405°F.

ΔT = 405° - 305° = 100°F

SAME CORRELATION AS #2A APPLIES.

$$\bar{h} = [\Delta T]^{1/3} K_{46} K_6 = [100°]^{1/3} (0.17)(710)$$

$\bar{h}$ = 560 BTU/H-FT²-°F

BABCOCK & WILCOX
DEPARTMENT Mt V- Comp. Engrg. DATE 6/78 BY LEW
FILM COEFFICIENTS CHECKED DATE BY
JOB NO. 620-0011-55

REVISION

TIME PERIOD #3 - 312.0+ TO 317.0 MIN.

PARAMETERS:

FLOW = 0 #/HR

FLUID = SATURATED STEAM

TEMP. = 212 °F (AVG. TEMP. FOR TIME PERIOD)

PRESSURE = 0 PSIG

TEMP. OF T.S. ASSUMED AS 500°

$$Gr_L = \frac{\rho^2 g \beta}{\mu^2} \times L^3 \times \Delta T$$

$\rho = 0.0373 \ \#/FT^3$

$g = [(32.2) FT/SEC^2][(3600)^2 SEC^2/HR^2] = 4.17(10^8) FT/HR^2$

$\mu = 2.51(10^{-7}) LBF SEC/FT^2 \times g = 0.029 \ LBM/FT\text{-}HR$

$\beta = 0.00149 /°F$

$$Gr_L = \frac{\left[\frac{(0.0373)^2 \#^2}{FT^6}\right]\left[\frac{4.17(10^8) FT}{HR^2}\right]\left[\frac{0.00149}{°F}\right]}{\left[\frac{(0.029)^2 \#^2}{FT^2\text{-}HR^2}\right]} \cdots$$

$$\cdots \left[(2.8)^3 FT^3\right]\left[282\right] °F$$

$Gr_L = 4500$

BABCOCK & WILCOX

DEPARTMENT MT. V- COMP. ENGR. DATE 6/79 BY LEW

FILM COEFFICIENTS CHECKED DATE BY

JOB NO. 620-0011-55

REVISION

SHEET 20 OF

$$P_R = \frac{\mu C_P}{K} = \frac{\left[\frac{0.029\ \#}{FT-HR}\right]\left[\frac{0.451\ BTU}{\# - °F}\right]}{\left[\frac{0.0145\ BTU}{HR-FT-°F}\right]} = 0.902$$

$G_R P_R = 4500(.902) = 4,059$

CORRELATION - HORIZ. PL - LAMINAR REGION

REF. 5, PG. 6

$$\bar{h} = \left[\frac{\Delta T}{L}\right]^{1/4} K_{45} K_2$$

$$\bar{h} = \left[\frac{282}{2.8}\right]^{1/4} (0.71)(1.09) = \underline{2.45\ BTU/HR-FT^2-°F}$$

TIME PERIOD #4A - 317.0 TO 318.75 MIN

PARAMETERS:
- FLOW = 0 #/HR
- FLUID = SATURATED WATER
- TEMP. = 375°F (AVG. FOR TIME PERIOD)
- PRESSURE = 550 PSIG (AVG. FOR TIME PERIOD)
- TUBESHEET TEMP. ASSUMED AS 450°F

$G_R P_R = K_{52} L^3 \Delta T = 1.38(10)^{10}$

CORRELATION - HORIZ. PLATE - TURBULENT REGION

REF. 5, PG. 7

$\bar{h} = [\Delta T]^{1/3} K_{46} K_6 = [75]^{1/3} (0.17)(910)$

$\bar{h} = 652$ BTU/HR-FT^2-°F

TIME PERIOD # 4B - 318.75+ TO 340.0 MIN.

PARAMETERS:

FLOW = 0 #/HR
FLUID = SATURATED WATER
TEMP. = 460°F (AVG. FOR TIME PERIOD)
PRESSURE = 450 PSIG (AVG. FOR TIME PERIOD)
TUBESHEET TEMP. ASSUMED AS 462°F.

SAME CORRELATION APPLIES AS FOR #4A.

$\bar{h} = [\Delta T]^{1/3} K_{46} K_6 = [2]^{1/3} (0.17)(850)$

$\bar{h} = 182$ BTU/HR-FT^2-°F

TIME PERIOD # 4C - 340.0+ TO 410.0 MIN.

PARAMETERS:

FLOW = 0 #/HR
FLUID = SATURATED WATER
TEMP. = 290°F (AVG. FOR TIME PERIOD)
PRESSURE = 60 PSIG (AVG. FOR TIME PERIOD)
TUBESHEET TEMP. ASSUMED AS 292°F

SAME CORRELATION APPLIES AS FOR #4A.

$\bar{h} = [\Delta T]^{1/3} K_{46} K_6 = [2]^{1/3} (0.17)(640.) = 137.$ BTU/HR-FT^2-°F

BABCOCK & WILCOX | REVISION
DEPARTMENT MT. V - COMP. ENGRG. DATE 6/78 BY LEW
FILM COEFFICIENTS CHECKED DATE BY
JOB NO. 620-0011-55 SHEET 22 OF

FLUID 193 - INSIDE OF LOWER HEAD

TIME PERIOD #1, #2, #3 - 0.0 TO 317.0 (100% S.S.)

PARAMETERS:
FLOW = 68.95 (10^6) #/HR
FLUID = WATER
TEMPERATURE = 568°F
PRESSURE = 2150 PSIG

FROM REF. 2, 'TUBESHEET ANALYSIS', PAGE B-3-5,

$\bar{h}$ = 317 BTU/HR-FT^2-°F (INCL. EFFECT OF CLAD.)

TIME PERIOD #4 - 317.0+ TO 410.0 MIN.

PARAMETERS:
FLOW = 68.95 (10^6) #/HR
FLUID = WATER
TEMPERATURE = 410°F (AVG. FOR TIME PERIOD)
PRESSURE ≈ 150 PSI

CORRELATION - CIRC. TUBE - VERT. INSIDE SURF. - TURB.

REF. 5, PG. 9

$$\bar{h} = K_{104}\left(\frac{\dot{m}^{0.8}}{D^{1.8}}\right) = (0.0254)\left(\frac{68.95(10^6)^{0.8}}{9.921875^{1.8}}\right)$$

$\bar{h}$ = 762 BTU/HR-FT^2-°F

BABCOCK & WILCOX | REVISION
DEPARTMENT NT.V - COMP. ENGRG. DATE 6/78 BY LEW
FILM COEFFICIENTS CHECKED DATE BY
JOB NO. 620-0011-55 SHEET 23 OF

TAKING THE CLADDING INTO ACCOUNT -

$$\bar{h}_{193} = \frac{1}{\frac{1}{h} + \frac{t}{K_{CLAD}}} = \frac{1}{\frac{1}{762} + \frac{0.1875}{123.3}}$$

$$= 352 \text{ BTU/HR-FT}^2\text{-°F}$$

HOWEVER, USE $\bar{h}$ = 317 BTU/HR-FT² -°F (SAME AS FOR PERIODS 1, 2 + 3)

FLUID 192 - INSIDE OF SOLID TUBESHEET RIM

TIME PERIOD #1, #2 #3, + #4 - 0.0 TO 410.0 MIN. (100% S.S.)

PARAMETERS:

FLOW = 68.95 (10^6) #/HR
FLUID = WATER
TEMP. = 568 °F
PRESSURE = 2150 PSIG

FROM REF. 2, 'TUBESHEET ANALYSIS', PAGE 3-3-8,

$$\bar{h}_{192} = 992 \text{ BTU/HR-FT}^2\text{-°F}$$

BABCOCK & WILCOX
DEPARTMENT Mt. V - COMP. ENGRG. DATE 6/78 BY LEW
FILM COEFFICIENTS
CHECKED DATE BY
JOB NO. 620-0011-55
REVISION
SHEET 24 OF

SUMMARY OF FILM COEFFICIENTS

TIME PERIOD	BLOCK 191	BLOCK 192	BLOCK 193
1	285	992	317
2A	455	992	317
2B	538	992	317
2C	560	992	317
3	245	992	317
4A	652	992	317
4B	182	992	317
4C	137	992	317

TEMPERATURE DISTRIBUTION PROGRAM 91167

The Fluid Transients, Film Coefficients, Model Geometry, and Material Codes were input into Program 91167 which determines temperature versus transient time.

The following pages contain sample output from 91167 to show its format and application.

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

SMUD--RAPID COOLDOWN TRANS.--OTSG LWR TUBESHEET ANALYSIS BY LEW

GENERAL INPUT DATA

NO SOLID BLOCKS	NO FLUID BLOCKS	NO OF EDGES	NO OF LINES	NO OF CYCLES
190	3	38	9	8

BASE TEMP	STARTING TEMP	STARTING TIME	STARTING ITER	PUNCH CARD TIME
530.0	530.0	0.00000	0	0.00000

TIME IS IN HOURS

GEOMETRY OF THE COLUMNS

ROW NO	BLOCK NO. LOW	HI	ADJ	RADIAL DIMS	MEAN RADIUS	LOW EDGE NO	ROW NO	BLOCK NO. LOW	HI	ADJ	RADIAL DIMS	MEAN RADIUS	LOW EDGE NO
1	1	12	6	1.74750	58.65750	15	2	13	38	32	2.00000	60.53130	1
3	39	64	58	2.00000	62.53130	1	4	65	90	84	2.00000	64.53130	1
5	91	116	110	2.00000	66.53130	1	6	117	127	121	1.40630	68.23440	16
7	128	150	132	2.00000	69.93750	16	8	151	171	153	2.00000	71.93750	18
9	172	190	172	2.62500	74.25000	20							

LEW
55-1100-02
6/78
27

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

DETERMINATION OF BLOCKS WITH FLUID BOUNDARIES

SERIES NO	FLUID	BLOCK NO. FIRST	LAST	SIDE NO	SERIES NO	FLUID	BLOCK NO. FIRST	LAST	SIDE NO	SERIES NO	FLUID	BLOCK NO. FIRST	LAST	SIDE NO
1	193	1	1	4	2	192	1	12	1	3	193	13	26	1
4	191	12	12	2	5	191	38	38	2	6	191	64	64	2
7	191	90	90	2	8	191	116	116	2	9	191	127	127	2
10	191	130	150	1										

AXIAL DIMENSION PER EDGE

EDGE	DIMENSION	EDGE	DIMENSION	EDGE	DIMENSION	EDGE	DIMENSION	EDGE	DIMENSION	EDGE	DIMENSION
1	2.00000	2	2.00000	3	2.00000	4	2.00000	5	2.00000	6	2.00000
7	2.00000	8	2.00000	9	2.00000	10	2.00000	11	1.00000	12	1.00000
13	1.00000	14	1.00000	15	2.00000	16	2.00000	17	2.00000	18	2.00000
19	2.00000	20	2.00000	21	2.00000	22	2.00000	23	2.00000	24	2.00000
25	2.00000	26	2.00000	27	1.00000	28	1.00000	29	1.00000	30	1.00000
31	2.00000	32	2.00000	33	2.00000	34	2.00000	35	2.00000	36	2.00000
37	2.00000	38	2.00000								

LEW
620-0011-55
6/78
28

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

MATERIAL SERIES

MATL NO	LAST BLOCK	MATL NO	LAST BLOCK	MATL NO	LAST BLOCK	MATL NO	LAST BLOCK	MATL NO	LAST BLOCK	MATL NO	LAST BLOCK	MATL NO	LAST BLOCK
12	12	2	24	12	38	2	50	12	64	2	76	12	90
2	102	12	140	1	150	12	161	1	171	12	180	1	190

FLUID BLOCK	FILM COEF.							
191	285.00	455.00	538.00	560.00	245.00	652.00	182.00	137.00
192	992.00	992.00	992.00	992.00	992.00	992.00	992.00	992.00
193	317.00	317.00	317.00	317.00	317.00	317.00	317.00	317.00

LEW
620-0011-55
6/78
29

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

CYCLE NO. 1 IS IMPLICIT
CYCLE NO. 2 IS IMPLICIT
CYCLE NO. 3 IS IMPLICIT
CYCLE NO. 4 IS IMPLICIT
CYCLE NO. 5 IS IMPLICIT
CYCLE NO. 6 IS IMPLICIT
CYCLE NO. 7 IS IMPLICIT
CYCLE NO. 8 IS IMPLICIT

IMPLICIT CYCLE INFORMATION

LAST STEP NO.	TIME STEP	LAST STEP NO.	TIME STEP	LAST STEP NO.	TIME STEP	LAST STEP NO.	TIME STEP	LAST STEP NO.	TIME STEP	LAST STEP NO.	TIME STEP	LAST STEP NO.	TIME STEP	LAST STEP NO.	TIME STEP
10	.010	14	.100	23	.500	25	.035	28	.013						
5	.010														
3	.011														
3	.011														
3	.020	5	.012												
2	.010	3	.009												
5	.020	9	.050	15	.009										
10	.100	15	.020	18	.022										

30 6/78 620-0011-5 LEW

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

TIMES AT WHICH EQUATIONS WILL VARY

5.08330 5.13330 5.16660 5.19990 5.28330 5.31250 5.66650
6.83310 .

TIMES FOR PRINTOUT

TIME LIMIT	TIME MULTIPLE
.01000	.01000
2.50000	2.49000
5.00000	2.50000
5.08330	.08330
5.13330	.01000
5.16660	.01110
5.19990	.01110
5.25990	.02000
5.28330	.01170
5.30330	.01000
5.31250	.00920
5.41250	.02000
5.61250	.10000
5.66650	.01800
5.76650	.10000
6.65650	.20000
6.76650	.02000
6.83310	.06660

LEW
620-0011-55
6/78

31

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

POINT NO. 191 TYPE 1

TIME	0.00000	5.08330	5.10000	5.13330	5.16660	5.18670	5.20000	5.28330	5.29580
TEMP	531.00000	531.00000	540.00000	483.00000	400.00000	320.00000	212.00000	212.00000	380.00000
TIME	5.31250	5.41670	5.66670	5.93330	6.20000	6.46670	6.83330	999.99000	0.00000
TEMP	540.00000	480.00000	380.00000	312.00000	280.00000	283.00000	304.00000	304.00000	0.00000

POINT NO. 192 TYPE 1

TIME	0.00000	5.08330	5.16660	5.25[illegible]	5.31250	5.41670	5.66670	5.93330	6.20000
TEMP	568.00000	568.00000	592.00000	592.00000	540.00000	480.00000	380.00000	312.00000	280.00000
TIME	6.45670	6.83330	999.99000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TEMP	283.00000	304.00000	304.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

LEW
620-0011-55
6/78
32

TRANSIENT TEMPERATURE DISTRIBUTION   PROGRAM   91167

POINT NO. 193   TYPE 1

TIME	0.00000	5.08330	5.16660	5.25000	5.31250	5.41670	5.66670	5.93330	6.20000
TEMP	568.00000	568.00000	592.00000	592.00000	540.00000	480.00000	380.00000	312.00000	280.00000
TIME	6.45670	6.83330	999.99000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TEMP	283.00000	304.00000	304.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

LEW
620-0011-55
6/78
33

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

	PT	K	A	TA	B	TB	C	TC	D	TD	E	TE
0	1	1.0	.169	192	.084	2	.105	27	.093	193	.550	1
0	2	1.0	.169	192	.084	3	.105	28	.084	1	.559	2
0	3	1.0	.169	192	.084	4	.105	29	.084	2	.559	3
0	4	1.0	.169	192	.084	5	.105	30	.084	3	.559	4
0	5	1.0	.169	192	.084	6	.105	31	.084	4	.559	5
0	6	1.0	.169	192	.084	7	.105	32	.084	5	.559	6
0	7	1.0	.169	192	.084	8	.105	33	.084	6	.559	7
0	8	1.0	.169	192	.084	9	.105	34	.084	7	.559	8
0	9	1.0	.169	192	.084	10	.105	35	.084	8	.559	9
0	10	1.0	.169	192	.084	11	.105	36	.084	9	.559	10
0	11	1.0	.169	192	.084	12	.105	37	.084	10	.559	11
0	12	1.0	.169	192	.089	191	.105	38	.084	11	.555	12
0	13	1.0	.097	193	.094	14	.095	39	0.000	194	.713	13
0	14	1.0	.097	193	.094	15	.096	40	.094	13	.619	14
0	15	1.0	.097	193	.094	16	.096	41	.094	14	.619	15
0	16	1.0	.097	193	.094	17	.096	42	.094	15	.619	16
0	17	1.0	.097	193	.094	18	.096	43	.094	16	.619	17
0	18	1.0	.097	193	.094	19	.096	44	.094	17	.619	18
0	19	1.0	.097	193	.094	20	.096	45	.094	18	.619	19
0	20	1.0	.097	193	.094	21	.096	46	.094	19	.619	20
0	21	1.0	.097	193	.094	22	.096	47	.094	20	.619	21
0	22	1.0	.097	193	.125	23	.096	48	.094	21	.588	22
0	23	1.0	.097	193	.376	24	.096	49	.251	22	.181	23
0	24	1.0	.097	193	.356	25	.096	50	.376	23	.075	24
0	25	1.0	.091	193	.338	26	.086	51	.356	24	.129	25
0	26	1.0	.091	193	.225	27	.085	52	.338	25	.260	26
0	27	1.0	.089	1	.084	28	.085	53	.113	26	.629	27
0	28	1.0	.089	2	.084	29	.086	54	.084	27	.657	28
0	29	1.0	.089	3	.084	30	.086	55	.084	28	.657	29
0	30	1.0	.089	4	.084	31	.085	56	.084	29	.657	30
0	31	1.0	.089	5	.084	32	.085	57	.084	30	.657	31
0	32	1.0	.089	6	.084	33	.085	58	.084	31	.657	32
0	33	1.0	.089	7	.084	34	.086	59	.084	32	.657	33
0	34	1.0	.089	8	.084	35	.086	60	.084	33	.657	34
0	35	1.0	.089	9	.084	36	.086	61	.084	34	.657	35
0	36	1.0	.089	10	.084	37	.086	62	.084	35	.657	36
0	37	1.0	.089	11	.084	39	.086	63	.084	36	.657	37
0	38	1.0	.089	12	.089	191	.086	64	.084	37	.653	38
0	39	1.0	.093	13	.094	40	.096	65	0.000	194	.718	39
0	40	1.0	.093	14	.094	41	.096	66	.094	39	.624	40

LEW
620-0011-55
6/78

34

TRANSIENT TEMPERATURE DISTRIBUTION   PROGRAM 91167

	PT	Y	A	TA	B	TB	C	TC	D	TD	E	TE
0	41	1.0	.093	15	.094	42	.096	67	.094	40	.624	41
0	42	1.0	.093	16	.094	43	.096	68	.094	41	.624	42
0	43	1.0	.093	17	.094	44	.096	69	.094	42	.624	43
0	44	1.0	.093	18	.094	45	.096	70	.094	43	.624	44
0	45	1.0	.093	19	.094	46	.096	71	.094	44	.624	45
0	45	1.0	.093	20	.094	47	.096	72	.094	45	.624	46
0	47	1.0	.093	21	.094	48	.096	73	.094	46	.624	47
0	49	1.0	.093	22	.125	49	.096	74	.094	47	.592	48
0	49	1.0	.093	23	.376	50	.096	75	.251	48	.185	49
0	50	1.0	.093	24	.356	51	.096	76	.376	49	.080	50
0	51	1.0	.083	25	.338	52	.086	77	.356	50	.138	51
0	52	1.0	.083	26	.225	53	.086	78	.338	51	.268	52
0	53	1.0	.083	27	.084	54	.086	79	.113	52	.634	53
0	54	1.0	.083	28	.084	55	.086	80	.094	53	.662	54
0	55	1.0	.083	29	.084	55	.086	81	.084	54	.662	55
0	55	1.0	.083	30	.084	57	.086	82	.084	55	.662	56
0	57	1.0	.083	31	.084	58	.086	83	.084	56	.662	57
0	58	1.0	.083	32	.084	59	.085	84	.084	57	.662	58
0	59	1.0	.083	33	.084	60	.085	85	.084	58	.662	59
0	60	1.0	.083	34	.084	61	.086	86	.094	59	.662	60
0	61	1.0	.083	35	.084	62	.086	87	.084	60	.662	61
0	62	1.0	.083	36	.084	63	.085	88	.084	61	.662	62
0	63	1.0	.083	37	.084	64	.085	89	.084	62	.662	63
0	64	1.0	.083	38	.089	191	.085	90	.084	63	.658	64
0	65	1.0	.093	39	.094	66	.095	91	0.000	194	.718	65
0	66	1.0	.093	40	.094	67	.095	92	.094	65	.624	66
0	67	1.0	.093	41	.094	68	.095	93	.094	66	.624	67
0	68	1.0	.093	42	.094	69	.095	94	.094	67	.624	68
0	69	1.0	.093	43	.094	70	.095	95	.094	68	.624	69
0	70	1.0	.093	44	.094	71	.095	96	.094	69	.624	70
0	71	1.0	.093	45	.094	72	.095	97	.094	70	.624	71
0	72	1.0	.093	46	.094	73	.095	98	.094	71	.624	72
0	73	1.0	.093	47	.094	74	.095	99	.094	72	.624	73
0	74	1.0	.093	48	.125	75	.095	100	.094	73	.592	74
0	75	1.0	.093	49	.376	76	.095	101	.251	74	.185	75
0	76	1.0	.093	50	.356	77	.095	102	.376	75	.080	76
0	77	1.0	.083	51	.338	78	.086	103	.356	76	.138	77
0	78	1.0	.083	52	.225	79	.086	104	.338	77	.268	78
0	79	1.0	.083	53	.084	80	.086	105	.113	78	.634	79
0	80	1.0	.083	54	.084	81	.086	106	.084	79	.662	80
0	81	1.0	.083	55	.084	82	.086	107	.084	80	.662	81

LEW
620-0011-55
6/78
35

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

	PT	K	A	TA	B	TB	C	TC	D	TD	E	TE
0	82	1.0	.083	56	.084	83	.086	108	.084	81	.662	82
0	83	1.0	.083	57	.084	84	.086	109	.084	82	.662	83
0	84	1.0	.083	58	.084	85	.086	110	.084	83	.662	84
0	85	1.0	.083	59	.084	86	.086	111	.084	84	.662	85
0	86	1.0	.083	60	.084	87	.086	112	.084	85	.662	86
0	87	1.0	.083	61	.084	88	.086	113	.084	86	.662	87
0	88	1.0	.083	62	.084	89	.086	114	.084	87	.662	88
0	89	1.0	.083	63	.084	90	.086	115	.084	88	.662	89
0	90	1.0	.083	64	.089	191	.086	116	.084	89	.658	90
0	91	1.0	.093	65	.094	92	0.000	194	0.000	194	.813	91
0	92	1.0	.093	66	.094	93	0.000	194	.094	91	.719	92
0	93	1.0	.093	67	.094	94	0.000	194	.094	92	.719	93
0	94	1.0	.093	68	.094	95	0.000	194	.094	93	.719	94
0	95	1.0	.093	69	.094	96	0.000	194	.094	94	.719	95
0	96	1.0	.093	70	.094	97	0.000	194	.094	95	.719	96
0	97	1.0	.093	71	.094	98	0.000	194	.094	96	.719	97
0	98	1.0	.093	72	.094	99	0.000	194	.094	97	.719	98
0	99	1.0	.093	73	.094	100	0.000	194	.094	98	.719	99
0	100	1.0	.093	74	.125	101	0.000	194	.094	99	.688	100
0	101	1.0	.093	75	.376	102	0.000	194	.251	100	.280	101
0	102	1.0	.093	76	.356	103	0.000	194	.375	101	.175	102
0	103	1.0	.063	77	.338	104	0.000	194	.356	102	.223	103
0	104	1.0	.083	78	.225	105	0.000	194	.338	103	.354	104
0	105	1.0	.083	79	.084	106	0.000	194	.113	104	.720	105
0	106	1.0	.083	80	[illegible]	107	.101	117	.084	105	.647	106
0	107	1.0	.083	81	.084	108	.101	118	.084	106	.647	107
0	108	1.0	.083	82	.084	109	.101	119	.084	107	.647	108
0	109	1.0	.083	83	.084	110	.101	120	.084	108	.647	109
0	110	1.0	.083	84	.084	111	.101	121	.084	109	.647	110
0	111	1.0	.083	85	.084	112	.101	122	.084	110	.647	111
0	112	1.0	.083	86	.084	113	.101	123	.084	111	.647	112
0	113	1.0	.083	87	.084	114	.101	124	.084	112	.647	113
0	114	1.0	.083	88	.084	115	.101	125	.084	113	.647	114
0	115	1.0	.083	89	.084	116	.101	126	.084	114	.647	115
0	116	1.0	.083	90	.089	191	.101	127	.084	115	.643	116
0	117	1.0	.140	106	.084	118	.142	128	0.000	194	.634	117
0	118	1.0	.140	107	.084	119	.142	129	.084	117	.549	118
0	119	1.0	.140	108	.084	120	.142	130	.084	118	.549	119
0	120	1.0	.140	109	.084	121	.142	131	.084	119	.549	120
0	121	1.0	.140	110	.084	122	.142	132	.084	120	.549	121
0	122	1.0	.140	111	.084	123	.142	133	.084	121	.549	122

LEW
620-0011-55
6/78
36

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

	PT	K	A	TA	B	TB	C	TC	D	TD	E	TE
0	123	1.0	.140	112	.084	124	.142	134	.084	122	.549	123
0	124	1.0	.140	113	.084	125	.142	135	.084	123	.549	124
0	125	1.0	.140	114	.084	126	.142	136	.084	124	.549	125
0	126	1.0	.140	115	.084	127	.142	137	.084	125	.549	126
0	127	1.0	.140	116	.089	191	.142	138	.084	126	.545	127
0	128	1.0	.099	117	.084	129	0.000	194	0.000	194	.818	128
0	129	1.0	.099	118	.084	130	0.000	194	.084	128	.733	129
0	130	1.0	.099	119	.084	131	.086	151	.084	129	.648	130
0	131	1.0	.099	120	.084	132	.086	152	.084	130	.648	131
0	132	1.0	.099	121	.084	133	.086	153	.084	131	.648	132
0	133	1.0	.099	122	.084	134	.086	154	.084	132	.648	133
0	134	1.0	.099	123	.084	135	.086	155	.084	133	.648	134
0	135	1.0	.099	124	.084	136	.085	156	.084	134	.648	135
0	136	1.0	.099	125	.084	137	.086	157	.084	135	.648	136
0	137	1.0	.099	126	.084	138	.086	158	.084	136	.648	137
0	138	1.0	.099	127	.113	139	.086	159	.084	137	.620	138
0	139	1.0	.087	191	.338	140	.086	160	.225	138	.264	139
0	140	1.0	.087	191	.375	141	.086	161	.338	139	.115	140
0	141	1.0	.097	191	.421	142	.107	162	.375	140	-.000	141
0	142	1.0	.097	191	.281	143	.107	163	.421	141	.094	142
0	143	1.0	.097	191	.105	144	.107	164	.140	142	.550	143
0	144	1.0	.097	191	.105	145	.107	165	.105	143	.585	144
0	145	1.0	.097	191	.105	146	.107	166	.105	144	.585	145
0	146	1.0	.097	191	.105	147	.107	167	.105	145	.585	146
0	147	1.0	.097	191	.105	148	.107	168	.105	146	.585	147
0	148	1.0	.097	191	.105	149	.107	169	.105	147	.585	148
0	149	1.0	.097	191	.105	150	.107	170	.105	148	.585	149
0	150	1.0	.097	191	0.000	194	.107	171	.105	149	.691	150
0	151	1.0	.083	130	.084	152	0.000	194	0.000	194	.832	151
0	152	1.0	.083	131	.084	153	0.000	194	.084	151	.748	152
0	153	1.0	.083	132	.084	154	.074	172	.084	152	.674	153
0	154	1.0	.083	133	.084	155	.074	173	.084	153	.674	154
0	155	1.0	.083	134	.084	156	.074	174	.084	154	.674	155
0	156	1.0	.083	135	.084	157	.074	175	.084	155	.674	156
0	157	1.0	.083	136	.084	158	.074	176	.084	156	.674	157
0	158	1.0	.083	137	.084	159	.074	177	.084	157	.674	158
0	159	1.0	.083	138	.113	160	.074	178	.084	158	.645	159
0	160	1.0	.083	139	.338	161	.074	179	.225	159	.280	160
0	161	1.0	.083	140	.375	162	.074	180	.338	160	.130	161
0	162	1.0	.104	141	.421	163	.092	181	.375	161	.009	162
0	163	1.0	.104	142	.261	164	.092	182	.421	162	.102	163

LEW
620-0011-55
6/78
37

SMUD--RAPID COOLDOWN TRANS.--OTSG LWR TUBESHEET ANALYSIS BY LEW **** 91167 REV 4 12-15-74 04/21/78 13.53.45 PAGE 15
**** FULL CERTIFICATION **** **** FULL CERTIFICATION **** **** FULL CERTIFICATION **** L91CCYX

TRANSIENT TEMPERATURE DISTRIBUTION PROGRAM 91167

	PT	K	A	TA	B	TB	C	TC	D	TD	E	TE
0	164	1.0	.104	143	.105	165	.092	183	.140	163	.558	164
0	165	1.0	.104	144	.105	166	.092	184	.105	164	.593	165
0	166	1.0	.104	145	.105	167	.092	185	.105	165	.593	166
0	167	1.0	.104	146	.105	158	.092	186	.105	166	.593	167
0	168	1.0	.104	147	.105	169	.092	187	.105	167	.593	168
0	169	1.0	.104	148	.105	170	.092	188	.105	168	.593	169
0	170	1.0	.104	149	.105	171	.092	189	.105	169	.593	170
0	171	1.0	.104	150	0.000	194	.092	190	.105	170	.699	171
0	172	1.0	.055	153	.084	173	0.000	194	0.000	194	.861	172
0	173	1.0	.055	154	.084	174	0.000	194	.084	172	.777	173
0	174	1.0	.055	155	.084	175	0.000	194	.084	173	.777	174
0	175	1.0	.055	156	.084	176	0.000	194	.084	174	.777	175
0	176	1.0	.055	157	.084	177	0.000	194	.084	175	.777	176
0	177	1.0	.055	158	.084	178	0.000	194	.084	176	.777	177
0	178	1.0	.055	159	.113	179	0.000	194	.084	177	.748	178
0	179	1.0	.055	160	.338	180	0.000	194	.225	178	.383	179
0	180	1.0	.055	161	.375	181	0.000	194	.338	179	.233	180
0	181	1.0	.069	162	.421	182	0.000	194	.375	180	.136	181
0	182	1.0	.069	163	.281	183	0.000	194	.421	181	.230	182
0	183	1.0	.069	164	.105	184	0.000	194	.140	182	.686	183
0	184	1.0	.069	165	.105	185	0.000	194	.105	183	.721	184
0	185	1.0	.069	166	.105	186	0.000	194	.105	184	.721	185
0	186	1.0	.069	167	.105	187	0.000	194	.105	185	.721	186
0	187	1.0	.069	168	.105	188	0.000	194	.105	186	.721	187
0	188	1.0	.069	169	.105	189	0.000	194	.105	187	.721	188
0	189	1.0	.069	170	.105	190	0.000	194	.105	188	.721	189
0	190	1.0	.069	171	0.000	194	0.000	194	.105	189	.827	190

DELTA THETA = .683E-02HRS/ITER BLOCK 141

LEW
620-0011-55
6/78
38

CRITICAL TIMES FOR ANALYSIS

Based on the temperature distributions output by Program 91167, the critical times for analysis were chosen.

The choice of times is a judgement based on experience. The factor considered are: 1) maximum radial gradients in the model, 2) maximum axial gradients, and 3) maximum tube-to-shell temperature difference (results in highest tube loads).

The following pages show 91167 temperature distribution which will be analyzed (those in brackets).

In reference to time scale on transient sketch (Page 9), the critical times are:

305.0 minutes (Iteration 26)
312.0 minutes (Iteration 39)
317.0 minutes (Iteration 45)
318.75 minutes (Iteration 49)
372.0 minutes (Iteration 72)

TEMPERATURE DISTRIBUTION

ITER	PT					TEMPERATURE						TIME
23	1	567	567	567	567	566	566	566	565	565	563	5.00000
23	11	561	554	568	568	569	568	568	568	568	568	5.00000
23	21	569	567	567	567	567	567	566	566	565	565	5.00000
23	31	564	563	562	561	559	557	552	544	568	568	5.00000
23	41	568	568	568	568	569	568	567	567	567	567	5.00000
23	51	566	566	565	565	564	563	562	561	559	557	5.00000
23	61	555	552	547	540	568	568	568	568	558	558	5.00000
23	71	569	567	567	567	566	565	566	565	565	563	5.00000
23	81	552	561	560	558	557	554	552	548	544	538	5.00000
23	91	568	568	568	568	568	568	567	567	557	567	5.00000
23	101	566	566	565	565	564	562	561	559	558	556	5.00000
23	111	554	552	549	546	542	537	561	560	558	557	5.00000
23	121	555	553	551	548	545	541	536	560	559	557	5.00000
23	131	555	554	552	549	547	544	541	537	535	534	5.00000
23	141	533	533	532	532	531	531	531	531	531	531	5.00000
23	151	556	555	552	550	548	546	544	541	538	536	5.00000
23	161	535	534	534	533	532	532	532	531	531	531	5.00000
23	171	531	551	549	548	546	543	541	538	537	536	5.00000
23	181	535	534	533	533	532	532	532	531	531	531	5.00000
23	191	531	568	568								
26	1	567	567	567	567	566	566	566	565	565	563	5.08330
26	11	561	554	568	568	568	568	568	568	568	568	5.08330
26	21	568	568	567	567	567	567	566	566	565	565	5.08330
26	31	564	563	562	561	559	557	552	544	568	558	5.08330
26	41	569	568	568	558	569	568	567	567	567	557	5.08330
26	51	565	566	565	565	564	563	562	561	559	557	5.08330
26	61	555	552	547	540	569	568	568	564	568	568	5.08330
26	71	568	567	567	567	566	566	566	565	565	553	5.08330
26	81	562	561	560	558	557	554	552	548	544	538	5.08330
26	91	568	568	569	568	568	568	567	567	557	567	5.08330
26	101	566	566	565	555	564	562	561	559	558	556	5.08330
26	111	554	552	549	546	542	537	561	560	558	557	5.08330
26	121	555	553	551	548	545	541	537	560	559	557	5.08330
26	131	556	554	552	549	547	544	541	537	535	534	5.08330
26	141	533	533	532	532	531	531	531	531	531	531	5.08330
26	151	556	555	552	551	549	546	544	541	538	536	5.08330
26	161	535	534	534	533	532	532	532	531	531	531	5.08330
26	171	531	551	549	548	545	543	541	538	537	536	5.08330
26	181	535	534	533	533	532	532	532	531	531	531	5.08330
26	191	531	568	568								

LEW
620-0011-55
6/78
40

TEMPERATURE DISTRIBUTION

ITER	PT					TEMPERATURE						TIME
38	1	585	583	582	582	581	581	581	580	579	575	5.19780
38	11	561	490	579	579	579	579	579	579	579	579	5.19780
38	21	573	579	578	578	577	577	574	572	571	570	5.19780
38	31	569	569	568	566	564	557	535	450	572	572	5.19780
38	41	572	572	572	572	572	571	571	571	571	570	5.19780
38	51	570	569	568	566	565	564	563	562	561	559	5.19780
38	61	555	548	525	440	569	569	569	569	569	569	5.19780
38	71	569	568	568	568	567	567	567	565	565	564	5.19780
38	81	563	561	560	559	557	555	551	544	520	437	5.19780
38	91	568	568	568	558	568	568	568	568	567	567	5.19780
38	101	566	566	566	565	564	562	561	560	558	556	5.19780
38	111	554	552	549	541	520	439	561	560	558	557	5.19780
38	121	555	553	551	547	541	523	452	560	559	557	5.19780
38	131	556	554	552	549	547	542	533	506	459	446	5.19780
38	141	438	435	434	433	433	433	433	432	432	432	5.19780
38	151	556	555	552	551	549	546	543	538	530	519	5.19780
38	161	514	510	508	506	505	505	505	505	505	504	5.19780
38	171	504	551	550	548	546	543	540	537	534	532	5.19780
38	181	530	529	528	527	527	526	526	526	526	526	5.19780
38	191	230	592	592								
39	1	585	583	582	582	582	581	581	580	579	575	5.20000
39	11	560	486	579	579	579	579	579	579	579	579	5.20000
39	21	579	579	579	578	578	577	574	572	571	570	5.20000
39	31	570	569	568	567	564	557	534	445	572	572	5.20000
39	41	572	572	572	572	572	572	571	571	571	570	5.20000
39	51	570	569	568	566	565	564	563	562	561	559	5.20000
39	61	556	548	523	434	569	569	569	569	569	569	5.20000
39	71	569	569	568	568	567	567	567	565	565	564	5.20000
39	81	563	561	560	559	557	555	551	543	519	432	5.20000
39	91	568	568	568	568	568	568	568	568	567	567	5.20000
39	101	566	566	566	565	564	562	561	560	558	556	5.20000
39	111	554	552	549	541	518	433	561	560	558	557	5.20000
39	121	555	553	551	547	541	522	447	560	559	557	5.20000
39	131	556	554	552	549	547	542	532	504	454	440	5.20000
39	141	432	429	427	427	426	426	426	426	426	426	5.20000
39	151	556	555	552	551	549	545	543	538	529	518	5.20000
39	161	513	508	506	505	504	503	503	503	503	503	5.20000
39	171	503	551	550	548	546	543	540	537	534	532	5.20000
39	181	530	529	527	527	526	526	526	525	525	525	5.20000
39	191	212	592	592								

41
6/78
620-0011-55
LEW

TEMPERATURE DISTRIBUTION

ITER	PT	TEMPERATURE										TIME
44	1	581	582	581	581	580	580	579	578	575	566	5.27340
44	11	540	463	580	580	580	580	580	580	580	580	5.27340
44	21	580	580	579	579	579	578	577	576	575	574	5.27340
44	31	573	572	571	569	562	544	497	395	575	575	5.27340
44	41	575	575	575	575	575	575	575	574	574	573	5.27340
44	51	573	572	571	569	568	567	566	565	563	559	5.27340
44	61	551	530	477	373	571	571	571	571	571	571	5.27340
44	71	571	571	570	570	569	569	569	568	567	565	5.27340
44	81	564	563	561	560	558	554	545	523	470	357	5.27340
44	91	570	570	569	569	569	569	569	569	569	568	5.27340
44	101	568	567	567	566	565	563	561	560	558	557	5.27340
44	111	554	551	543	522	473	374	561	560	558	557	5.27340
44	121	553	553	549	542	526	485	397	560	559	557	5.27340
44	131	555	554	552	549	543	532	505	454	400	380	5.27340
44	141	370	365	360	358	357	357	357	357	356	356	5.27340
44	151	556	555	552	551	548	544	538	524	501	480	5.27340
44	161	469	458	453	448	446	445	444	444	444	444	5.27340
44	171	444	551	550	548	545	541	535	526	517	512	5.27340
44	181	506	503	500	497	496	496	496	496	496	495	5.27340
44	191	212	573	573								

45	1	577	578	578	577	577	577	576	575	572	562	5.28330
45	11	535	459	578	578	579	578	578	578	578	578	5.28330
45	21	578	578	577	577	577	576	577	576	575	574	5.28330
45	31	573	572	571	568	561	541	493	392	575	575	5.28330
45	41	575	575	575	575	575	575	575	574	574	573	5.28330
45	51	573	572	571	570	568	567	566	565	563	559	5.28330
45	61	550	527	472	368	572	572	571	571	571	571	5.28330
45	71	571	571	571	570	570	569	569	568	567	565	5.28330
45	81	564	563	561	550	558	553	544	520	466	353	5.28330
45	91	570	570	570	570	570	569	569	569	569	568	5.28330
45	101	568	567	567	566	565	563	561	560	559	557	5.28330
45	111	554	550	541	519	468	369	561	560	559	557	5.28330
45	121	555	553	549	541	523	481	393	560	559	557	5.28330
45	131	555	554	552	548	542	530	502	449	395	375	5.28330
45	141	365	360	355	353	352	352	351	351	351	351	5.28330
45	151	555	555	552	550	548	544	536	522	497	475	5.28330
45	161	463	453	447	442	439	438	438	434	437	437	5.28330
45	171	437	551	550	548	545	541	534	523	514	508	5.28330
45	181	502	499	495	492	491	491	491	490	490	490	5.28330
45	191	212	564	564								

LEW
620-0011-5
6/78
42

TEMPERATURE DISTRIBUTION

ITER	PT	TEMPERATURE										TIME
48	1	565	568	568	568	568	568	567	565	561	551	5.30500
48	11	525	474	572	572	572	572	572	572	572	572	5.30500
48	21	572	571	571	571	571	571	574	574	573	572	5.30500
48	31	571	571	569	566	557	535	487	419	574	574	5.30500
48	41	574	574	574	574	574	574	574	573	573	573	5.30500
48	51	572	572	571	570	569	568	566	565	563	558	5.30500
48	61	547	521	466	398	572	572	572	572	572	572	5.30500
48	71	572	571	571	571	570	570	569	568	567	566	5.30500
48	81	564	563	562	560	558	553	541	514	459	393	5.30500
48	91	570	570	570	570	570	570	570	570	569	569	5.30500
48	101	568	568	567	567	565	563	562	560	559	557	5.30500
48	111	554	549	533	513	462	398	561	560	559	557	5.30500
48	121	555	553	548	539	518	475	417	560	559	557	5.30500
48	131	556	554	551	548	541	525	495	445	411	396	5.30500
48	141	389	384	380	378	377	376	376	376	376	376	5.30500
48	151	556	555	552	550	547	543	534	517	490	467	5.30500
48	161	454	445	439	433	430	428	428	427	427	427	5.30500
48	171	427	551	549	547	544	539	530	518	507	500	5.30500
48	181	493	489	484	481	480	479	479	479	478	478	5.30500
48	191	468	546	546								
49	1	561	565	565	565	564	564	563	562	557	547	5.31250
49	11	523	489	569	569	569	569	569	569	569	569	5.31250
49	21	569	569	569	569	569	569	572	573	572	571	5.31250
49	31	571	570	568	564	555	533	488	441	574	574	5.31250
49	41	574	574	574	574	574	573	573	573	572	572	5.31250
49	51	572	571	571	570	569	568	566	565	563	558	5.31250
49	61	546	519	467	421	572	572	572	572	572	572	5.31250
49	71	572	571	571	571	570	570	569	569	568	566	5.31250
49	81	565	563	562	560	557	552	540	512	460	416	5.31250
49	91	570	570	570	570	570	570	570	570	569	569	5.31250
49	101	568	568	567	567	566	563	562	560	559	557	5.31250
49	111	554	549	537	512	463	421	561	560	559	557	5.31250
49	121	555	552	548	538	517	476	435	560	559	557	5.31250
49	131	556	554	551	547	540	524	493	448	429	417	5.31250
49	141	412	408	404	402	401	401	401	400	400	400	5.31250
49	151	556	555	552	550	547	542	533	515	488	457	5.31250
49	161	454	445	440	434	430	429	428	428	428	428	5.31250
49	171	429	551	549	547	544	538	529	516	505	497	5.31250
49	181	490	486	481	477	476	475	475	475	475	475	5.31250
49	191	540	540	540								

620-0011-5
6/78
43
LEW

TEMPERATURE DISTRIBUTION

ITER	PT	TEMPERATURE										TIME
72	1	307	315	318	319	319	318	317	315	312	308	6.20000
72	11	303	295	334	334	334	335	335	335	335	335	6.20000
72	21	336	338	339	341	343	348	358	367	371	373	6.20000
72	31	373	372	369	364	357	347	333	315	379	379	6.20000
72	41	379	379	379	380	380	381	382	385	388	390	6.20000
72	51	394	398	405	413	418	421	420	418	413	406	6.20000
72	61	395	380	359	331	410	410	410	410	410	411	6.20000
72	71	411	412	414	417	421	424	428	432	439	449	6.20000
72	81	455	457	457	454	448	439	425	406	380	345	6.20000
72	91	425	425	425	426	426	426	427	428	430	434	6.20000
72	101	438	441	445	450	457	475	482	484	484	480	6.20000
72	111	473	463	449	428	399	359	495	498	500	499	6.20000
72	121	495	489	479	464	444	415	376	506	508	511	6.20000
72	131	510	507	500	490	476	457	433	401	376	365	6.20000
72	141	358	353	348	344	341	339	338	337	337	336	6.20000
72	151	519	517	514	508	499	486	470	449	425	407	6.20000
72	161	397	389	383	376	370	366	363	362	361	360	6.20000
72	171	360	518	513	505	493	478	460	440	425	416	6.20000
72	181	409	402	394	387	383	380	377	376	375	375	6.20000
72	191	280	280	280								
74	1	301	307	309	316	310	310	308	307	304	300	6.40000
74	11	296	291	318	318	318	318	318	319	319	320	6.40000
74	21	320	322	324	325	328	331	339	347	351	353	6.40000
74	31	354	352	349	345	338	329	318	304	350	350	6.40000
74	41	350	351	351	351	352	353	355	358	361	364	6.40000
74	51	367	371	378	387	392	395	395	393	389	382	6.40000
74	61	371	357	339	318	374	374	375	375	375	376	6.40000
74	71	377	378	380	384	388	392	396	401	409	420	6.40000
74	81	427	430	431	428	422	413	400	382	359	331	6.40000
74	91	387	397	387	397	388	388	389	391	394	398	6.40000
74	101	403	406	411	417	427	446	454	454	458	455	6.40000
74	111	448	438	424	404	378	344	467	471	475	475	6.40000
74	121	472	465	455	440	420	394	359	479	482	487	6.40000
74	131	488	485	479	468	454	435	410	381	358	348	6.40000
74	141	341	337	332	327	324	322	320	319	319	319	6.40000
74	151	496	496	494	489	479	465	448	426	403	385	6.40000
74	161	375	367	361	354	347	343	340	338	336	336	6.40090
74	171	335	499	495	486	473	457	437	417	401	392	6.40000
74	181	383	377	369	361	356	352	350	348	348	347	6.40000
74	191	282	282	282								

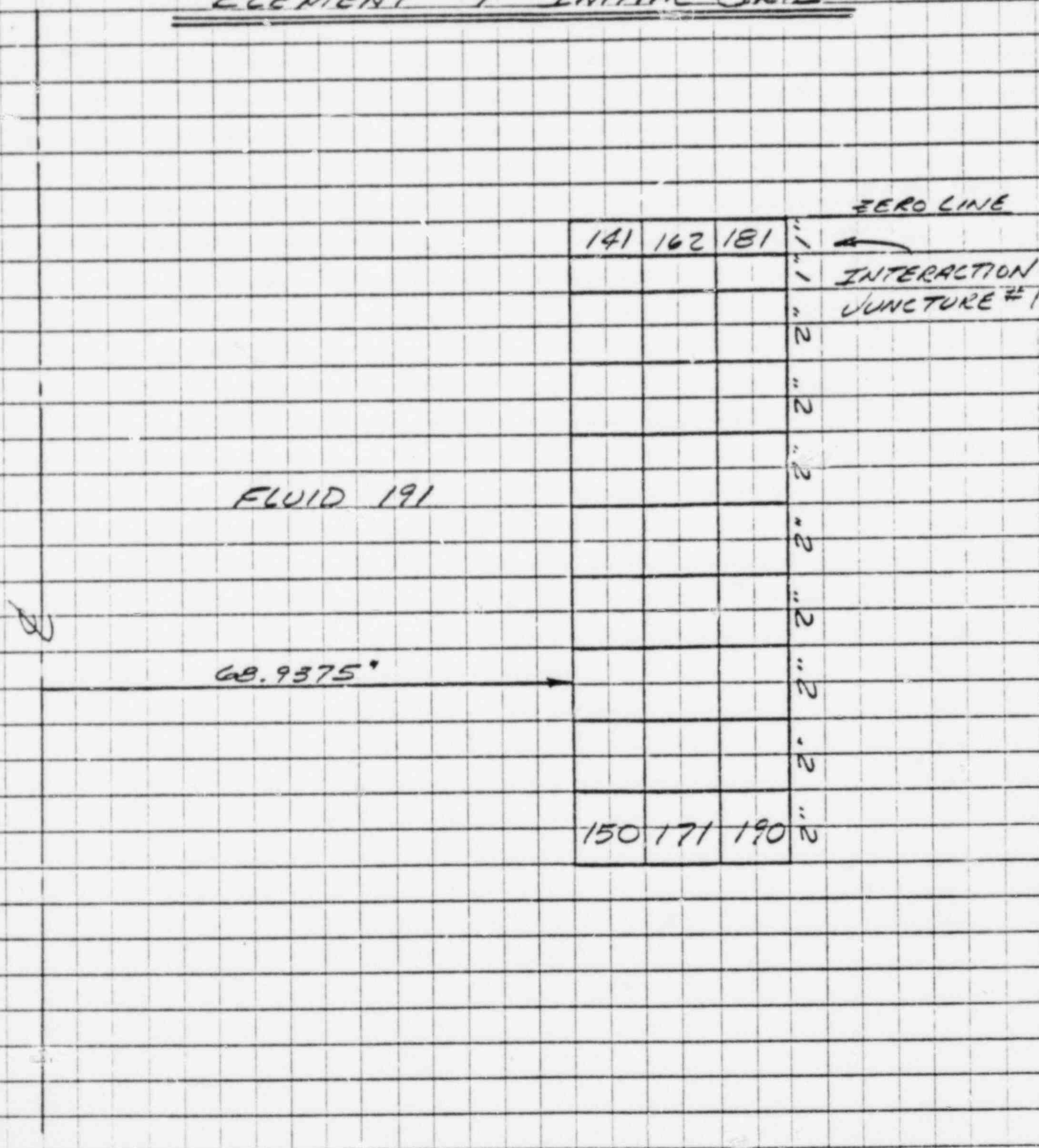
LEW
6/78
620-0011-55
44

TEMPERATURE INTERPOLATION

In order to determine the Free-body Thermal Stresses and motions of the interaction elements (Reference 2, Page B-2-2), B&W Computer Program 91206 will be used. However, in order to change the 91167 output format to the input format of 91206, this intermediate step of temperature interpolation must be performed by B&W Program 91032.

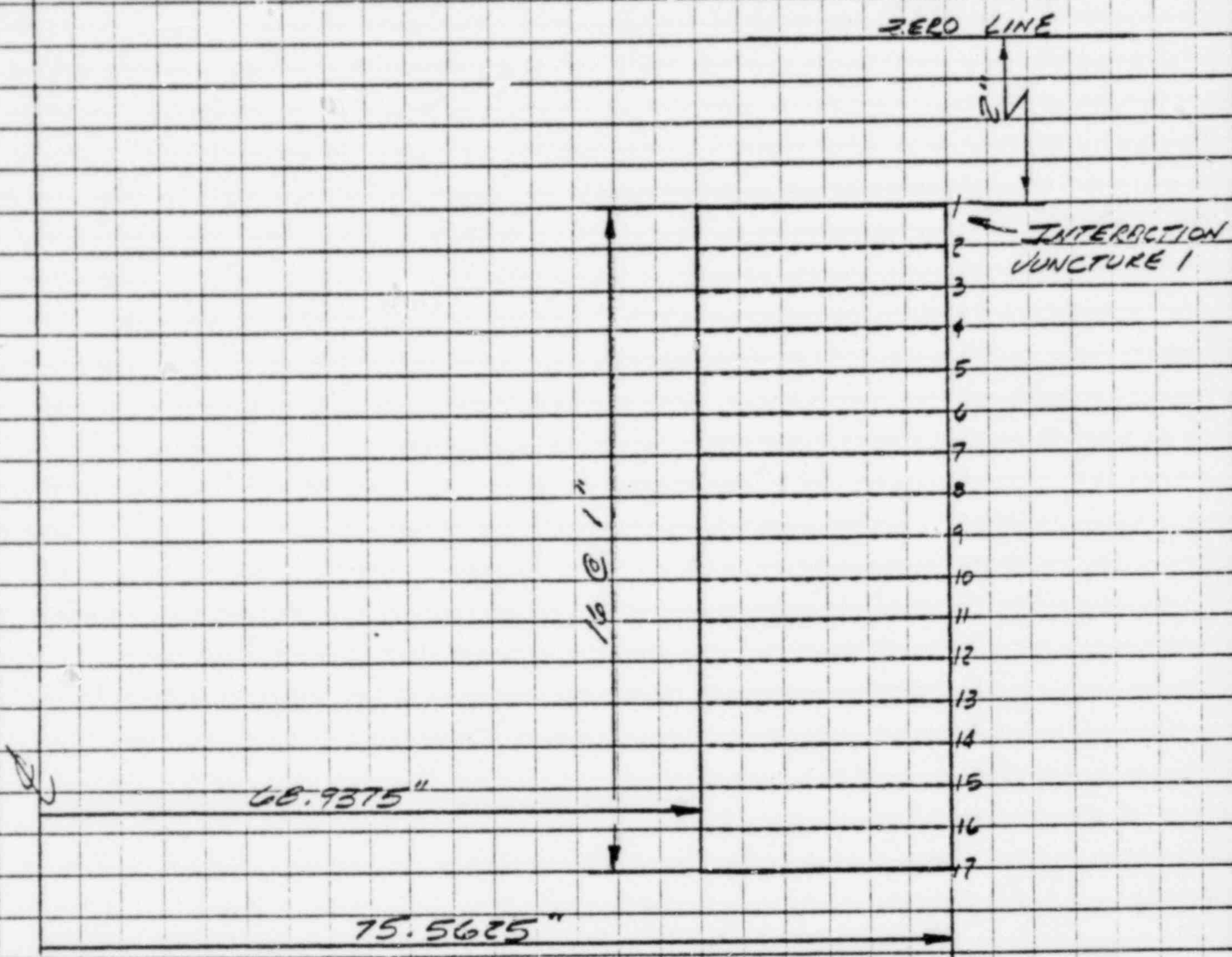
Contained on the following pages are the 91167 Grid (Initial Grid) and the 91206 Grid (Final Grid) for each interaction element. Also, there is a sample 91032 output for Element 5, since it is the most geometrically complex, to show its format and application.

ELEMENT #1 - INITIAL GRID



BABCOCK & WILCOX DEPARTMENT NH V-COMP. ENGRG. DATE 6/79 BY LEW ELEMENT #1 CHECKED DATE BY INITIAL GRID JOB NO. 620-0011-55	REVISION SHEET 4 OF

ELEMENT #1 – FINAL GRID



BABCOCK & WILCOX

DEPARTMENT Mt.V – Comp. Engrg. DATE 6/78 BY LEW

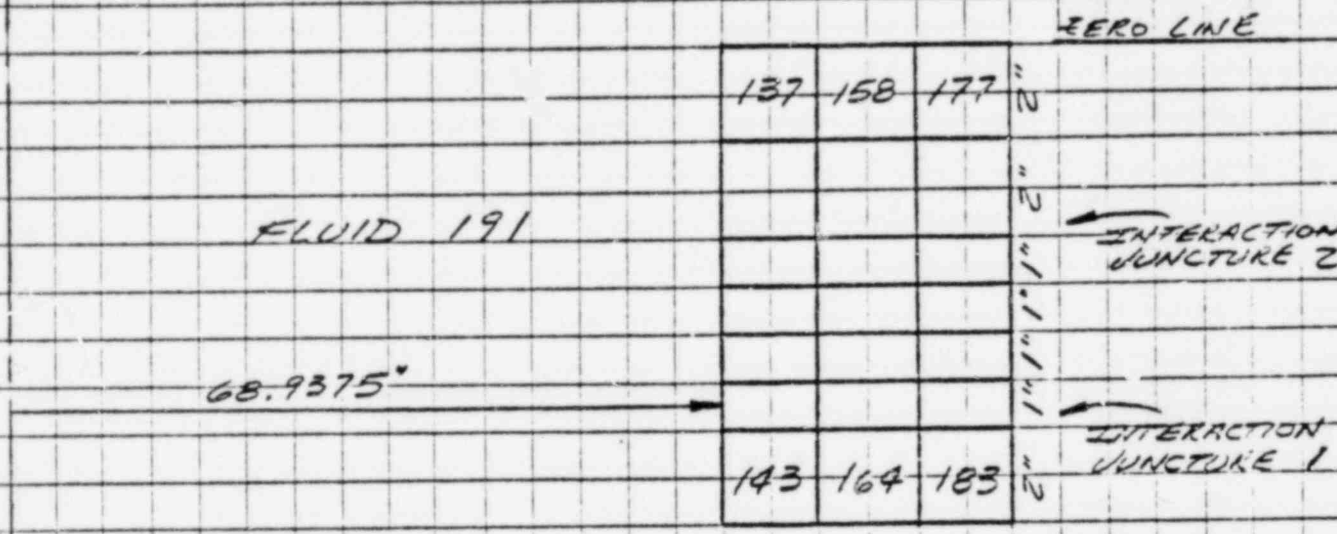
ELEMENT #1 CHECKED DATE BY

FINAL GRID JOB NO. 620-0011-55

REVISION

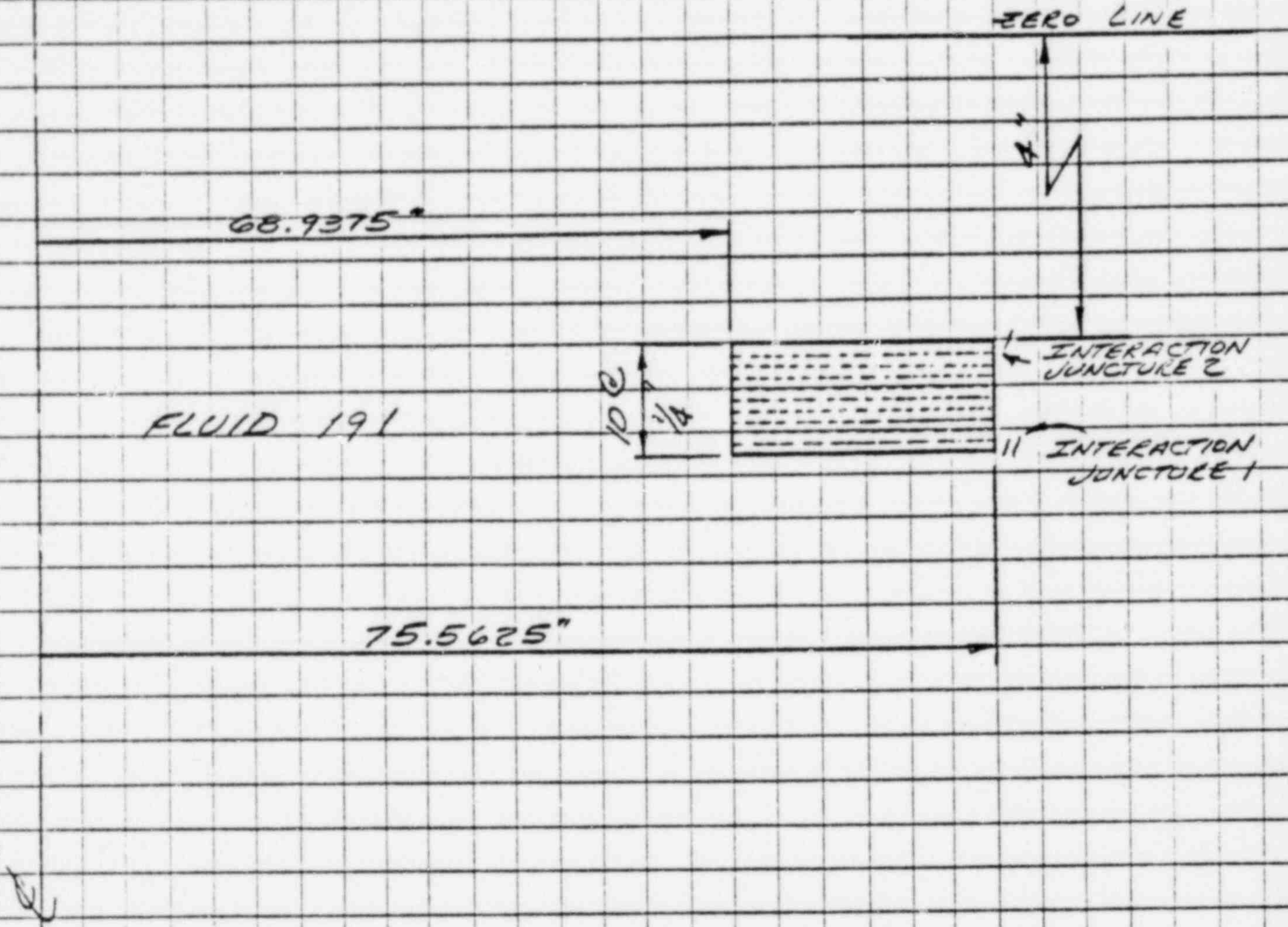
SHEET 47 OF

ELEMENT # 2 - INITIAL GRID



BABCOCK & WILCOX			REVISION
DEPARTMENT Mt. V - Comp. Engrg.	DATE 6/79	BY LEW	
ELEMENT # 2	CHECKED DATE	BY	
INITIAL GRID	JOB NO. 620-0011-55		SHEET 49 OF

ELEMENT #2 - FINAL GRID

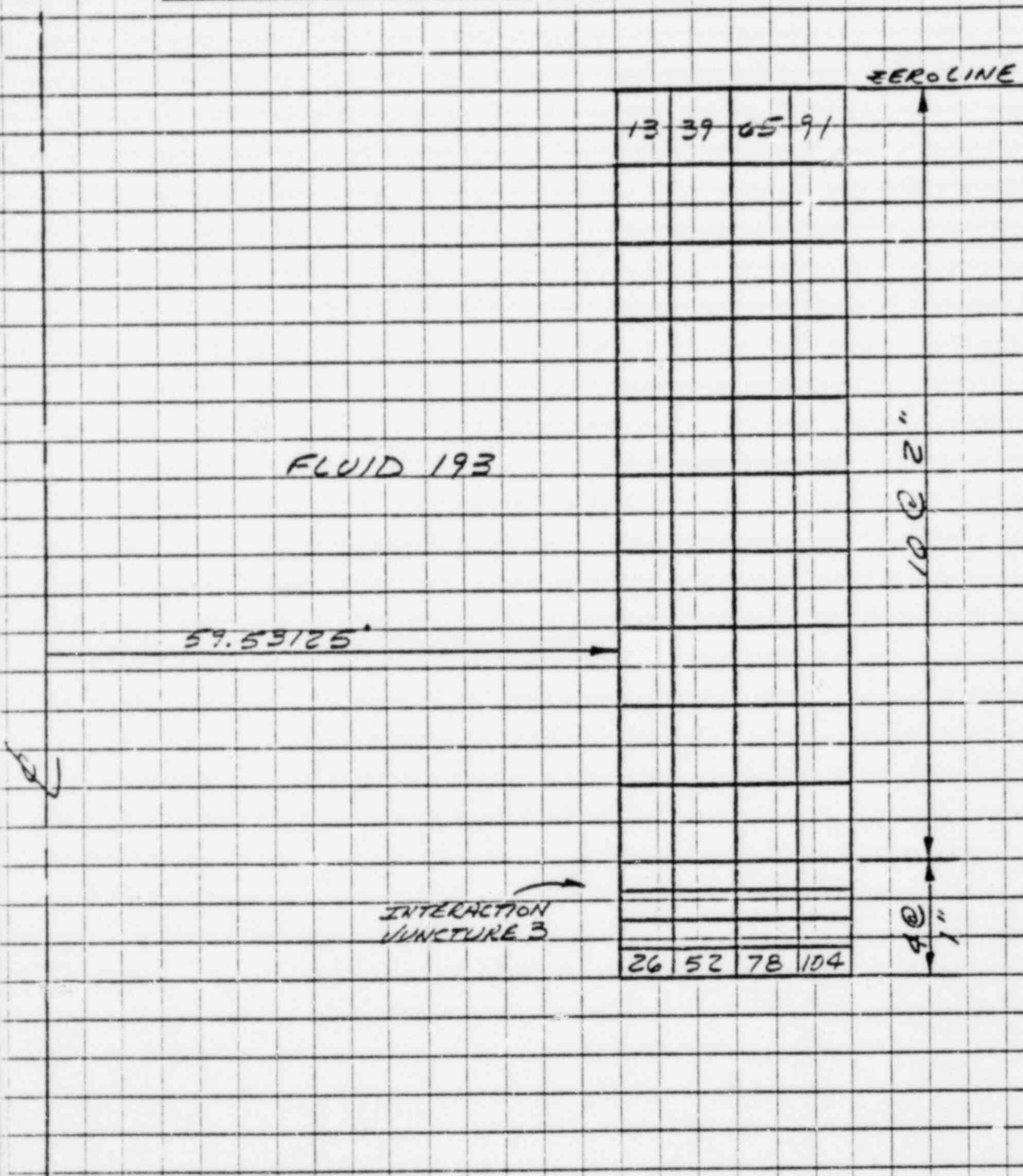


BABCOCK & WILCOX
DEPARTMENT M-V-COMP. ENGRG. DATE 6/78 BY LEW
ELEMENT #2 CHECKED DATE BY
FINAL GRID JOB NO. 620-0011-55

REVISION

SHEET 49 OF

ELEMENT #3 - INITIAL GRID

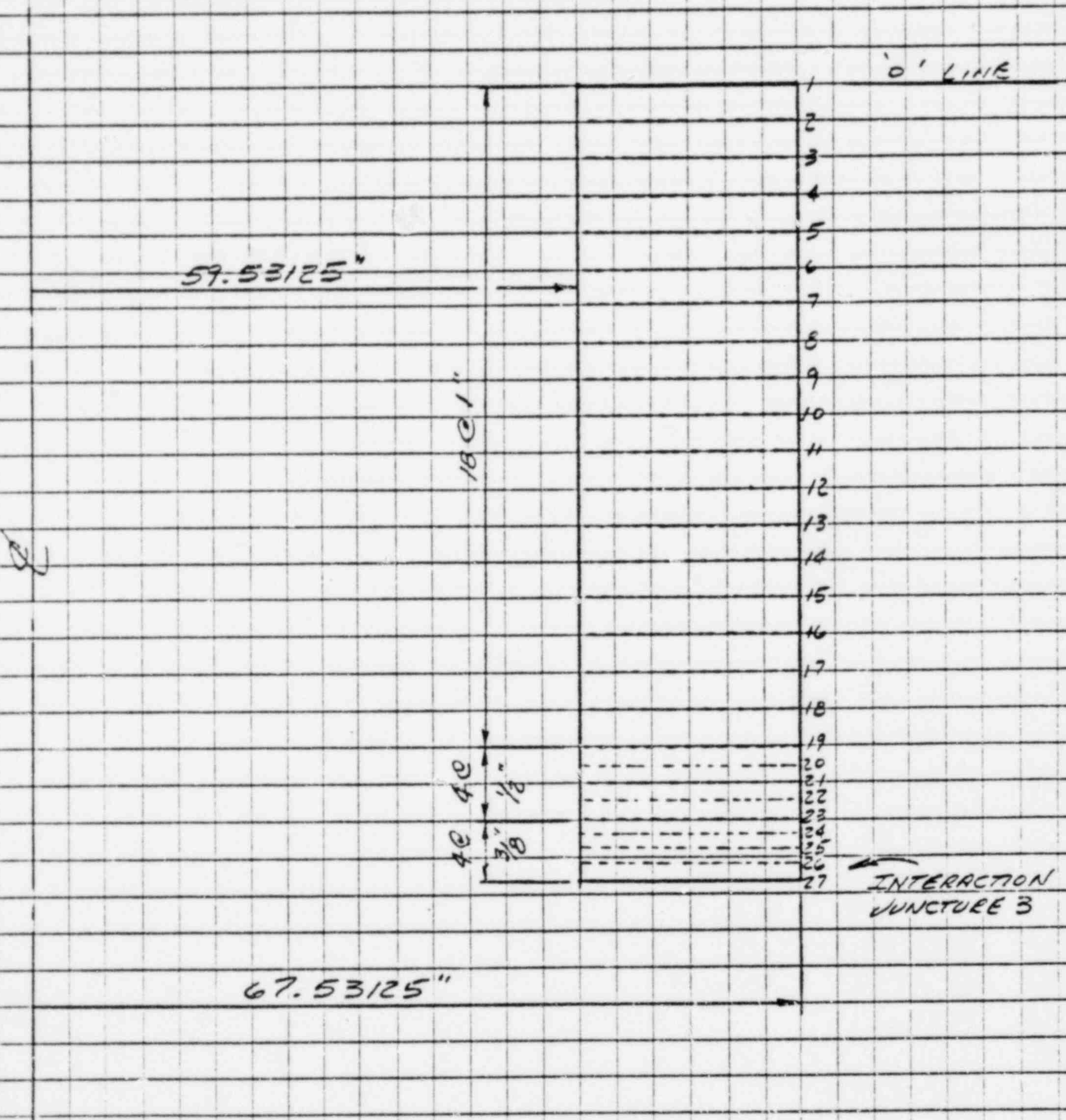


BABCOCK & WILCOX
DEPARTMENT NA + V - COMP. ENGRG. DATE 6/78 BY LEW
ELEMENT #3
CHECKED DATE BY
INITIAL GRID
JOB NO. 620-0011-55

REVISION

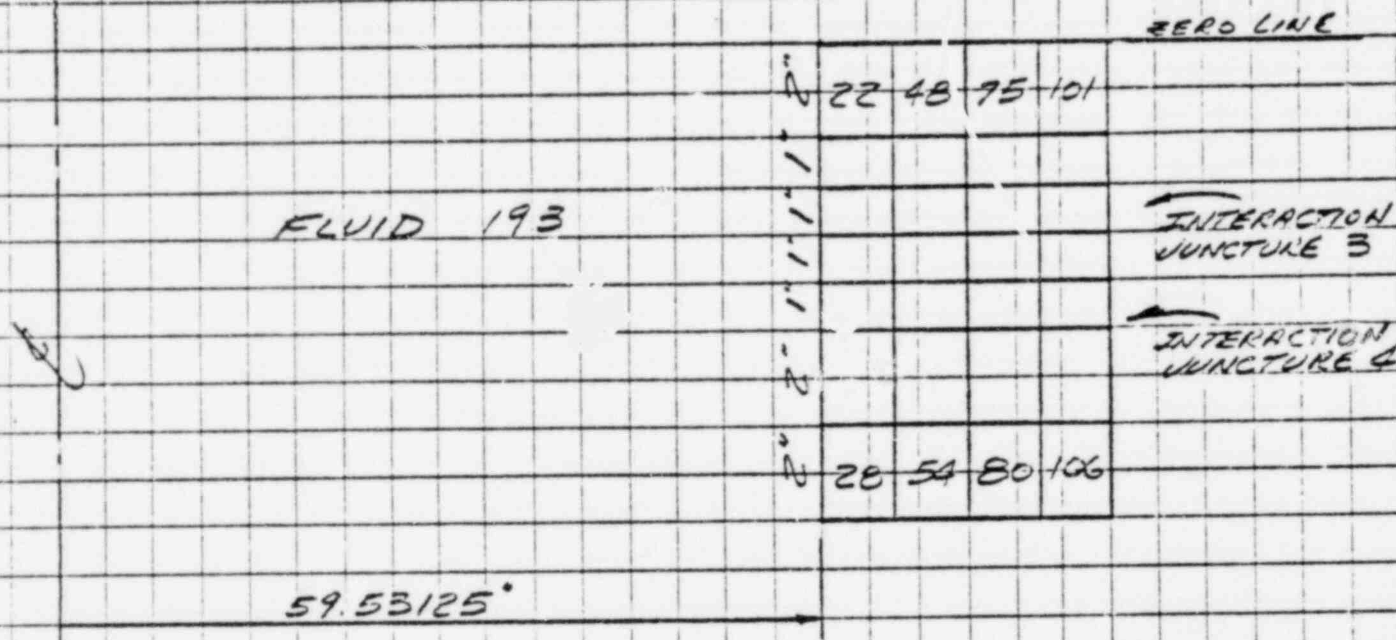
SHEET 50 OF

ELEMENT #3 - FINAL GRID



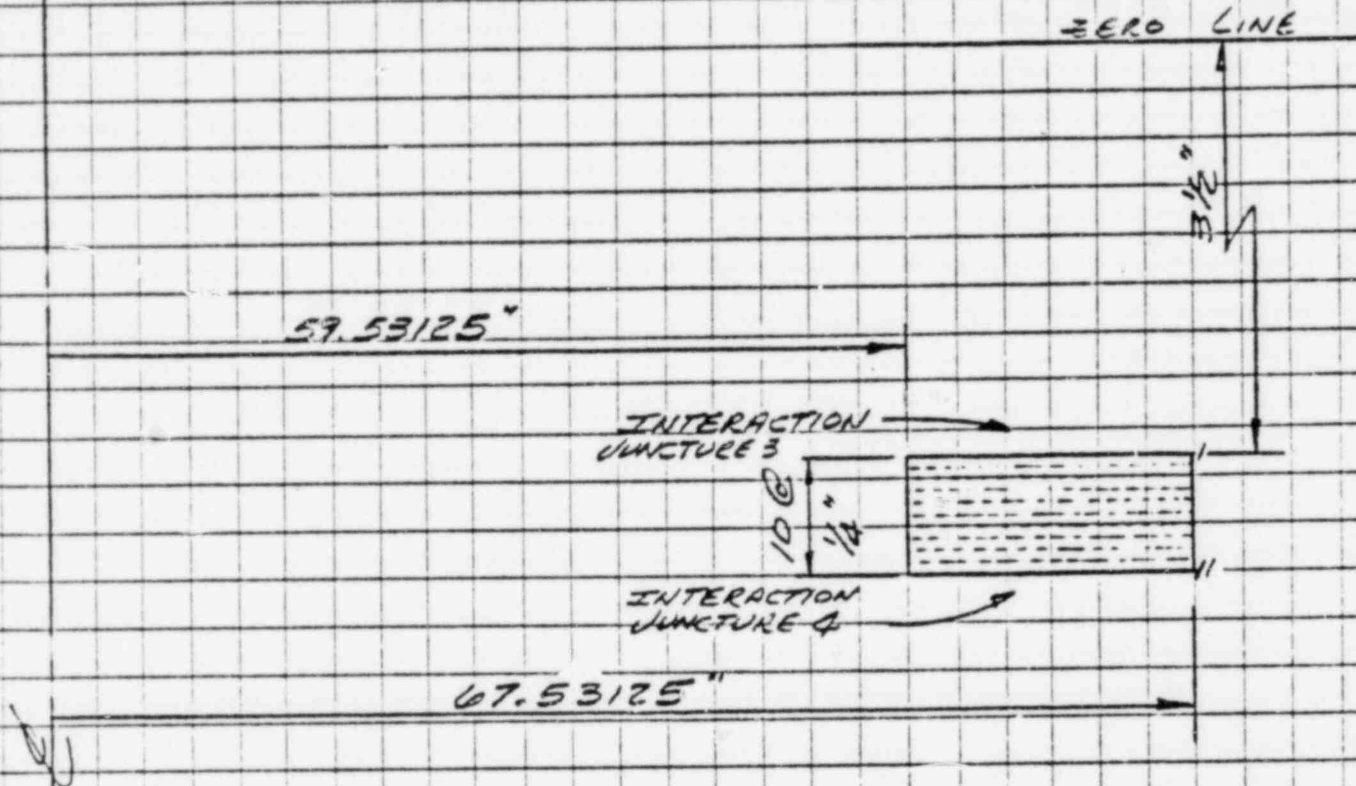
BABCOCK & WILCOX	REVISION
DEPARTMENT NIT. Y - COMP. ENGRG. DATE 6/78 BY LEW	
ELEMENT #3 CHECKED DATE BY	
FINAL GRID JOB NO. 620-0011-55	SHEET 51 OF

ELEMENT # 4 - INITIAL GRID



BABCOCK & WILCOX		REVISION
DEPARTMENT Nt. V - Comp Engrg. DATE 6/78 BY LEW		
ELEMENT # 4	CHECKED DATE BY	
INITIAL GRID	JOB NO. 620-0011-55	SHEET 52 OF

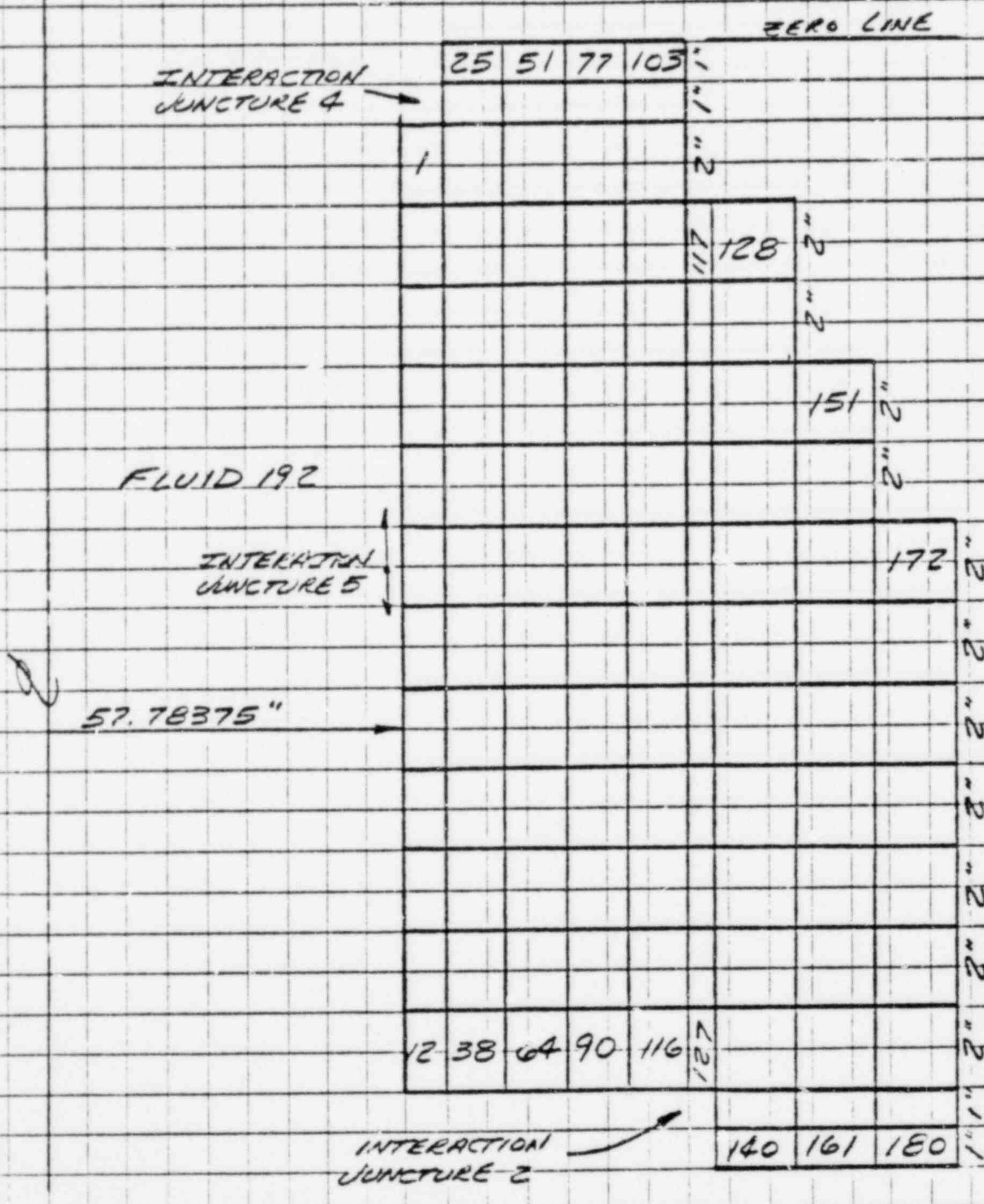
ELEMENT # 4 - FINAL GRID



BABCOCK & WILCOX
DEPARTMENT Nt. V-Comp Engrg. DATE 6/78 BY LEW
ELEMENT #4 CHECKED DATE BY
FINAL GRID JOB NO. 620-0011-55

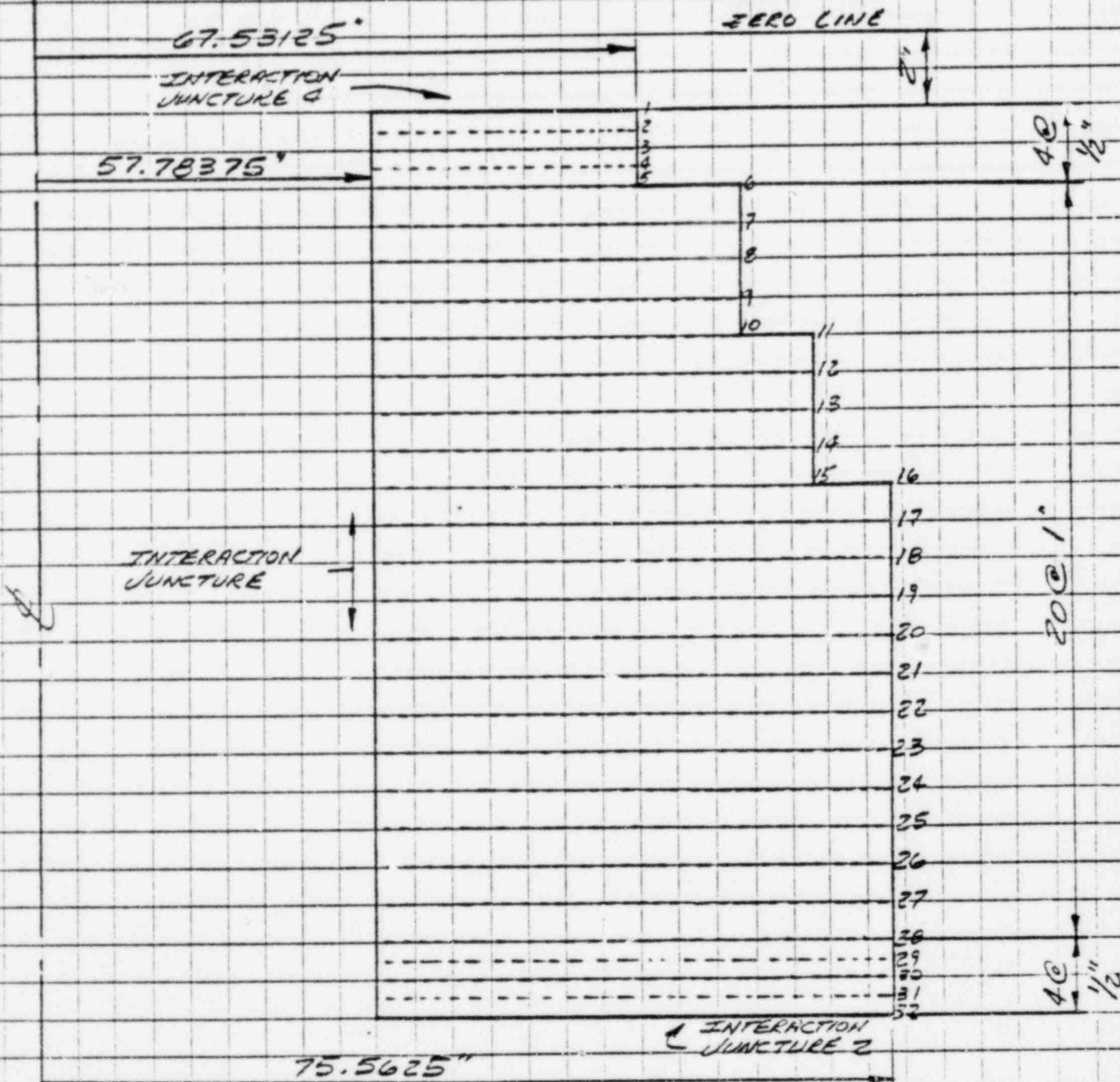
REVISION
SHEET 53 OF

ELEMENT #5 - INITIAL GRID



BABCOCK & WILCOX			REVISION
DEPARTMENT NM V-COMP ENGR.	DATE 5/78	BY LEW	
ELEMENT #1	CHECKED DATE	BY	
INITIAL GRID	JOB NO. 620-0011-55		SHEET 54 OF

ELEMENT #5 - FINAL GRID



BABCOCK & WILCOX		REVISION
DEPARTMENT NM. V-COMP. ENGRG.	DATE 6/78 BY LEW	
ELEMENT #5	CHECKED DATE BY	
FINAL GRID	JOB NO. 620-0011-55	SHEET 55 OF

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 04/24/78

SMUD RAPID COOLDOWN---OTSG LOWER TUBESHEET ANALYSIS---BY LEW ELEMENT 5.

CALCULATION CODE 7

PRINTED OUTPUT PLUS PUNCHED TEMPERATURE CARDS

BASE TEMPERATURE 70.00

NUMBER OF INPUT TEMPERATURES 91167 GRID - 193

INPUT PER EDGE FOR INITIAL GRID

EDGE NO.	TEMP. BLOCK HEIGHT	DIST FROM ZERO LINE TO EDGE	ZERO LINE TO BLOCK BOUNDARY	INSIDE SURFACE RADIUS	INSIDE SURFACE ADJ. BLOCK	INSIDE SURFACE FILM COEFF.	OUTSIDE SURFACE RADIUS	OUTSIDE SURFACE ADJ. BLOCK	OUTSIDE SURFACE FILM COEFF.	MATERIAL TYPE
1	1.0000	.5000	1.0000	59.5313	193	317.0000	67.5313	0	0.0000	SA-508 STEEL
2	1.0000	1.5000	2.0000	59.5313	193	317.0000	67.5313	0	0.0000	SA-508 STEEL
3	2.0000	3.0000	4.0000	57.7838	192	992.0000	67.5313	0	0.0000	SA-508 STEEL
4	2.0000	5.0000	6.0000	57.7838	192	992.0000	70.9375	0	0.0000	SA-508 STEEL
5	2.0000	7.0000	8.0000	57.7838	192	992.0000	70.9375	0	0.0000	SA-508 STEEL
6	2.0000	9.0000	10.0000	57.7838	192	992.0000	72.9375	0	0.0000	SA-508 STEEL
7	2.0000	11.0000	12.0000	57.7838	192	992.0000	72.9375	0	0.0000	SA-508 STEEL
8	2.0000	13.0000	14.0000	57.7838	192	992.0000	75.5625	0	0.0000	SA-508 STEEL
9	2.0000	15.0000	16.0000	57.7838	192	992.0000	75.5625	0	0.0000	SA-508 STEEL
10	2.0000	17.0000	18.0000	57.7838	192	992.0000	75.5625	0	0.0000	SA-508 STEEL
11	2.0000	19.0000	20.0000	57.7838	192	992.0000	75.5625	0	0.0000	SA-508 STEEL
12	2.0000	21.0000	22.0000	57.7838	192	992.0000	75.5625	0	0.0000	SA-508 STEEL
13	2.0000	23.0000	24.0000	57.7838	192	992.0000	75.5625	0	0.0000	SA-508 STEEL
14	2.0000	25.0000	26.0000	57.7838	192	992.0000	75.5625	0	0.0000	SA-508 STEEL
15	1.0000	26.5000	27.0000	68.9375	191	285.0000	75.5625	0	0.0000	SA-508 STEEL
16	1.0000	27.5000	28.0000	68.9375	191	285.0000	75.5625	0	0.0000	SA-508 STEEL

LEW
620-0011-55
6/78
56

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 04/24/78

SMUD RAPID COOLDOWN---OTSG LOWER TUBESHEET ANALYSIS---BY LEW ELEMENT 5.

DIMENSION PER COLUMN OF THE INITIAL GRID

91167 TEMPERATURE GRID

COLUMN NO.	INSIDE RADIUS	BLOCK WIDTH	NODAL RADIUS	OUTSIDE RADIUS	LOW BLOCK NO.	HIGH BLOCK NO.
1	57.7838	1.7474	58.6575	59.5312	1	12
2	59.5312	2.0002	60.5313	61.5314	25	38
3	61.5314	1.9998	62.5313	63.5312	51	64
4	63.5312	2.0002	64.5313	65.5314	77	90
5	65.5314	1.9998	66.5313	67.5312	103	116
6	67.5312	1.4064	68.2344	68.9376	117	127
7	68.9376	1.9998	69.9375	70.9374	128	140
8	70.9374	2.0002	71.9375	72.9376	151	161
9	72.9376	2.6248	74.2500	75.5624	172	180

57
6/78
55-1100-02
LEW

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 04/24/78

SMUD RAPID COOLDOWN---OTSG LOWER TUBESHEET ANALYSIS---BY LEW ELEMENT 5.

INITIAL INTERNAL RADIUS	INITIAL GRID DISTANCE FROM ZERO LINE TO CLOSEST SURFACE	INITIAL GRID DISTANCE FROM ZERO LINE TO FURTHEST SURFACE
58.6575	2.0000	26.0000
62.5313	0.0000	26.0000
66.5313	0.0000	26.0000
69.9375	4.0000	28.0001
74.2500	12.0000	28.0001

INITIAL INTERNAL RADIUS	INITIAL GRID DISTANCE FROM ZERO LINE TO CLOSEST SURFACE	INITIAL GRID DISTANCE FROM ZERO LINE TO FURTHEST SURFACE
60.5313	0.0000	26.0000
64.5313	0.0000	26.0000
68.2344	4.0000	26.0000
71.9375	8.0000	28.0001

LEW
620-0011-55
6/78
58

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 04/24/78

SMUD RAPID COOLDOWN---OTSG LOWER TUBESHEET ANALYSIS---BY LEW ELEMENT 5.

FINAL GRID		INITIAL GRID		FINAL GRID				
EDGE NUMBER	DISTANCE FROM ZERO LINE	INSIDE RADIUS	OUTSIDE RADIUS	INSIDE RADIUS	RB(2)	RB(3)	RB(4)	OUTSIDE RADIUS
1	2.0000	57.7838	67.5313	57.7838	60.2207	62.6576	65.0944	67.5313
2	2.5000	57.7838	67.5313	57.7838	60.2207	62.6576	65.0944	67.5313
3	3.0000	57.7838	67.5313	57.7838	60.2207	62.6576	65.0944	67.5313
4	3.5000	57.7838	67.5313	57.7838	60.2207	62.6576	65.0944	67.5313
5	4.0000	57.7838	67.5313	57.7838	60.2207	62.6576	65.0944	67.5313
6	4.0000	57.7838	70.9375	57.7838	61.0722	64.3607	67.6491	70.9375
7	5.0000	57.7838	70.9375	57.7838	61.0722	64.3607	67.6491	70.9375
8	6.0000	57.7838	70.9375	57.7838	61.0722	64.3607	67.6491	70.9375
9	7.0000	57.7838	70.9375	57.7838	61.0722	64.3607	67.6491	70.9375
10	8.0000	57.7838	70.9375	57.7838	61.0722	64.3607	67.6491	70.9375
11	8.0000	57.7838	72.9375	57.7838	61.5722	65.3607	69.1491	72.9375
12	9.0000	57.7838	72.9375	57.7838	61.5722	65.3607	69.1491	72.9375
13	10.0000	57.7838	72.9375	57.7838	61.5722	65.3607	69.1491	72.9375
14	11.0000	57.7838	72.9375	57.7838	61.5722	65.3607	69.1491	72.9375
15	12.0000	57.7838	72.9375	57.7838	61.5722	65.3607	69.1491	72.9375
16	12.0000	57.7838	75.5625	57.7838	62.2285	66.6732	71.1178	75.5625
17	13.0000	57.7838	75.5625	57.7838	62.2285	66.6732	71.1178	75.5625
18	14.0000	57.7838	75.5625	57.7838	62.2285	66.6732	71.1178	75.5625
19	15.0000	57.7838	75.5625	57.7838	62.2285	66.6732	71.1178	75.5625
20	16.0000	57.7838	75.5625	57.7838	62.2285	66.6732	71.1178	75.5625
21	17.0000	57.7838	75.5625	57.7838	62.2285	66.6732	71.1178	75.5625
22	18.0000	57.7838	75.5625	57.7838	62.2285	66.6732	71.1178	75.5625
23	19.0000	57.7838	75.5625	57.7838	62.2285	66.6732	71.1178	75.5625
24	20.0000	57.7838	75.5625	57.7838	62.2285	66.6732	71.1178	75.5625
25	21.0000	57.7838	75.5625	57.7838	62.2285	66.6732	71.1178	75.5625
26	22.0000	57.7838	75.5625	57.7838	62.2285	66.6732	71.1178	75.5625
27	23.0000	57.7838	75.5625	57.7838	62.2285	66.6732	71.1178	75.5625
28	24.0000	57.7838	75.5625	57.7838	62.2285	66.6732	71.1178	75.5625
29	24.5000	57.7838	75.5625	57.7838	62.2285	66.6732	71.1178	75.5625
30	25.0000	57.7838	75.5625	57.7838	62.2285	66.6732	71.1178	75.5625
31	25.5000	57.7838	75.5625	57.7838	62.2285	66.6732	71.1178	75.5625
32	26.0000	57.7838	75.5625	57.7838	62.2285	66.6732	71.1178	75.5625

69
6/78
55-1100-029
LEW

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 04/24/78

SMUD RAPID COOLDOWN---OTSG LOWER TUBESHEET ANALYSIS---BY LEW ELEMENT 5.

TEMPERATURE OF NODE PER EDGE OF THE FINAL GRID FOR ITERATION 72

*IDENTIFIES PHANTOM SEGMENTS

SEGN NO.	OUTSIDE				INSIDE	CARD NO.
1	392	371	333	271	215	401.
2	395	373	335	275	216	402.
3	399	375	338	279	216	403.
4	403	379	340	282	217	404.
5	408	381	342	285	217	405.
6	443	413	371	306	217	406.*
7	442	419	376	310	218	407.
8	443	421	380	313	219	408.
9	444	423	382	315	219	409.
10	445	425	384	316	219	410.
11	452	435	399	328	219	411.*
12	452	437	399	329	219	412.
13	451	436	400	329	219	413.
14	451	435	399	329	219	414.
15	449	434	398	328	219	415.
16	451	444	414	343	219	416.*

*************** NOTE THESE TEMPERATURES ARE T(ACTUAL) MINUS T(BASE) ***************

TEMPERATURE INTERPOLATION GRID CHANGE PROGRAM 91032 - REVISION 3 04/24/78

SMUD RAPID COOLDOWN---OTSG LOWER TUBESHEET ANALYSIS---BY LEW ELEMENT 5.

TEMPERATURE OF NODE PER EDGE OF THE FINAL GRID FOR ITERATION 72

*IDENTIFIES PHANTOM SEGMENTS

SEGN NO.						CARD NO.
17	450	442	412	342	219	417.
18	448	439	403	340	219	418.
19	446	435	405	337	219	419.
20	442	431	400	334	218	420.
21	438	425	394	330	218	421.
22	433	420	389	326	218	422.
23	427	412	380	320	217	423.
24	420	404	371	313	217	424.
25	413	395	359	306	217	425.
26	405	385	345	296	216	426.
27	396	373	330	285	215	4[illegible]
28	388	360	312	273	215	428.
29	383	353	301	266	214	429.
30	379	345	290	259	214	430.
31	374	339	279	251	213	431.
32	370	332	265	243	212	432.

*************** NOTE THESE TEMPERATURES ARE T(ACTUAL) MINUS T(BASE) ***************

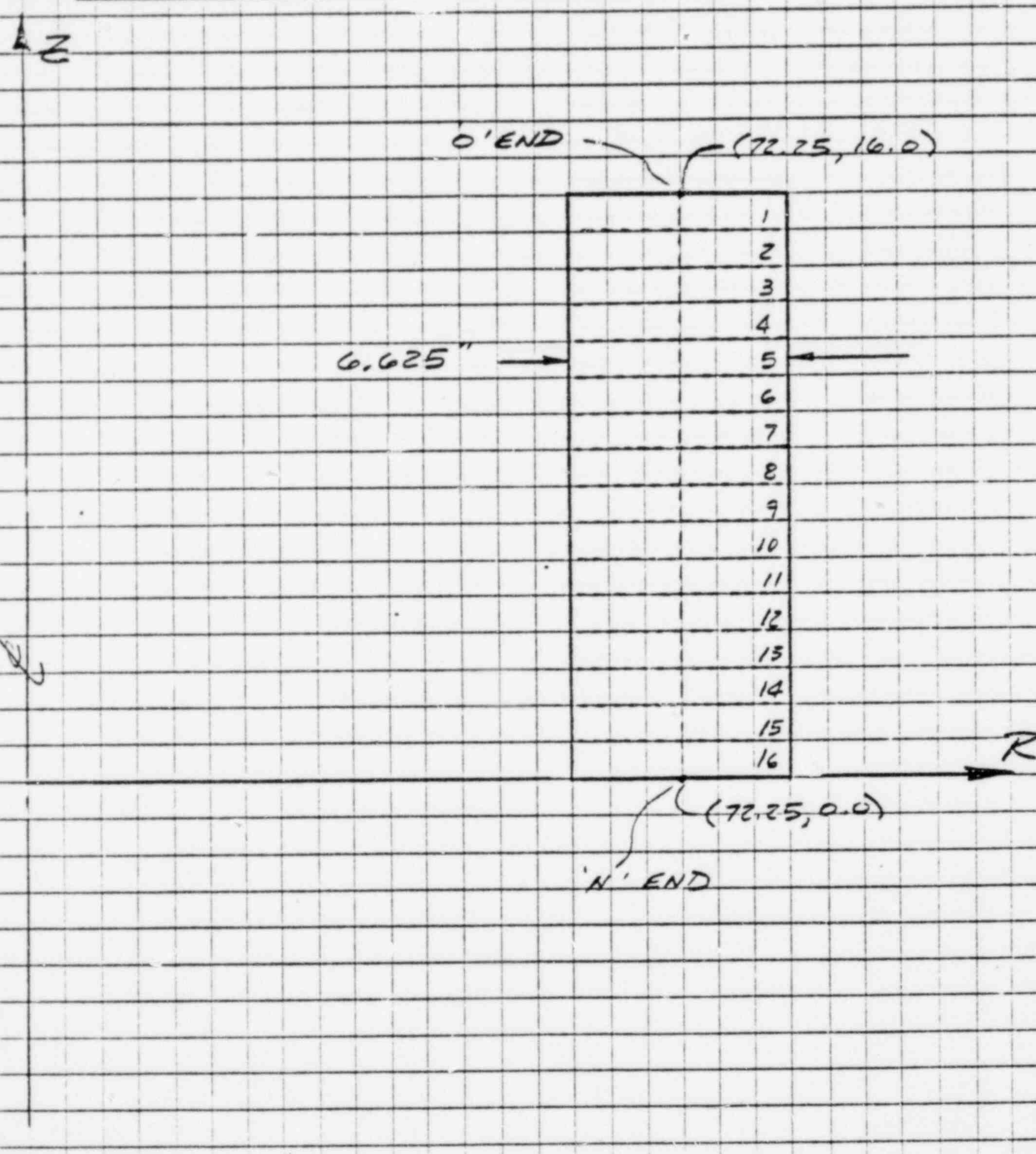
55-1100-020
6/78
LEW
19

FREEBODY THERMAL MOTIONS & STRESSES

The following pages contain a sample output from Program 91206 to show its format and application, a tabulation of Primary Plus Secondary Freebody Thermal Stresses, Peak Free-body Thermal Stresses, Free-body Thermal Motions, Motion Adjustments for Element #5 (Tubesheet Ring), and Program 91206 models.

BMS 247-1

ELEMENT #1 - PROG. 91206 MODEL

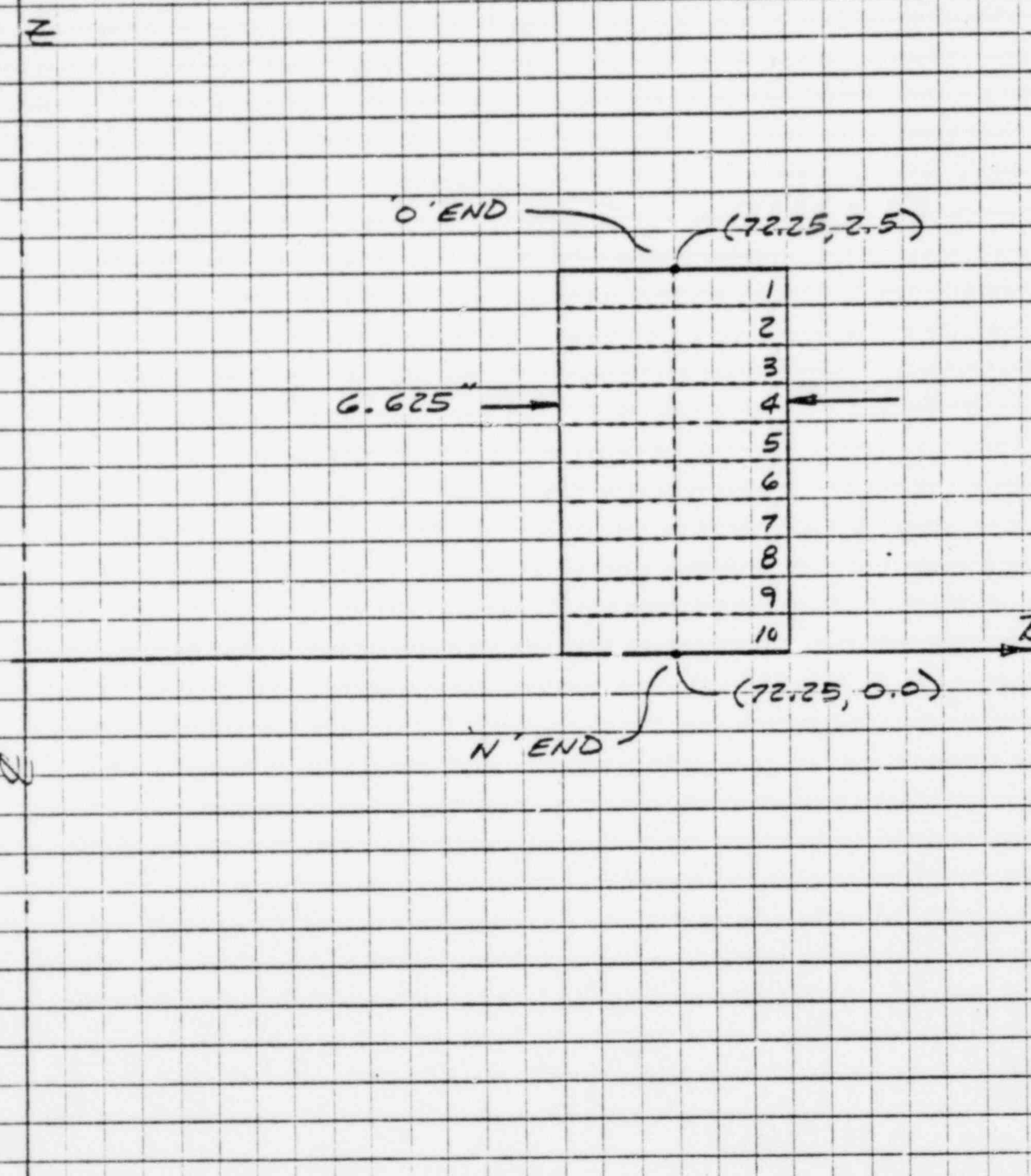


BABCOCK & WILCOX
DEPARTMENT NSV - COMP. ENGRG. DATE 6/78 BY LEW
ELEMENT #1 CHECKED DATE BY
91206 MODEL JOB NO. 620-0011-55

REVISION

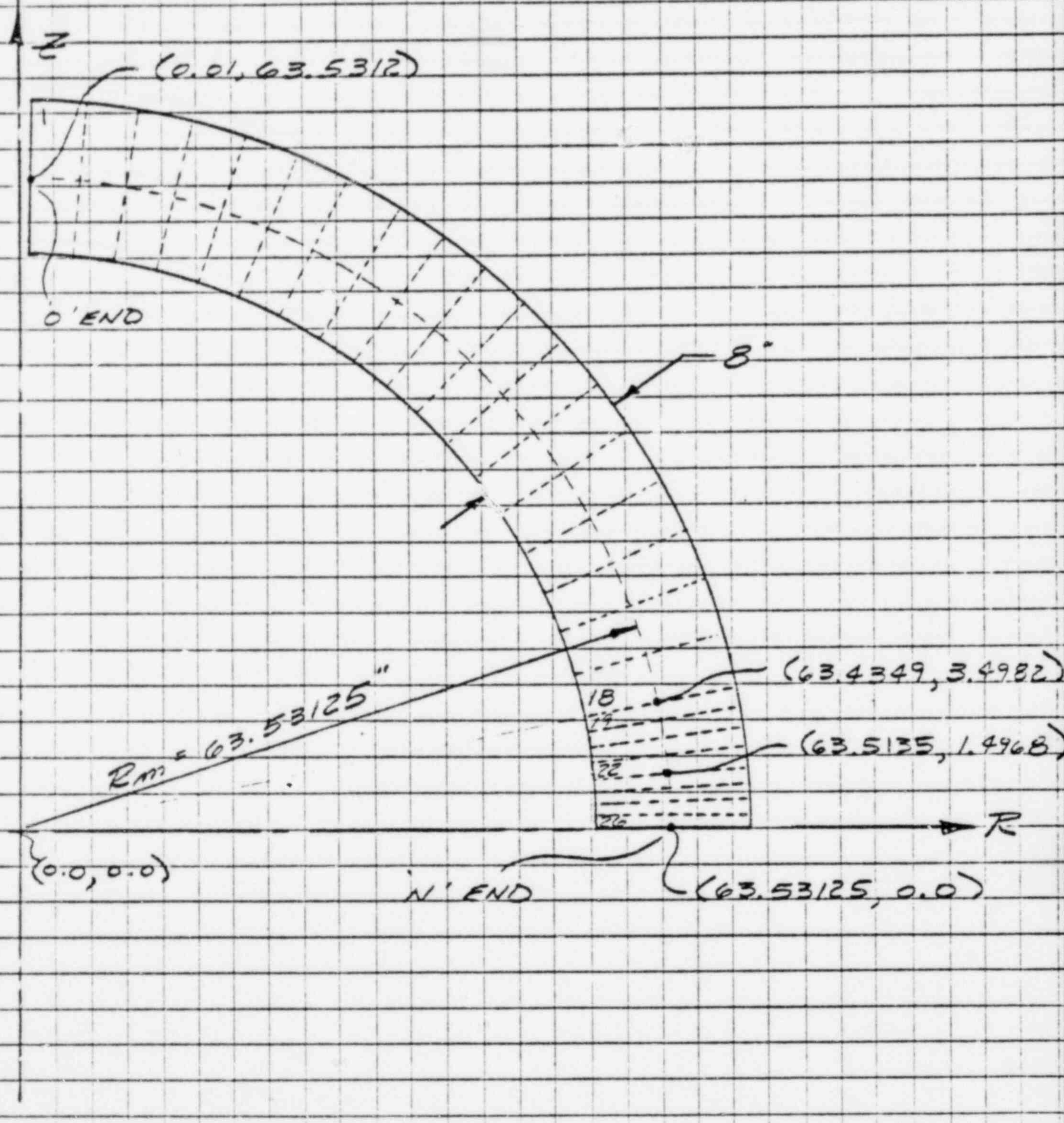
SHEET 63 OF

ELEMENT #2 - PROGRAM 91206 MODEL



BWS 247-1

ELEMENT # 3 - 91206 MODEL



BABCOCK & WILCOX

DEPARTMENT NT. V-COMP ENGRG. DATE 6/78 BY LEW

ELEMENT # 3

91206 MODEL

CHECKED DATE BY

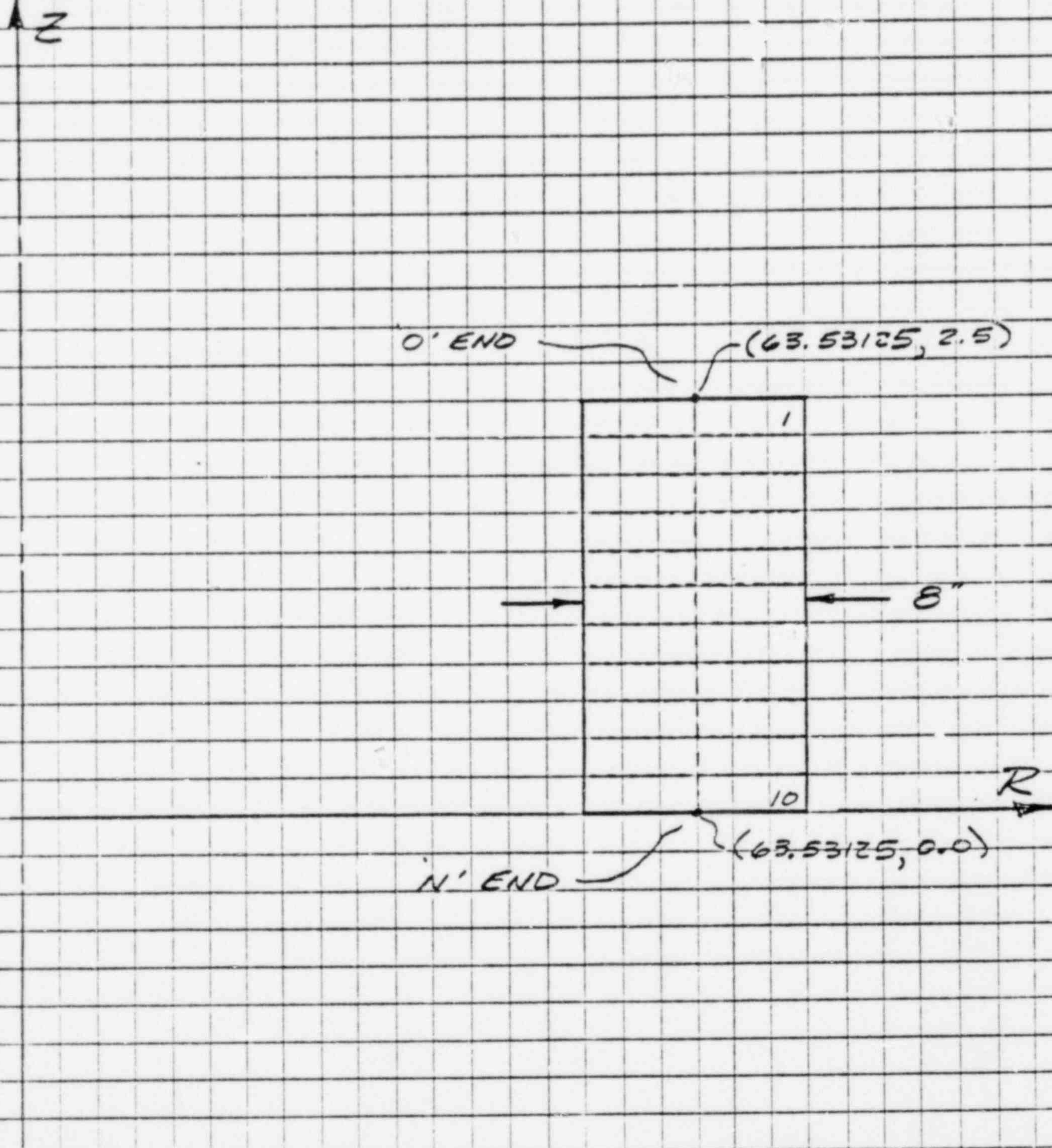
JOB NO. 620-001-55

REVISION

SHEET 65 OF

BMS 247-1

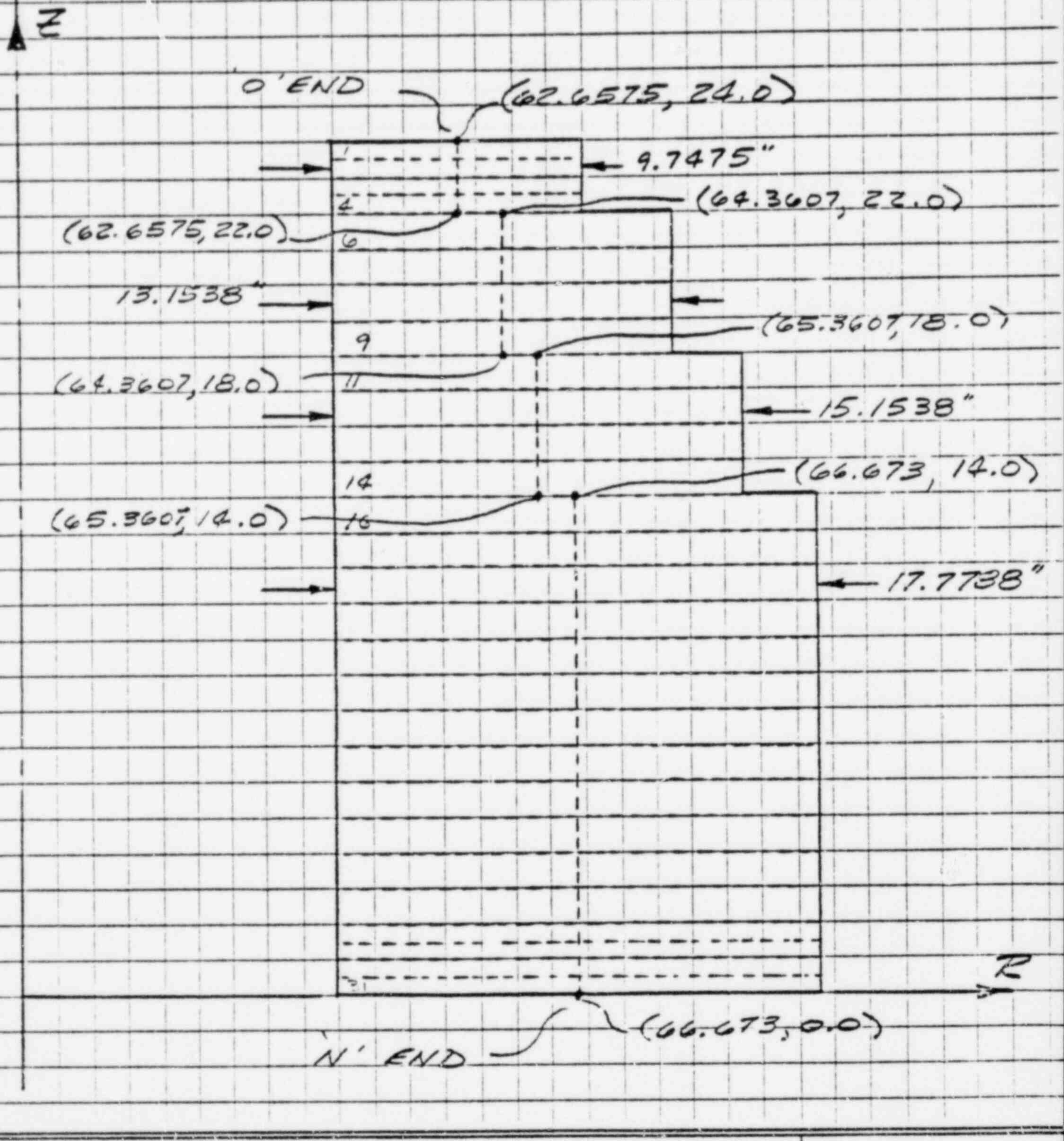
ELEMENT #4 - PROG. 91206 MODEL



BABCOCK & WILCOX		REVISION
DEPARTMENT NT. V-COMP. ENG'G.	DATE 6/78 BY LEW	
ELEMENT #4 -	CHECKED DATE BY	
91206 MODEL	JOB NO. 620-0011-55	SHEET 66 OF

PMS 287-1

ELEMENT #5 - PROG. 91206 MODEL



BABCOCK & WILCOX		REVISION
DEPARTMENT NT.V - COMP. ENGRG.	DATE 6/78 BY LEW	
ELEMENT #5	CHECKED DATE BY	
91206 MODEL	JOB NO. 620-0011-55	SHEET 67 OF

ELEMENT 5. ITERATION 72 PAGE 1 DATE 04/26/78

INPUT DATA DATE 04/26/78

TOTAL NO. OF SEGMENTS = 31

BOUNDARY CONDITIONS AT THE TOP (O) END

1. A RADIAL SHEAR OF 0.00000 POUNDS
2. A MOMENT OF 0.00000 INCH-LBS.

BOUNDARY CONDITIONS AT THE BOTTOM (N) END

1. AN AXIAL FORCE OF 0.00000 POUNDS
2. A RADIAL SHEAR OF 0.00000 POUNDS
3. A MOMENT OF 0.00000 INCH-LBS.

* NOTE * A SEGMENTAL GROUP MAY CONSIST OF FROM ONE TO THE TOTAL NO. OF SEGMENTS.
SEGMENT ONE IS CONSIDERED AT THE TOP OF THE GEOMETRY.
ALL LOADS ABOVE, ARE ON A TOTAL LOAD BASIS.

LEW
620-0011-55
6/78
68

ELEMENT 5. ITERATION 72 PAGE 2 DATE 04/26/78

MID-SURFACE GEOMETRY

AT TOP BOUNDARY, MEAN RADIUS = 62.6575 Z COORDINATE = 24.0000

SEGMENTAL GEOMETRY DATA BY GROUPS

SEGMENT DATA			CENTER OF CURVATURE DATA		
BOTTOM SEG. NO.	MEAN RADIUS	Z COORD.	RADIUS TO CENTER	Z COORD.	CURVATURE IDENTIFIER
4.0	62.658	22.000	0.000	0.000	0.0
5.0	54.361	22.000	0.000	0.000	0.0
9.0	54.361	18.000	0.000	0.000	0.0
10.0	65.361	18.000	0.000	0.000	0.0
14.0	65.361	14.000	0.000	0.000	0.0
15.0	66.673	14.000	0.000	0.000	0.0
31.0	66.673	0.000	0.000	0.000	0.0

NOTE- CURVATURE IDENTIFIER +1= POSITIVE CURVATURE
0= NO CURVATURE
-1= NEGATIVE CURVATURE

LEW
620-0011-55
6/78
69

ELEMENT 5. ITERATION 72 PAGE 3 DATE 04/26/78

SEGMENTAL GEOMETRY BY SEGMENTS (K= SEGMENT NO.)

MEAN RADIUS

K	R(K-1)	R(K)	R(K+1)	R(K+2)	R(K+3)	R(K+4)	R(K+5)	R(K+6)	R(K+7)	R(K+8)
1	62.56	62.66	62.66	62.66	62.66	64.36	64.36	64.36	64.36	64.36
11	65.36	65.36	65.36	65.36	65.36	66.67	66.67	66.67	66.67	66.67
21	66.57	66.67	66.67	66.67	66.67	66.67	66.67	66.67	66.67	66.67
31	66.57	66.67								

Z COORDINATE

K	Z(K-1)	Z(K)	Z(K+1)	Z(K+2)	Z(K+3)	Z(K+4)	Z(K+5)	Z(K+6)	Z(K+7)	Z(K+8)
1	24.00	23.50	23.00	22.50	22.00	22.00	21.00	20.00	19.00	18.00
11	18.00	17.00	16.00	15.00	14.00	14.00	13.13	12.25	11.38	10.50
21	9.63	8.75	7.88	7.00	6.13	5.25	4.38	3.50	2.63	1.75
31	.88	0.00								

LEW
620-0011-55
6/78
70

ELEMENT 5. ITERATION 72 PAGE 4 DATE 04/26/78

SEGMENT THICKNESS DATA BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	TOP THICK. OF TOP SEG.	BOTTOM THICK. OF BOTTOM SEG.
1.00	4.00	9.75	9.75
5.00	5.00	0.00	0.00
6.00	9.00	13.15	13.15
10.00	10.00	0.00	0.00
11.00	14.00	15.15	15.15
15.00	15.00	0.00	0.00
16.00	31.00	17.78	17.78

SEGMENTAL THICKNESS BY SEGMENTS

THICKNESS AT TOP OF SEGMENT (HA)

K	HA(K)	HA(K+1)	HA(K+2)	HA(K+3)	HA(K+4)	HA(K+5)	HA(K+6)	HA(K+7)	HA(K+8)	HA(K+9)
1	9.75	9.75	9.75	9.75	0.00	13.15	13.15	13.15	13.15	0.00
11	15.15	15.15	15.15	15.15	0.00	17.78	17.78	17.78	17.78	17.78
21	17.78	17.78	17.78	17.78	17.78	17.78	17.78	17.78	17.78	17.78
31	17.78									

THICKNESS AT BOTTOM OF SEGMENT (HB)

K	HB(K)	HB(K+1)	HB(K+2)	HB(K+3)	HB(K+4)	HB(K+5)	HB(K+6)	HB(K+7)	HB(K+8)	HB(K+9)
1	9.75	9.75	9.75	9.75	0.00	13.15	13.15	13.15	13.15	0.00
11	15.15	15.15	15.15	15.15	0.00	17.78	17.78	17.78	17.78	17.78
21	17.78	17.78	17.78	17.78	17.78	17.78	17.78	17.78	17.78	17.78
31	17.78									

55-1100-029
6/78
Lew
71

ELEMENT 5. ITERATION 72 PAGE 5 DATE 04/26/78

MATERIAL PROPERTIES BY SEGMENTS

SEG. NO.	ALPHA	MODULUS OF TENSION	MODULUS OF SHEAR	POISSON<S RATIO
1	.7304E-05	.2858E+08	.1099E+08	.3000E+00
2	.7306E-05	.2856E+08	.1099E+08	.3000E+00
3	.7309E-05	.2855E+08	.1098E+08	.3000E+00
4	.7310E-05	.2854E+08	.1098E+08	.3000E+00
5	.7324E-05	.2846E+08	.1095E+08	.3000E+00
6	.7338E-05	.2837E+08	.1091E+08	.3000E+00
7	.7342E-05	.2834E+08	.1090E+08	.3000E+00
8	.7345E-05	.2833E+08	.1089E+08	.3000E+00
9	.7347E-05	.2832E+08	.1089E+08	.3000E+00
10	.7354E-05	.2827E+08	.1087E+08	.3000E+00
11	.7350E-05	.2823E+08	.1085E+08	.3000E+00
12	.7351E-05	.2822E+08	.1086E+08	.3000E+00
13	.7361E-05	.2822E+08	.1086E+08	.3000E+00
14	.7360E-05	.2823E+08	.1086E+08	.3000E+00
15	.7366E-05	.2819E+08	.1084E+08	.3000E+00
16	.7373E-05	.2815E+08	.1083E+08	.3000E+00
17	.7370E-05	.2816E+08	.1083E+08	.3000E+00
18	.7357E-05	.2819E+08	.1084E+08	.3000E+00
19	.7363E-05	.2821E+08	.1085E+08	.3000E+00
20	.7359E-05	.2824E+08	.1085E+08	.3000E+00
21	.7353E-05	.2827E+08	.1087E+08	.3000E+00
22	.7347E-05	.2831E+08	.1089E+08	.3000E+00
23	.7340E-05	.2836E+08	.1091E+08	.3000E+00
24	.7331E-05	.2841E+08	.1093E+08	.3000E+00
25	.7320E-05	.2848E+08	.1095E+08	.3000E+00
26	.7308E-05	.2856E+08	.1098E+08	.3000E+00
27	.7293E-05	.2864E+08	.1102E+08	.3000E+00
28	.7280E-05	.2872E+08	.1104E+08	.3000E+00
29	.7269E-05	.2877E+08	.1107E+08	.3000E+00
30	.7259E-05	.2883E+08	.1109E+08	.3000E+00
31	.7247E-05	.2889E+08	.1111E+08	.3000E+00

LEW
620-0011-55
6/78
72

ELEMENT 5. ITERATION 72 PAGE 6 DATE 04/26/78

PRESSURE INPUT DATA BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	INTERNAL PRESSURE	EXTERNAL PRESSURE
1.0	31.0	0.0	0.0

MECHANICAL LOADING ON SEGMENTAL GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	RADIAL FORCE	MOMENT	AXIAL FORCE
1.0	31.0	0.	0.	0.

STRESS CONCENTRATION FACTORS BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	INSIDE TENSION	INSIDE BENDING	OUTSIDE TENSION	OUTSIDE BENDING
1	31	1.00	1.00	1.00	1.00

LEW
620-0011-55
6/78
73

ELEMENT 5. ITERATION 72 PAGE 7 DATE 04/26/78

TEMPERATURES PER SEGMENT USED IN PRIMARY + SECONDARY ANALYSIS

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5	SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	417.	370.	323.	276.	229.	16	494.	440.	385.	332.	278.
2	420.	373.	326.	279.	232.	17	490.	437.	383.	330.	277.
3	424.	376.	329.	281.	234.	18	486.	433.	380.	327.	275.
4	427.	379.	331.	283.	235.	19	481.	429.	377.	324.	272.
5	467.	412.	357.	302.	247.	20	475.	424.	372.	321.	269.
6	470.	415.	360.	305.	250.	21	469.	418.	368.	317.	267.
7	473.	418.	363.	308.	253.	22	460.	410.	361.	312.	263.
8	475.	420.	365.	310.	255.	23	450.	402.	354.	306.	258.
9	477.	422.	366.	311.	255.	24	440.	393.	346.	299.	253.
10	489.	433.	377.	321.	265.	25	428.	382.	336.	291.	245.
11	490.	434.	378.	322.	266.	26	415.	370.	325.	281.	236.
12	489.	433.	378.	322.	266.	27	400.	357.	313.	270.	227.
13	488.	433.	377.	322.	266.	28	392.	349.	306.	263.	221.
14	487.	431.	376.	321.	266.	29	384.	342.	299.	257.	215.
15	496.	441.	387.	333.	279.	30	376.	334.	292.	250.	208.
						31	369.	327.	285.	243.	201.

LEW
620-0011-55
6/78
74

ELEMENT 5. ITERATION 72 PAGE 8 DATE 04/26/78

PRIMARY + SECONDARY BOUNDARY AND FLEXABILITY MATRICES

BOUNDARY FORCES DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL SHEAR (O)	MOMENT (O)	RADIAL SHEAR (N)	MOMENT (N)	SUM
AXIAL FORCE (N)	0.	0.	0.	0.	0.	0.	0.	0.	0.
RADIAL SHEAR (O)	0.	0.	0.	0.	0.	0.	0.	0.	0.
MOMENT (O)	0.	0.	0.	0.	0.	0.	0.	0.	0.
RADIAL SHEAR (N)	0.	0.	0.	0.	0.	0.	0.	0.	0.
MOMENT (N)	0.	0.	0.	0.	0.	0.	0.	0.	0.

FLEXIBILITY MATRIX DUE TO A UNIT LOAD (TOTAL LOAD BASIS)

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL SHEAR (O)	MOMENT (O)	RADIAL SHEAR (N)	MOMENT (N)
AXIAL DEFL. (N)	.6368E-01	0.	0.	.4880E-09	-.9990E-09	.9194E-10	-.1032E-08	-.8375E-10
RADIAL DEFL. (O)	-.1701E+00	0.	0.	-.9990E-09	.4644E-08	-.2854E-09	.2088E-08	.2743E-09
ROTATION (O)	-.4359E-03	0.	0.	.9194E-10	-.2854E-09	.2633E-10	-.2357E-09	-.2133E-10
RADIAL DEFL. (N)	.1498E+00	0.	0.	-.1032E-08	.2088E-08	-.2357E-09	.3657E-08	.2418E-09
ROTATION (N)	-.2621E-02	0.	0.	-.8375E-10	.2743E-09	-.2133E-10	.2418E-09	.2346E-10

BOUNDARY DEFLECTIONS DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL SHEAR (O)	MOMENT (O)	RADIAL SHEAR (N)	MOMENT (N)	SUM
AXIAL DEFL. (N)	.6368E-01	0.	0.	0.	0.	0.	0.	0.	.6368E-01
RADIAL DEFL. (O)	-.1701E+00	0.	0.	0.	0.	0.	0.	0.	-.1701E+00
ROTATION (O)	-.4359E-03	0.	0.	0.	0.	0.	0.	0.	-.4359E-03
RADIAL DEFL. (N)	.1498E+00	0.	0.	0.	0.	0.	0.	0.	.1498E+00
ROTATION (N)	-.2621E-02	0.	0.	0.	0.	0.	0.	0.	-.2621E-02

LEW 6/78

620-0011-55

ELEMENT 5. ITERATION 72 PAGE 9 DATE 04/26/78

FLEXIBILITY MATRIX OF ASSEMBLY AS IN PROGRAM 91060
(THIS MATRIX ONLY IS ON A PER RADIAN BASIS)

	M(O)	Q(O)	M(N)	Q(N)
ROTATION(O)	.165448E-09	.179330E-08	-.133994E-09	-.148085E-08
DEFLECTION(O)	.179330E-08	.291817E-07	-.172376E-08	-.131176E-07
ROTATION(N)	-.133994E-09	-.172376E-08	.147422E-09	.151941E-08
DEFLECTION(N)	-.148085E-08	-.131176E-07	.151941E-08	.229760E-07

NOTE- THE +1 SIGN CONVENTION IS USED IN THE MATRIX PRINTED HERE.
IF IT IS DESIRED TO USE THE -1 SIGN CONVENTION THEN THE
SIGNS MUST BE CHANGED ON ALL OF THE OFF-DIAGONAL ELEMENTS.

LEW
620-0011-55
6/78

76

ELEMENT 5. ITERATION 72 PAGE 10 DATE 04/26/78

PRIMARY + SECONDARY FORCES AND MOTIONS
****

POSITIVE DIRECTIONS (+) ARE AS FOLLOWS

TOP OF SEGMENT NO.1	BOTTOM OF REMAINING SEGMENTS
RADIAL------ TO THE LEFT	RADIAL------ TO THE RIGHT
ROTATIONAL-- CLOCKWISE	ROTATIONAL-- COUNTERCLOCKWISE
AXIAL------- UPWARD	AXIAL------- DOWNWARD

** SIGN CONVENTIONS ARE FOR A RIGHT HAND VIEW **

SEG. NO.	LOC.	RADIAL FORCE	MOMENT	AXIAL FORCE	LOC.	RADIAL MOTION	ROTATION	AXIAL MOTION
1	TOP	0.	0.	0.	TOP	-.1701E+00	-.4359E-03	0.
1	BOT.	.3392E+06	-.8514E+05	0.	BOT.	.1703E+00	.3424E-03	.1113E-02
2	BOT.	.6593E+06	-.3353E+06	0.	BOT.	.1704E+00	.2492E-03	.2240E-02
3	BOT.	.9627E+06	-.7414E+06	0.	BOT.	.1705E+00	.1550E-03	.3381E-02
4	BOT.	.1259E+07	-.1295E+07	0.	BOT.	.1706E+00	.6001E-04	.4534E-02
5	BOT.	.1250E+07	-.1295E+07	0.	BOT.	.1749E+00	.6001E-04	.4432E-02
6	BOT.	.1517E+07	-.2685E+07	0.	BOT.	.1749E+00	-.1014E-03	.7020E-02
7	BOT.	.1721E+07	-.4309E+07	0.	BOT.	.1748E+00	-.2632E-03	.9641E-02
8	BOT.	.1873E+07	-.6109E+07	0.	BOT.	.1744E+00	-.4258E-03	.1229E-01
9	BOT.	.1993E+07	-.8041E+07	0.	BOT.	.1740E+00	-.5898E-03	.1495E-01
10	BOT.	.1993E+07	-.8041E+07	0.	BOT.	.1767E+00	-.5898E-03	.1554E-01
11	BOT.	.1853E+07	-.9963E+07	0.	BOT.	.1761E+00	-.7332E-03	.1832E-01
12	BOT.	.1645E+07	-.1173E+08	0.	BOT.	.1753E+00	-.8764E-03	.2111E-01
13	BOT.	.1489E+07	-.1332E+08	0.	BOT.	.1744E+00	-.1020E-02	.2390E-01
14	BOT.	.1267E+07	-.1470E+08	0.	BOT.	.1733E+00	-.1163E-02	.2668E-01
15	BOT.	.1267E+07	-.1470E+08	0.	BOT.	.1770E+00	-.1163E-02	.2821E-01
16	BOT.	.7961E+06	-.1561E+08	0.	BOT.	.1760E+00	-.1266E-02	.3074E-01
17	BOT.	.3212E+06	-.1610E+08	0.	BOT.	.1748E+00	-.1368E-02	.3325E-01
18	BOT.	-.1450E+06	-.1617E+08	0.	BOT.	.1736E+00	-.1469E-02	.3575E-01
19	BOT.	-.5952E+06	-.1585E+08	0.	BOT.	.1722E+00	-.1564E-02	.3822E-01
20	BOT.	-.1019E+07	-.1514E+08	0.	BOT.	.1709E+00	-.1668E-02	.4066E-01
21	BOT.	-.1407E+07	-.1409E+08	0.	BOT.	.1693E+00	-.1765E-02	.4307E-01
22	BOT.	-.1741E+07	-.1269E+08	0.	BOT.	.1677E+00	-.1859E-02	.4543E-01
23	BOT.	-.1998E+07	-.1105E+08	0.	BOT.	.1660E+00	-.1952E-02	.4775E-01
24	BOT.	-.2168E+07	-.9224E+07	0.	BOT.	.1642E+00	-.2042E-02	.5000E-01
25	BOT.	-.2225E+07	-.7294E+07	0.	BOT.	.1624E+00	-.2130E-02	.5218E-01
26	BOT.	-.2139E+07	-.5373E+07	0.	BOT.	.1604E+00	-.2215E-02	.5428E-01
27	BOT.	-.1985E+07	-.3601E+07	0.	BOT.	.1584E+00	-.2299E-02	.5629E-01
28	BOT.	-.1510E+07	-.2112E+07	0.	BOT.	.1564E+00	-.2380E-02	.5822E-01
29	BOT.	-.1073E+07	-.9773E+06	0.	BOT.	.1542E+00	-.2461E-02	.6009E-01
30	BOT.	-.5711E+06	-.2540E+06	0.	BOT.	.1520E+00	-.2541E-02	.6192E-01
31	BOT.	0.	0.	0.	BOT.	.1498E+00	-.2621E-02	.6368E-01

(FORCE AND MOTION OUTPUT IS IN GLOBAL DIRECTIONS R AND Z)

ELEMENT 5. ITERATION 72 PAGE 11 DATE 04/26/78

PRIMARY + SECONDARY STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	285.9	-9149.2	231.9	346.8	10881.0	1630.1	-87.6	32060.0	231.9
2	313.5	-9796.4	231.1	343.0	10261.8	1623.7	-119.1	31473.2	231.1
3	370.3	-10423.5	231.6	341.6	9713.9	1626.5	-176.8	31008.6	231.6
4	449.2	-10994.2	232.4	340.5	9221.9	1631.5	-259.7	30597.7	232.4
6	422.0	-19424.1	340.7	499.9	2934.5	2373.1	-143.7	26952.5	340.7
7	541.0	-19797.3	338.4	491.5	2229.2	2355.0	-274.3	26101.8	338.4
8	679.7	-20465.6	336.7	482.8	1695.4	2342.1	-424.0	25498.6	335.7
9	829.0	-21024.4	336.3	475.5	1173.1	2338.4	-585.0	25014.5	336.3
11	725.9	-23478.7	378.9	536.6	-1495.9	2621.4	-447.8	22321.3	378.9
12	825.7	-23552.3	376.8	531.8	-1788.0	2605.6	-559.2	21780.5	376.8
13	915.6	-23585.4	373.3	522.0	-2091.3	2580.4	-659.0	21292.5	373.3
14	993.1	-23780.6	370.4	514.1	-2343.7	2559.3	-745.8	20969.3	370.4
16	704.2	-25139.6	406.0	569.6	-4759.0	2785.7	-416.0	17544.1	406.0
17	725.6	-24996.5	402.4	563.2	-4707.0	2760.2	-442.4	17387.6	402.4
18	739.9	-24501.6	398.8	557.4	-4587.0	2735.7	-451.1	17318.3	398.8
19	721.2	-24191.7	395.1	553.0	-4391.8	2711.0	-443.2	17300.[illegible]	395.1
20	599.2	-23531.3	391.0	548.5	-4049.2	2683.6	-420.7	17386.0	391.0
21	560.3	-22988.8	385.3	544.3	-3669.3	2645.7	-303.4	17367.3	385.3
22	519.5	-21950.9	379.0	536.3	-2938.6	2604.2	-341.2	17772.9	379.0
23	569.0	-20749.5	373.6	531.3	-2125.6	2569.8	-288.6	18277.9	373.6
24	513.4	-19424.4	367.7	527.3	-1161.1	2532.6	-231.4	18856.8	367.7
25	465.0	-18010.6	363.8	521.1	138.0	2510.0	-178.2	20060.8	363.8
26	425.5	-16182.1	361.7	522.9	1759.6	2500.5	-133.4	21469.6	361.7
27	399.9	-14210.3	358.9	521.7	3543.8	2487.7	-100.7	23071.5	358.9
28	352.6	-13455.7	357.1	521.9	4237.7	2480.3	-50.5	23705.3	357.1
29	313.7	-12770.4	356.0	522.8	4839.0	2474.9	-14.0	24219.8	356.0
30	309.7	-12076.1	355.9	522.2	5557.6	2476.4	.1	24980.2	355.9
31	317.5	-11457.8	357.3	524.2	6239.4	2488.6	-6.5	25741.1	357.3

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

LEW
620-0011-55
6/78
78

ELEMENT 5. ITERATION 72 PAGE 12 DATE 04/26/78

TEMPERATURES PER SEGMENT USED IN PEAK PRINCIPLE ANALYSIS

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	375.	373.	335.	275.	216.
2	379.	376.	338.	279.	216.
3	403.	379.	340.	282.	217.
4	409.	381.	342.	285.	217.
5	443.	413.	371.	305.	217.
6	442.	418.	376.	310.	218.
7	443.	421.	380.	313.	219.
8	444.	423.	382.	315.	219.
9	445.	425.	384.	316.	219.
10	452.	435.	399.	328.	219.
11	452.	437.	399.	329.	219.
12	451.	436.	400.	329.	219.
13	451.	435.	399.	329.	219.
14	449.	434.	398.	328.	219.
15	451.	444.	414.	343.	219.

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
16	450.	442.	412.	342.	219.
17	448.	439.	408.	340.	219.
18	446.	435.	405.	337.	219.
19	442.	431.	400.	334.	218.
20	438.	426.	394.	330.	218.
21	433.	420.	388.	326.	218.
22	427.	412.	380.	320.	217.
23	420.	404.	371.	313.	217.
24	413.	395.	359.	306.	217.
25	405.	385.	346.	296.	216.
26	396.	373.	330.	285.	215.
27	388.	360.	312.	273.	215.
28	383.	353.	301.	266.	214.
29	379.	346.	290.	259.	214.
30	374.	339.	278.	251.	213.
31	370.	332.	266.	243.	212.

LEW
620-0011-55
6/78
79

ELEMENT 5. ITERATION 72 PAGE 13 DATE 04/26/78

PEAK BOUNDARY AND FLEXABILITY MATRICES

BOUNDARY FORCES DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL SHEAR (O)	MOMENT (O)	RADIAL SHEAR (N)	MOMENT (N)	SUM
AXIAL FORCE (N)	0.	0.	0.	0.	0.	0.	0.	0.	0.
RADIAL SHEAR (O)	0.	0.	0.	0.	0.	0.	0.	0.	0.
MOMENT (O)	0.	0.	0.	0.	0.	0.	0.	0.	0.
RADIAL SHEAR (N)	0.	0.	0.	0.	0.	0.	0.	0.	0.
MOMENT (N)	0.	0.	0.	0.	0.	0.	0.	0.	0.

FLEXIBILITY MATRIX DUE TO A UNIT LOAD (TOTAL LOAD BASIS)

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL SHEAR (O)	MOMENT (O)	RADIAL SHEAR (N)	MOMENT (N)
AXIAL DEFL. (N)	.6384E-01	0.	0.	.4880E-09	-.9990E-09	.9194E-10	-.1032E-08	-.8375E-10
RADIAL DEFL. (O)	-.1701E+00	0.	0.	-.9990E-09	.4644E-08	-.2854E-09	.2088E-08	.2743E-09
ROTATION (O)	-.3927E-03	0.	0.	.9194E-10	-.2854E-09	.2633E-10	-.2357E-09	-.2133E-10
RADIAL DEFL. (N)	.1500E+00	0.	0.	-.1032E-08	.2088E-08	-.2357E-09	.3657E-08	.2418E-09
ROTATION (N)	-.2616E-02	0.	0.	-.8375E-10	.2743E-09	-.2133E-10	.2418E-09	.2346E-10

LEW 6/78

620-0011-55

BOUNDARY DEFLECTIONS DUE TO THE END CONDITIONS

	TEMP.	PRESS.	EXTERNAL LOAD	AXIAL FORCE (N)	RADIAL SHEAR (O)	MOMENT (O)	RADIAL SHEAR (N)	MOMENT (N)	SUM
AXIAL DEFL. (N)	.6384E-01	0.	0.	0.	0.	0.	0.	0.	.6384E-01
RADIAL DEFL. (O)	-.1701E+00	0.	0.	0.	0.	0.	0.	0.	-.1701E+00
ROTATION (O)	-.3927E-03	0.	0.	0.	0.	0.	0.	0.	-.3927E-03
RADIAL DEFL. (N)	.1500E+00	0.	0.	0.	0.	0.	0.	0.	.1500E+00
ROTATION (N)	-.2616E-02	0.	0.	0.	0.	0.	0.	0.	-.2616E-02

ELEMENT 5. ITERATION 72 PAGE 14 DATE 04/26/78

FLEXIBILITY MATRIX OF ASSEMBLY AS IN PROGRAM 91060
(THIS MATRIX ONLY IS ON A PER RADIAN BASIS)

	M(O)	Q(O)	M(N)	Q(N)
ROTATION(O)	.165448E-09	.179330E-08	-.133994E-09	-.148085E-08
DEFLECTION(O)	.179330E-08	.291817E-07	-.172376E-08	-.131176E-07
ROTATION(N)	-.133994E-09	-.172376E-08	.147422E-09	.151941E-08
DEFLECTION(N)	-.148085E-08	-.131176E-07	.151941E-08	.229760E-07

NOTE- THE +1 SIGN CONVENTION IS USED IN THE MATRIX PRINTED HERE. IF IT IS DESIRED TO USE THE -1 SIGN CONVENTION THEN THE SIGNS MUST BE CHANGED ON ALL OF THE OFF-DIAGONAL ELEMENTS.

LEW
620-0011-55
6/78
81

ELEMENT 5. ITERATION 72 PAGE 15 DATE 04/26/78

PEAK FORCES AND MOTIONS

POSITIVE DIRECTIONS (+) ARE AS FOLLOWS

TOP OF SEGMENT NO.1	BOTTOM OF REMAINING SEGMENTS
RADIAL------ TO THE LEFT	RADIAL------ TO THE RIGHT
ROTATIONAL-- CLOCKWISE	ROTATIONAL-- COUNTERCLOCKWISE
AXIAL------- UPWARD	AXIAL------- DOWNWARD

** SIGN CONVENTIONS ARE FOR A RIGHT HAND VIEW **

SEG. NO.	LOC.	RADIAL FORCE	MOMENT	AXIAL FORCE	LOC.	RADIAL MOTION	ROTATION	AXIAL MOTION
1	TOP	0.	0.	0.	TOP	-.1701E+00	-.3927E-03	0.
1	BOT.	.3401E+06	-.8565E+05	0.	BOT.	.1703E+00	.2995E-03	.1112E-02
2	BOT.	.6624E+06	-.3370E+06	0.	BOT.	.1704E+00	.2065E-03	.2238E-02
3	BOT.	.9662E+06	-.7449E+06	0.	BOT.	.1705E+00	.1128E-03	.3379E-02
4	BOT.	.1254E+07	-.1300E+07	0.	BOT.	.1705E+00	.1829E-04	.4532E-02
5	BOT.	.1254E+07	-.1300E+07	0.	BOT.	.1750E+00	.1829E-04	.4501E-02
6	BOT.	.1523E+07	-.2694E+07	0.	BOT.	.1750E+00	-.1411E-03	.7088E-02
7	BOT.	.1725E+07	-.4323E+07	0.	BOT.	.1748E+00	-.3009E-03	.9710E-02
8	BOT.	.1873E+07	-.6129E+07	0.	BOT.	.1744E+00	-.4614E-03	.1236E-01
9	BOT.	.1995E+07	-.8064E+07	0.	BOT.	.1739E+00	-.6231E-03	.1502E-01
10	BOT.	.1995E+07	-.8064E+07	0.	BOT.	.1768E+00	-.6231E-03	.1564E-01
11	BOT.	.1855E+07	-.9949E+07	0.	BOT.	.1761E+00	-.7637E-03	.1842E-01
12	BOT.	.1685E+07	-.1175E+08	0.	BOT.	.1753E+00	-.9045E-03	.2121E-01
13	BOT.	.1487E+07	-.1335E+08	0.	BOT.	.1744E+00	-.1045E-02	.2400E-01
14	BOT.	.1262E+07	-.1473E+08	0.	BOT.	.1733E+00	-.1185E-02	.2679E-01
15	BOT.	.1262E+07	-.1473E+08	0.	BOT.	.1772E+00	-.1185E-02	.2834E-01
16	BOT.	.7929E+06	-.1563E+08	0.	BOT.	.1762E+00	-.1285E-02	.3087E-01
17	BOT.	.3189E+06	-.1611E+08	0.	BOT.	.1750E+00	-.1384E-02	.3339E-01
18	BOT.	-.1469E+05	-.1617E+08	0.	BOT.	.1739E+00	-.1482E-02	.3588E-01
19	BOT.	-.5953E+06	-.1565E+08	0.	BOT.	.1724E+00	-.1579E-02	.3836E-01
20	BOT.	-.1023E+07	-.1515E+08	0.	BOT.	.1710E+00	-.1675E-02	.4080E-01
21	BOT.	-.1409E+07	-.1409E+08	0.	BOT.	.1695E+00	-.1769E-02	.4321E-01
22	BOT.	-.1743E+07	-.1270E+08	0.	BOT.	.1679E+00	-.1861E-02	.4554E-01
23	BOT.	-.2001E+07	-.1105E+08	0.	BOT.	.1661E+00	-.1952E-02	.4789E-01
24	BOT.	-.2171E+07	-.9227E+07	0.	BOT.	.1644E+00	-.2040E-02	.5014E-01
25	BOT.	-.2227E+07	-.7294E+07	0.	BOT.	.1625E+00	-.2126E-02	.5233E-01
26	BOT.	-.2143E+07	-.5373E+07	0.	BOT.	.1606E+00	-.2210E-02	.5443E-01
27	BOT.	-.1885E+07	-.3600E+07	0.	BOT.	.1586E+00	-.2293E-02	.5643E-01
28	BOT.	-.1513E+07	-.2110E+07	0.	BOT.	.1565E+00	-.2375E-02	.5837E-01
29	BOT.	-.1073E+07	-.9771E+06	0.	BOT.	.1544E+00	-.2455E-02	.6025E-01
30	BOT.	-.5705E+06	-.2537E+06	0.	BOT.	.1522E+00	-.2534E-02	.6207E-01
31	BOT.	0.	0.	0.	BOT.	.1500E+00	-.2616E-02	.6384E-01

(FORCE AND MOTION OUTPUT IS IN GLOBAL DIRECTIONS R AND Z)

LEW 620-0011-055 6/9/78 28

ELEMENT 5. ITERATION 72 PAGE 16 DATE 04/26/78

PEAK PRINCIPAL STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	6554.2	-2772.7	212.8	-3327.4	7241.9	1694.4	3830.4	35968.1	212.8
2	6459.0	-3540.5	217.9	-3278.3	6657.0	1664.9	4643.0	36172.9	217.9
3	6363.1	-4327.5	222.8	-3050.3	6320.0	1650.5	4909.0	35999.4	222.8
4	5969.6	-5467.3	228.5	-2927.3	5937.2	1636.5	5361.3	36077.8	228.5
6	8447.9	-11107.0	355.1	-4180.8	-1730.1	2294.0	9895.6	36709.7	355.1
7	9083.9	-11162.5	350.2	-4533.6	-2795.1	2243.4	10326.9	36386.4	350.2
8	9504.6	-11355.5	349.2	-4611.2	-3418.1	2266.3	10644.0	36212.9	349.2
9	9791.0	-11582.5	348.9	-4793.1	-4129.2	2261.5	10685.2	35911.6	348.9
11	11372.3	-12391.9	407.9	-5803.0	-7833.0	2464.8	14053.1	36328.6	407.9
12	11441.9	-12489.2	405.1	-6191.1	-8511.4	2451.2	14091.5	35921.1	405.1
13	11235.2	-12730.3	403.8	-6052.5	-8680.6	2416.3	13997.0	35417.6	403.8
14	11472.4	-12879.9	400.8	-6061.9	-8963.7	2395.6	13753.5	34835.7	400.8
16	12584.8	-12495.8	461.7	-7280.3	-12562.0	2499.8	18046.0	35371.7	461.7
17	12302.5	-12686.5	458.7	-6835.9	-12071.2	2473.8	17608.4	34760.2	458.7
18	11727.7	-12784.0	455.0	-6456.9	-11961.8	2451.7	16974.1	34087.6	455.0
19	11512.9	-12806.5	450.4	-6431.7	-11337.7	2432.4	16573.0	33669.5	450.4
20	11004.7	-12767.8	443.5	-5935.3	-10509.5	2419.4	15714.6	32907.3	443.5
21	10419.1	-12502.0	435.1	-5566.1	-9756.6	2395.8	14974.4	32140.2	435.1
22	9589.0	-12385.2	426.9	-5156.6	-8607.2	2365.2	13977.1	31547.6	426.9
23	8729.9	-11940.1	416.2	-4589.2	-7219.9	2356.0	12515.9	30609.4	416.2
24	7705.7	-11657.1	403.1	-3348.9	-5022.0	2354.6	10962.6	29638.6	403.1
25	6799.0	-11178.5	390.2	-2319.5	-2687.8	2376.7	8871.2	28796.4	390.2
26	5729.8	-10675.2	376.4	-842.7	400.8	2423.3	6509.4	27999.3	376.4
27	3754.7	-10569.7	362.6	984.2	4005.8	2467.3	3554.7	26637.9	362.6
28	3133.1	-10661.3	351.6	2219.2	5923.4	2508.8	2033.2	25764.5	351.6
29	2082.7	-11071.6	343.1	3498.1	7794.2	2542.6	231.9	24516.5	343.1
30	1315.5	-11217.0	333.7	4484.5	9887.6	2590.9	-1046.3	23465.4	333.7
31	369.4	-11641.4	325.0	6300.1	11971.3	2653.7	-3599.4	22359.8	325.0

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

BMS 247-1

PRI. + SEC. FREE BODY THERMAL STRESSES

FOR

TRANSIENT = SMUD RAPID COOLDOWN

ITERATION = 26

JUNCTURE	INSIDE			OUTSIDE		
	σ_L	σ_C	σ_R	σ_L	σ_C	σ_R
#1	0.0	0.5	0.0	0.0	-0.4	0.0
#2	0.0	0.7	0.0	0.0	+1.9	0.0
#3	0.0	-0.4	0.0	0.0	0.4	0.0
#4	0.0	0.7	0.0	0.0	1.1	0.0
#5	0.0	-0.5	0.0	0.0	0.7	0.0

NOTE: STRESS VALUES FOR ADJACENT ELEMENTS AT EACH JUNCTURE WERE COMPARED AND THE LARGER OF THE VALUES WAS TABULATED.

PRI. + SEC. FREE BODY THERMAL STRESSES

FOR

TRANSIENT - SMUD RAPID COOLDOWN

ITERATION = 39

JUNCTURE	INSIDE			OUTSIDE		
	σ_L	σ_C	σ_R	σ_L	σ_C	σ_R
#1	0.1	17.6	0.2	0.0	-17.7	0.2
#2	0.4	14.2	0.3	0.5	-14.3	0.3
#3	0.0	-1.8	0.0	+0.1	+3.0	0.0
#4	0.1	2.8	0.0	0.1	1.8	0.0
#5	-0.3	32.0	0.3	0.1	2.8	0.0

BMC 247-1

PRI. + SEC. FREE BODY THERMAL STRESSES

FOR

TRANSIENT - SMUD RAPID COOLDOWN

ITERATION = 45

JUNCTURE	INSIDE			OUTSIDE		
	σ_L	σ_C	σ_R	σ_L	σ_C	σ_R
#1	0.1	22.1	0.2	0.1	-22.4	0.2
#2	0.5	18.5	0.4	0.6	-18.6	0.4
#3	0.0	-1.6	0.0	0.0	+2.2	0.0
#4	-0.2	8.1	0.0	0.2	9.0	0.0
#5	-0.3	38.4	0.4	-0.2	8.1	0.0

PRI. + SEC. FREE BODY THERMAL STRESSES

FOR

TRANSIENT = SMUD RAPID COOLDOWN

ITERATION = 49

JUNCTURE	INSIDE			OUTSIDE		
	σ_L	σ_C	σ_R	σ_L	σ_C	σ_R
#1	0.0	10.0	0.1	0.0	-10.5	0.1
#2	0.2	10.0	0.1	0.3	-9.8	0.1
#3	0.0	0.0	0.0	0.0	-0.2	0.0
#4	0.1	8.5	0.0	0.1	5.6	0.0
#5	-0.2	15.7	0.1	-0.1	8.5	0.0

BWS 247-1

PRI. + SEC. FREE BODY THERMAL STRESSES

FOR

TRANSIENT = SMUD RAPID COOLDOWN

ITERATION = 72

JUNCTURE	INSIDE			OUTSIDE		
	σ_L	σ_C	σ_R	σ_L	σ_C	σ_R
#1	0.0	8.1	0.0	0.0	-8.4	0.0
#2	0.0	8.0	0.4	0.3	-11.5	0.3
#3	-0.2	+15.3	+0.1	-0.5	-23.2	+0.1
#4	-0.1	32.1	0.2	0.3	-16.2	0.2
#5	0.0	25.7	0.4	0.1	32.1	0.2

BABCOCK & WILCOX
DEPARTMENT Mt.V-Comp. Engrg. DATE 6/78 BY LEW
PRI. + SEC. FBTS
CHECKED DATE BY
JOB NO. 620-001-55
REVISION
SHEET 88 OF

BMC 247-1

PEAK INCREM. FREE BODY THERMAL STRESSES

FOR

TRANSIENT = SMUD RAPID COOLDOWN

ITERATION = 26

JUNCTURE	INSIDE			OUTSIDE		
	σ_L	σ_C	σ_R	σ_L	σ_C	σ_R
#1	-0.1	0.0	0.0	+0.1	+0.1	0.0
#2	+1.2	-1.3	+0.2	-1.6	-1.8	-0.1
#3	-0.1	-0.1	0.0	-0.1	-0.1	0.0
#4	-0.3	-0.3	0.0	0.0	0.0	0.0
#5	-6.1	-5.9	-0.1	-0.3	-0.3	0.0

BABCOCK & WILCOX
DEPARTMENT NUC - COMP. ENGRG. DATE 3/78 BY LEW
PEAK INCREMENT CHECKED DATE BY
FBTS JOB NO. 620-0011-55

REVISION

SHEET 89 OF

PEAK INCREM. FREE BODY THERMAL STRESSES

FOR

TRANSIENT = SMUD RAPID COOLDOWN

ITERATION = 39

JUNCTURE	INSIDE			OUTSIDE		
	σ_L	σ_C	σ_R	σ_L	σ_C	σ_R
#1	+39.2	+38.3	+0.1	+10.4	+11.3	+0.1
#2	+46.5	+45.2	-0.5	+9.6	+10.5	-0.4
#3	-2.1	-2.1	0.0	-1.0	-1.0	0.0
#4	-2.4	-2.3	0.0	-1.5	-1.5	0.0
#5	-57.0	-54.4	-0.5	-2.0	+2.1	0.0

BWS 247-1

PEAK INCREM. FREE BODY THERMAL STRESSES

FOR

TRANSIENT = SMUD RAPID COOLDOWN

ITERATION = 45

JUNCTURE	INSIDE			OUTSIDE		
	σ_L	σ_C	σ_R	σ_L	σ_C	σ_R
#1	+14.6	+14.3	+0.1	+6.4	+7.1	+0.1
#2	+27.0	+26.9	-0.5	-15.0	-17.6	-0.5
#3	+2.4	+2.4	0.0	-0.1	0.0	0.0
#4	+3.3	+3.0	0.0	-0.3	+0.4	0.0
#5	-69.7	66.3	-0.5	+3.3	+3.0	0.0

BABCOCK & WILCOX
DEPARTMENT MT. V - COMP. ENGRG. DATE 6/78 BY LEW
PEAK INCREMENT CHECKED DATE BY
FBTS JOB NO. 620-0011-55
REVISION
SHEET 91 OF

PEAK INCREM. FREE BODY THERMAL STRESSES

FOR

TRANSIENT = SMUD RAPID COOLDOWN

ITERATION = 49

JUNCTURE	INSIDE			OUTSIDE		
	σ_L	σ_C	σ_R	σ_L	σ_C	σ_R
#1	-31.4	-30.7	-0.1	-4.1	-4.9	-0.1
#2	-26.5	-25.8	-0.1	-15.5	-17.3	-0.1
#3	+5.2	+5.0	0.0	+1.0	+1.1	0.0
#4	+6.0	+6.0	0.0	+1.6	+1.9	0.0
#5	-35.4	-34.0	-0.1	+6.0	+6.0	0.0

BMS 247-1

PEAK INCREM. FREE BODY THERMAL STRESSES

FOR

TRANSIENT = SMUD RAPID COOLDOWN

ITERATION = 72

JUNCTURE	INSIDE			OUTSIDE		
	σ_L	σ_C	σ_R	σ_L	σ_C	σ_R
#1	+5.1	+5.0	0.0	+2.1	+2.2	0.0
#2	+7.6	+7.4	+0.1	+2.5	+2.6	+0.1
#3	+6.7	+6.5	0.0	+5.6	+5.6	0.0
#4	+7.3	+7.2	+0.1	+5.4	+5.4	0.0
#5	-3.6	-3.4	0.0	+3.8	+3.9	0.0

ELEMENT # 5 FREE BODY THERMAL MOTIONS

(ADJUSTMENT OF MOTIONS TO INTERACTION JUNCTURES)

ITERATION NUMBER = 26

JUNCTURE 2

R_2 = JUNCTURE 2 MEAN RADIUS = 72.250"

$R_{'N'}$ = PROGRAM 91206 "O" END RADIUS = 66.673"

$$\theta_{JCT.2} = \theta_{91206}^{'N' END} = -0.5275E-03$$

$$\delta_{JCT.2} = \delta_{91206}^{'N' END}\left(\frac{72.250}{66.673}\right) = (1.084)(+0.2334)$$

$$= +0.2530E+00$$

JUNCTURE 4

R_4 = JUNCTURE 4 MEAN RADIUS = 63.53125"

$R_{'O'}$ = PROGRAM 91206 'O' END RADIUS = 62.6575"

$$\theta_{JCT.4} = \theta_{91206}^{'O' END} = -0.7215E-03$$

$$\delta_{JCT.4} = \delta_{91206}^{'O' END}\left(\frac{63.53125}{62.6575}\right) = (1.0139)(0.2339)$$

$$= +0.2372E+00$$

JUNCTURE 5

R_5 = JUNCTURE 5 MEAN RADIUS = 57.47125"

$R_{"SEG 17"}$ = PROGRAM 91206 SEGMENT 17 RAD. = 66.673"

$$\theta_{JCT.5} = \theta_{91206}^{SEG.17} = -0.6409E-03$$

$$\delta_{JCT.5} = \delta_{91206}^{SEG.17}\left(\frac{57.47125}{66.673}\right) = (0.8620)(0.2405) = +0.2073E+00$$

BABCOCK & WILCOX			REVISION
DEPARTMENT Mt. V - Comp. Engrg.	DATE 6/78	BY LEW	
JUNCTURE #5	CHECKED DATE	BY	
FBTM	JOB NO. 620-0011-55		SHEET 94 OF

ELEMENT # 5 FREE BODY THERMAL MOTIONS

(ADJUSTMENT OF MOTIONS TO INTERACTION JUNCTURES)

ITERATION NUMBER = 39

JUNCTURE 2

R_2 = JUNCTURE 2 MEAN RADIUS = 72.250"
$R_{'N'}$ = PROGRAM 91206 "O" END RADIUS = 66.673"

$$\theta_{JCT.2} = \theta_{91206}^{'N' END} = -0.2141E-02$$

$$\delta_{JCT.2} = \delta_{91206}^{'N' END}\left(\frac{72.250}{66.673}\right) = (1.084)(0.2123)$$

$$= \underline{+0.2301E+00}$$

JUNCTURE 4

R_4 = JUNCTURE 4 MEAN RADIUS = 63.53125"
$R_{'O'}$ = PROGRAM 91206 'O' END RADIUS = 62.6575"

$$\theta_{JCT.4} = \theta_{91206}^{'O' END} = -0.2234E-02$$

$$\delta_{JCT.4} = \delta_{91206}^{'O' END}\left(\frac{63.53125}{62.6575}\right) = (1.0139)(0.2470)$$

$$= \underline{+0.2504E+00}$$

JUNCTURE 5

R_5 = JUNCTURE 5 MEAN RADIUS = 57.47125"
$R_{"SEG\ 17"}$ = PROGRAM 91206 SEGMENT 17 RAD. = 66.673"

$$\theta_{JCT.5} = \theta_{91206}^{SEG.17} = -0.2050E-02$$

$$\delta_{JCT.5} = \delta_{91206}^{SEG.17}\left(\frac{57.47125}{66.673}\right) = (0.8620)(0.2370)$$

$$= \underline{+0.2043E+00}$$

BWF 247-1

ELEMENT # 5 FREE BODY THERMAL MOTIONS

(ADJUSTMENT OF MOTIONS TO INTERACTION JUNCTURES)

ITERATION NUMBER = 45

JUNCTURE 2

R_2 = JUNCTURE 2 MEAN RADIUS = 72.250"
$R_{'N'}$ = PROGRAM 91206 "O" END RADIUS = 66.673"

$$\theta_{JCT.2} = \theta_{91206}^{'N' END} = -0.3543E-02$$

$$\delta_{JCT.2} = \delta_{91206}^{'N' END}\left(\frac{72.250}{66.673}\right) = (1.084)(0.1911)$$

$$= +0.2072\ E+00$$

JUNCTURE 4

R_4 = JUNCTURE 4 MEAN RADIUS = 63.53125"
$R_{'O'}$ = PROGRAM 91206 'O' END RADIUS = 62.6575"

$$\theta_{JCT.4} = \theta_{91206}^{'O' END} = -0.3401E-02$$

$$\delta_{JCT.4} = \delta_{91206}^{'O' END}\left(\frac{63.53125}{62.6575}\right) = (1.0139)(0.2558)$$

$$= +0.2594\ E+00$$

JUNCTURE 5

R_5 = JUNCTURE 5 MEAN RADIUS = 57.47125"
$R_{"SEG.17"}$ = PROGRAM 91206 SEGMENT 17 RAD. = 66.673"

$$\theta_{JCT.5} = \theta_{91206}^{SEG.17} = -0.3285E-02$$

$$\delta_{JCT.5} = \delta_{91206}^{SEG.17}\left(\frac{57.47125}{66.673}\right) = (0.8620)(0.2318)$$

$$= +0.1998\ E+00$$

RMS 247-1

ELEMENT # 5 FREE-BODY-THERMAL-MOTIONS

(ADJUSTMENT OF MOTIONS TO INTERACTION JUNCTURES)

ITERATION NUMBER = 49

JUNCTURE 2

R_2 = JUNCTURE 2 MEAN RADIUS = 72.250"
$R_{'N'}$ = PROGRAM 91206 "O" END RADIUS = 66.673"

$\theta_{JCT.2} = \theta_{91206}^{'N' END} = -0.2946E-02$

$\delta_{JCT.2} = \delta_{91206}^{'N' END}\left(\frac{72.250}{66.673}\right) = (1.084)(0.1976)$

$= +0.2142E+00$

JUNCTURE 4

R_4 = JUNCTURE 4 MEAN RADIUS = 63.53125"
$R_{'O'}$ = PROGRAM 91206 'O' END RADIUS = 62.6575"

$\theta_{JCT.4} = \theta_{91206}^{'O' END} = -0.2769E-02$

$\delta_{JCT.4} = \delta_{91206}^{'O' END}\left(\frac{63.53125}{62.6575}\right) = (1.0139)(0.2497)$

$= +0.2532E+00$

JUNCTURE 5

R_5 = JUNCTURE 5 MEAN RADIUS = 57.47125"
$R_{"SEG 17"}$ = PROGRAM 91206 SEGMENT 17 RAD. = 66.673"

$\theta_{JCT.5} = \theta_{91206}^{SEG.17} = -0.2792E-02$

$\delta_{JCT.5} = \delta_{91206}^{SEG.17}\left(\frac{57.47125}{66.673}\right) = (0.8620)(0.2322)$
$= +0.2002E+00$

BWT 247-1

ELEMENT # 5 FREE BODY THERMAL MOTIONS

(ADJUSTMENT OF MOTIONS TO INTERACTION JUNCTURES)

ITERATION NUMBER = 72 [REFER TO PG. 82 FOR 91206 MOTIONS]

JUNCTURE 2

R_2 = JUNCTURE 2 MEAN RADIUS = 72.250"
$R_{'N'}$ = PROGRAM 91206 "O" END RADIUS = 66.673"

$$\theta_{JCT.2} = \theta_{91206}^{'N'END} = -0.2616E-02$$

$$\delta_{JCT.2} = \delta_{91206}^{'N'END}\left(\frac{72.250}{66.673}\right) = (1.084)(0.1500)$$

$$= +0.1626E+00$$

JUNCTURE 4

R_4 = JUNCTURE 4 MEAN RADIUS = 63.53125"
$R_{'O'}$ = PROGRAM 91206 'O' END RADIUS = 62.6575"

$$\theta_{JCT.4} = \theta_{91206}^{'O'END} = +0.3927E-03$$

$$\delta_{JCT.4} = \delta_{91206}^{'O'END}\left(\frac{63.53125}{62.6575}\right) = (1.0139)(0.1701)$$

$$= +0.1725E+00$$

JUNCTURE 5

R_5 = JUNCTURE 5 MEAN RADIUS = 57.47125"
$R_{"SEG.17"}$ = PROGRAM 91206 SEGMENT 17 RAD. = 66.673"

$$\theta_{JCT.5} = \theta_{91206}^{SEG.17} = -0.1384E-02$$

$$\delta_{JCT.5} = \delta_{91206}^{SEG.17}\left(\frac{57.47125}{66.673}\right) = (0.8620)(0.1750) = +0.1509E+00$$

FREE BODY THERMAL MOTIONS

FOR

TRANSIENT = SMUD RAPID COOLDOWN

ITERATION = 26

ELEM. #	JUNC. #	ROTATION	DEFLECTION
1	1	-0.6092E-04	+0.2400E+00
2	1	-0.5881E-03	+0.2488E+00
	2	-0.5761E-03	+0.2502E+00
3	3	+0.1953E-04	+0.2256E+00
4	3	-0.2298E-03	+0.2351E+00
	4	-0.2199E-03	+0.2345E+00
5*	2	-0.5275E-03	+0.2530E+00
	4	-0.7215E-03	+0.2372E+00
	5	-0.6409E-03	+0.2073E+00

FOR EL. 5 JUNC. MOTIONS, SEE PAGE 94 (TYPICAL FOR ALL ITERS)

UNITS:
DEFLECTION - INCHES
ROTATION - RADIANS

FREE BODY THERMAL MOTIONS

FOR

TRANSIENT = SMUD RAPID COOLDOWN

ITERATION = 39

ELEM. #	JUNC. #	ROTATION	DEFLECTION
1	1	+0.1729E-02	+0.2121E+00
2	1	-0.4156E-02	+0.2265E+00
	2	-0.3621E-02	+0.2362E+00
3	3	+0.3081E-03	+0.2299E+00
4	3	-0.5058E-03	+0.2373E+00
	4	-0.4526E-03	+0.2361E+00
5	2	-0.2141E-02	+0.2301E+00
	4	-0.2234E-02	+0.2504E+00
	5	-0.2050E-02	+0.2043E+00

UNITS:
DEFLECTION - INCHES
ROTATION - RADIANS

FREE BODY THERMAL MOTIONS

FOR

TRANSIENT = SMUD RAPID COOLDOWN

ITERATION = 45

ELEM. #	JUNC. #	ROTATION	DEFLECTION
1	1	+0.2164E-02	+0.1778E+00
2	1	-0.6998E-02	+0.1976E+00
	2	-0.6282E-02	+0.2141E+00
3	3	+0.2280E-03	+0.2304E+00
4	3	-0.4569E-03	+0.2381E+00
	4	-0.4134E-03	+0.2371E+00
5	2	-0.3543E-02	+0.2072E+00
	4	-0.3401E-02	+0.2594E+00
	5	-0.3285E-02	+0.1998E+00

UNITS:
DEFLECTION - INCHES
ROTATION - RADIANS

FREE BODY THERMAL MOTIONS

FOR

TRANSIENT = SMUD RAPID COOLDOWN

ITERATION = 49

ELEM. #	JUNC. #	ROTATION	DEFLECTION
1	1	+0.9129 E-03	+0.1825E+00
2	1	-0.5708 E-02	+0.2000 E+00
	2	-0.5324E-02	+0.2137 E+00
3	3	-0.3484 E-04	+0.2271E+00
4	3	-0.1771E-03	+0.2370E+00
	4	-0.1697E-03	+0.2365E+00
5*	2	-0.2946E-02	+0.2142 E+00
	4	-0.2769 E-02	+0.2532E+00
	5	-0.2792E-02	+0.2002 E+00

*FOR EL. 5 JUNC. MOTIONS, SEE PG. 98 (TYPICAL ALL ITERS)

UNITS:
DEFLECTION - INCHES
ROTATION - RADIANS

FREE BODY THERMAL MOTIONS

FOR

TRANSIENT = SMUD RAPID COOLDOWN

ITERATION = 72

ELEM. #	JUNC. #	ROTATION	DEFLECTION
1	1	+0.1127E-03	+0.1473E+00
2	1	-0.5439E-02	+0.1661E+00
	2	-0.5161E-02	+0.1793E+00
3	3	-0.2418E-02	+0.1179E+00
4	3	+0.2917E-02	+0.1524E+00
	4	+0.2478E-02	+0.1591E+00
5	2	-0.2616E-02	+0.1626E+00
	4	+0.3927E-03	+0.1725E+00
	5	-0.1384E-02	+0.1509E+00

UNITS:
DEFLECTION - INCHES
ROTATION - RADIANS

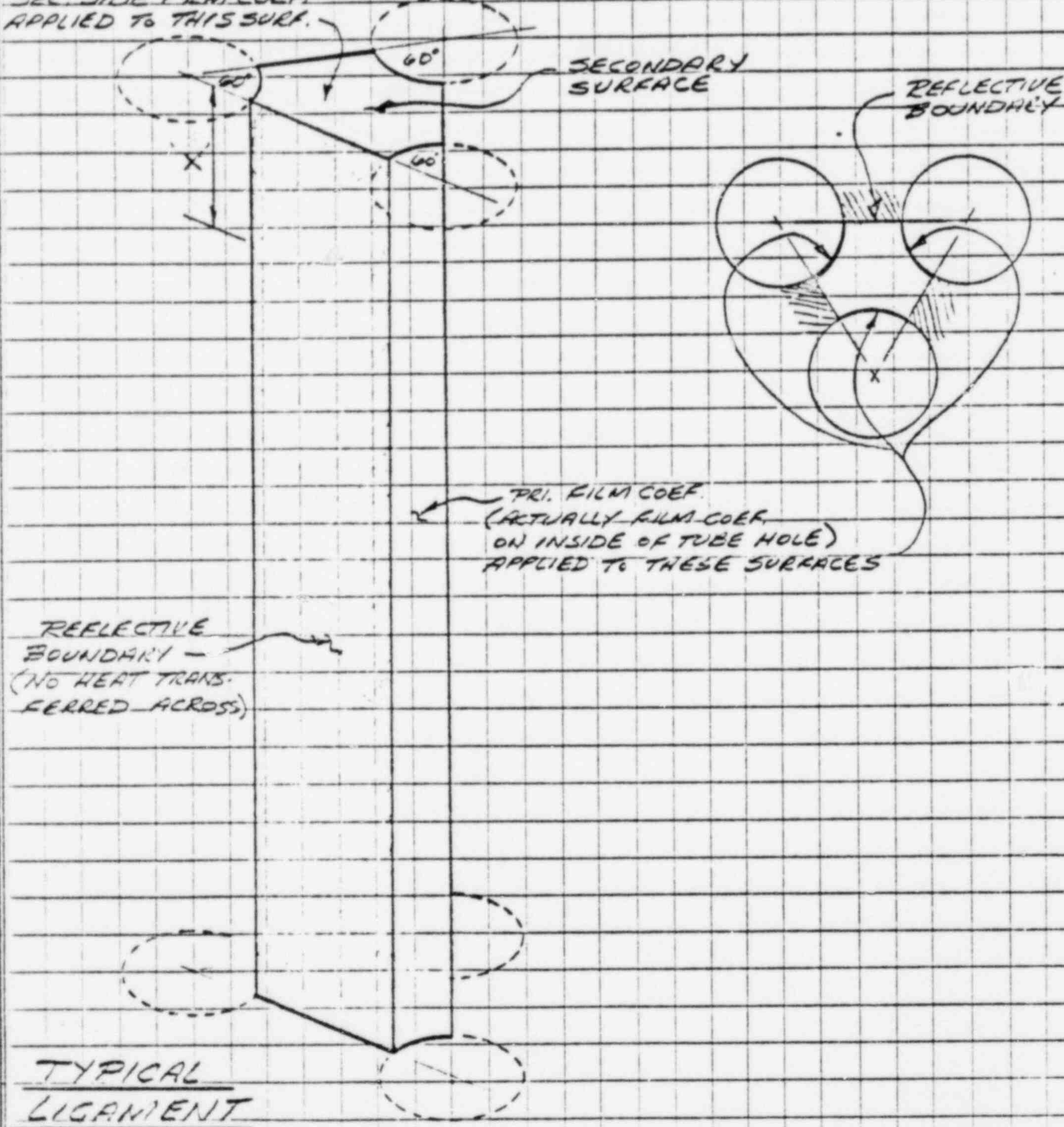
BABCOCK & WILCOX		REVISION
DEPARTMENT Mt.V - Comp. Engrg	DATE 6/72 BY LEW	
FREE BODY THERMAL MOTIONS	CHECKED DATE BY	
	JOB NO. 620-0011-55	SHEET 703 OF

TEMPERATURES THROUGH THE THICKNESS OF THE TUBESHEET

The temperature distribution through the thickness of the perforated portion of the tubesheet is determined based on a method contained in Reference 6. This method uses equations pertaining to a 'Not Very Long Rod Protruding From A Heat Source'. These equations have been programed into a computer terminal.

The following pages contain a model of the rod and temperature distribution for each iteration. The point spacing through the tubesheet is chosen to agree with the input requirements of Program 91249 (Tubesheet Area Interaction Analysis) in which the temperatures are used.

MODEL OF A 'NOT VERY LONG ROD PROTRUDING FROM A HEAT SOURCE'



TYPICAL LIGAMENT

BMS 247-1

BABCOCK & WILCOX

DEPARTMENT Mt. V - Comp Engrg. DATE 6/78 BY CEW

TUBESHEET LIGAMENT CHECKED DATE BY

THERMAL MODEL JOB NO. 620-0011-55

REVISION

SHEET 105 OF

TEMPS. THROUGH THE THICKNESS OF THE TUBESHEET--BY LARRY WHITE

```
ITERATION NUMBER             =   26

 TUBE HOLE DIA. (IN)        = 0.641  TUBE HOLE PITCH (IN)              =0.875
 TUBESHEET THK. (IN)        = 24.00  TUBESHEET MATL CODE               = 12
 PRIMARY CLAD. THK. (IN)    = 0.0    PRI. CLAD MATL CODE               =  0
 SEC. CLAD. THK. (IN)       = 0.0    SEC. CLAD MATL CODE               =  0
 PRIMARY FLUID TEMP (F)     = 568.0  PRI. FILM COEF. (BTU/H-FT*FT-F) =  640.
 SECONDARY FLUID TEMP (F)=  531.0  SEC. FILM COEF. (BTU/H-FT*FT-F) =  285.

SECONDARY SURFACE TEMPERATURE = TS   =  559.71
          AT X = 0.005 * THK,    T 1 =  562.77
          AT X = 0.015 * THK,    T 2 =  565.92
          AT X = 0.025 * THK,    T 3 =  567.17
          AT X = 0.035 * THK,    T 4 =  567.67
          AT X = 0.045 * THK,    T 5 =  567.87
          AT X = 0.055 * THK,    T 6 =  567.95
          AT X = 0.065 * THK,    T 7 =  567.98
          AT X = 0.075 * THK,    T 8 =  567.99
          AT X = 0.085 * THK,    T 9 =  568.00
          AT X = 0.095 * THK,    T10 =  568.00
          AT X = 0.150 * THK,    T11 =  568.00
          AT X = 0.300 * THK,    T12 =  568.00
          AT X = 0.500 * THK,    T13 =  568.00
          AT X = 0.700 * THK,    T14 =  568.00
          AT X = 0.900 * THK,    T15 =  568.00
PRIMARY SURFACE TEMPERATURE   = TP   =  568.00

WEIGHTED AVERAGE TEMPERATURE  = AT   =  567.91
```

TEMPS. THROUGH THE THICKNESS OF THE TUBESHEET--BY LARRY WHITE

ITERATION NUMBER = 39

TUBE HOLE DIA. (IN)	= 0.641	TUBE HOLE PITCH (IN)	=0.875
TUBESHEET THK. (IN)	= 24.00	TUBESHEET MATL CODE	= 12
PRIMARY CLAD. THK. (IN)	= 0.0	PRI. CLAD MATL CODE	= 0
SEC. CLAD. THK. (IN)	= 0.0	SEC. CLAD MATL CODE	= 0
PRIMARY FLUID TEMP (F)	= 592.0	PRI. FILM COEF. (BTU/H-FT*FT-F)	= 640.
SECONDARY FLUID TEMP (F)	= 212.0	SEC. FILM COEF. (BTU/H-FT*FT-F)	= 560.

SECONDARY SURFACE TEMPERATURE	= TS	= 454.25
AT X = 0.005 * THK,	T 1	= 505.17
AT X = 0.015 * THK,	T 2	= 557.49
AT X = 0.025 * THK,	T 3	= 578.29
AT X = 0.035 * THK,	T 4	= 586.55
AT X = 0.045 * THK,	T 5	= 589.83
AT X = 0.055 * THK,	T 6	= 591.14
AT X = 0.065 * THK,	T 7	= 591.66
AT X = 0.075 * THK,	T 8	= 591.86
AT X = 0.085 * THK,	T 9	= 591.95
AT X = 0.095 * THK,	T10	= 591.98
AT X = 0.150 * THK,	T11	= 592.00
AT X = 0.300 * THK,	T12	= 592.00
AT X = 0.500 * THK,	T13	= 592.00
AT X = 0.700 * THK,	T14	= 592.00
AT X = 0.900 * THK,	T15	= 592.00
PRIMARY SURFACE TEMPERATURE	= TP	= 592.00

WEIGHTED AVERAGE TEMPERATURE = AT = 590.56

107
620-0011-55
6/78
LEW

```
TEMPS. THROUGH THE THICKNESS OF THE TUBESHEET--BY LARRY WHITE
----------------------------------------------------

ITERATION NUMBER          =   45

 TUBE HOLE DIA. (IN)      = 0.641  TUBE HOLE PITCH (IN)              =0.875
 TUBESHEET THK. (IN)      = 24.00  TUBESHEET MATL CODE               = 12
 PRIMARY CLAD. THK. (IN)  = 0.0    PRI. CLAD MATL CODE               =  0
 SEC. CLAD. THK. (IN)     = 0.0    SEC. CLAD MATL CODE               =  0
 PRIMARY FLUID TEMP (F)   = 564.0  PRI. FILM COEF. (BTU/H-FT*FT-F) =  640.
 SECONDARY FLUID TEMP (F)= 212.0   SEC. FILM COEF. (BTU/H-FT*FT-F) =  245.

SECONDARY SURFACE TEMPERATURE = TS   =   494.02
          AT X = 0.005 * THK,   T 1 =   519.83
          AT X = 0.015 * THK,   T 2 =   546.41
          AT X = 0.025 * THK,   T 3 =   556.99
          AT X = 0.035 * THK,   T 4 =   561.21
          AT X = 0.045 * THK,   T 5 =   562.89
          AT X = 0.055 * THK,   T 6 =   563.56
          AT X = 0.065 * THK,   T 7 =   563.82
          AT X = 0.075 * THK,   T 8 =   563.93
          AT X = 0.085 * THK,   T 9 =   563.97
          AT X = 0.095 * THK,   T10 =   563.99
          AT X = 0.150 * THK,   T11 =   564.00
          AT X = 0.300 * THK,   T12 =   564.00
          AT X = 0.500 * THK,   T13 =   564.00
          AT X = 0.700 * THK,   T14 =   564.00
          AT X = 0.900 * THK,   T15 =   564.00
PRIMARY SURFACE TEMPERATURE   = TP   =   564.00

WEIGHTED AVERAGE TEMPERATURE  = AT   =   563.27
```

LEW 6/78 55-1100-029

108

TEMPS. THROUGH THE THICKNESS OF THE TUBESHEET--BY LARRY WHITE

ITERATION NUMBER = 49

TUBE HOLE DIA. (IN)	= 0.641	TUBE HOLE PITCH (IN)	=0.875
TUBESHEET THK. (IN)	= 24.00	TUBESHEET MATL CODE	= 12
PRIMARY CLAD. THK. (IN)	= 0.0	PRI. CLAD MATL CODE	= 0
SEC. CLAD. THK. (IN)	= 0.0	SEC. CLAD MATL CODE	= 0
PRIMARY FLUID TEMP (F)	= 538.0	PRI. FILM COEF. (BTU/H-FT*FT-F)	= 640.
SECONDARY FLUID TEMP (F)	= 540.0	SEC. FILM COEF. (BTU/H-FT*FT-F)	= 652.

SECONDARY SURFACE TEMPERATURE	= TS	= 538.79
AT X = 0.005 * THK,	T 1	= 538.50
AT X = 0.015 * THK,	T 2	= 538.20
AT X = 0.025 * THK,	T 3	= 538.08
AT X = 0.035 * THK,	T 4	= 538.03
AT X = 0.045 * THK,	T 5	= 538.01
AT X = 0.055 * THK,	T 6	= 538.00
AT X = 0.065 * THK,	T 7	= 538.00
AT X = 0.075 * THK,	T 8	= 538.00
AT X = 0.085 * THK,	T 9	= 538.00
AT X = 0.095 * THK,	T10	= 538.00
AT X = 0.150 * THK,	T11	= 538.00
AT X = 0.300 * THK,	T12	= 538.00
AT X = 0.500 * THK,	T13	= 538.00
AT X = 0.700 * THK,	T14	= 538.00
AT X = 0.900 * THK,	T15	= 538.00
PRIMARY SURFACE TEMPERATURE	= TP	= 538.00

WEIGHTED AVERAGE TEMPERATURE = AT = 538.01

109

TEMPS. THROUGH THE THICKNESS OF THE TUBESHEET--BY LARRY WHITE

ITERATION NUMBER = 72

TUBE HOLE DIA. (IN)	= 0.641	TUBE HOLE PITCH (IN)	=0.875
TUBESHEET THK. (IN)	= 24.00	TUBESHEET MATL CODE	= 12
PRIMARY CLAD. THK. (IN)	= 0.0	PRI. CLAD MATL CODE	= 5
SEC. CLAD. THK. (IN)	= 0.0	SEC. CLAD MATL CODE	= 5
PRIMARY FLUID TEMP (F)	= 278.0	PRI. FILM COEF. (BTU/H-FT*FT-F)	= 640.
SECONDARY FLUID TEMP (F)	= 280.0	SEC. FILM COEF. (BTU/H-FT*FT-F)	= 137.

SECONDARY SURFACE TEMPERATURE	= TS	= 278.24
AT X = 0.005 * THK,	T 1	= 278.15
AT X = 0.015 * THK,	T 2	= 278.06
AT X = 0.025 * THK,	T 3	= 278.02
AT X = 0.035 * THK,	T 4	= 278.01
AT X = 0.045 * THK,	T 5	= 278.00
AT X = 0.055 * THK,	T 6	= 278.00
AT X = 0.065 * THK,	T 7	= 278.00
AT X = 0.075 * THK,	T 8	= 278.00
AT X = 0.085 * THK,	T 9	= 278.00
AT X = 0.095 * THK,	T10	= 278.00
AT X = 0.150 * THK,	T11	= 278.00
AT X = 0.300 * THK,	T12	= 278.00
AT X = 0.500 * THK,	T13	= 278.00
AT X = 0.700 * THK,	T14	= 278.00
AT X = 0.900 * THK,	T15	= 278.00
PRIMARY SURFACE TEMPERATURE	= TP	= 278.00

WEIGHTED AVERAGE TEMPERATURE = AT = 278.00

MECHANICAL LOADING

The Mechanical Loading is represented by the primary pressure and secondary pressure. Below is a tabulation of pressure for each iteration which will be input into the 'Tubesheet Interaction Program' 91249.

ITERATION	PRIMARY PRESS.	SECONDARY PRESS.
26	2150 PSI	890 PSI
39	2030 PSI	0 PSI
45	1650 PSI	0 PSI
49	1450 PSI	1100 PSI
72	2050 PSI	140 PSI

INTERACTION ANALYSIS PROGRAM 91249

The following pages contain a brief description of Program 91249 Analysis and sample 91249 output to show its format and application.

It should be noted here that late arriving transient information (See Page A-11 of Appendix) redefined the maximum tube-to-shell ΔT. To calculate the effects of this larger ΔT, the 91249, Iter. 72 was revised and now includes these effects.

BRIEF DESCRIPTION OF PROGRAM 91249 ANALYSIS
(CONSULT PROGRAM 91249 'USER'S GUIDE' FOR MORE DETAIL (REF. 10)

This program analyzes the straight-tube steam generator vessel as a six-element, five-juncture interaction. The program calculates the element flexibility matrices and the redundant forces at each juncture.

Element 1 is a long cylinder extending from Juncture 1 to the secondary face of the opposite tubesheet. Each section may have a different E, α, and thickness. Elements 2 and 4 are transition elements. Element 5 is an irregular shaped ring. Element 6 is a perforated plate on an elastic foundation.

The free-body pressure motions and some of the free-body thermal motions at the junctures on each element are calculated by the program. The remaining free-body thermal motions must be input according to the following sign convention. Deflection outward from the centerline and rotation in a counterclockwise direction on the view shown in Fig. 2.1-2 are positive. This sign convention is only used for input. Rotation and radial deflection are positive in the direction of the corresponding redundant for output.

The total matrix includes the effects of local flexibility at junctures 2 and 4, for the redundant moments, shears, and vertical loads at each juncture. The only redundant vertical load is the load at juncture 5. The vertical equilibrium equations for elements 2 and 5 yield $V_1 = V_2 = V_5$ plus the free-body pressure loads on element 5.

Principal stresses and stress intensities are calculated at the inner and outer surface of each element at preset intervals along the element, except for tapered cylinders. The use of tapered cylinders rather than short cylinders results in stress calculations only at the junctures.

The program calculates peak stress intensities in the tubesheet ligaments using the method described in the ASME Code, Section III. Peak stresses are not calculated at the junctures between elements. The program also does not include any free-body thermal stress due to the linear portion of a radial temperature gradient.

PMC 247-1

ITERATION	PRI. PRESS.	SEC. PRESS.
26	2150	890
39	2030	0
45	1650	0
49	1450	1100
72	2050*	140*

ITERATION	AVERAGE SHELL TEMPERATURE
26	570°
39	570°
45	570°
49	570°
72	545.8°*

ITERATION	AVERAGE TUBE TEMPERATURE
26	568°
39	592°
45	564°
49	540°
72	359.8°*

* REVISED PER INFORMATION CONTAINED ON PAGE A-11 OF THE APPENDIX

BABCOCK & WILCOX

DEPARTMENT NNV - COMP. ENGRG DATE 6/78 BY LEW

91249 INPUT PARAMETERS CHECKED DATE BY

JOB NO. 620-0011-55

REVISION

SHEET 114 OF

BMS 247-1

ITER	$T_{AVG.}^{EL.2}$	$T_{AVG.}^{EL.3}$	$T_{AVG}^{EL.4}$	$T_{AVG}^{EL.5}$
26	535°	568°	566°	554°
39	513°	572°	569°	554°
45	463°	575°	572°	554°
49	454°	574°	571°	554°
72	397°	379°	398°	473°

BABCOCK & WILCOX
DEPARTMENT MTV - COMP. ENGRG. DATE 6/78 BY LEW
91249 INPUT PARAMETERS CHECKED DATE BY
JOB NO. 620-0011-55

REVISION
SHEET 115 OF

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

INPUT DATA

PIECE	ELEMENT	INSIDE RADIUS	THICKNESS (TOP)	THICKNESS (BOTTOM)	LENGTH	YOUNGS MODULUS	ALPHA	AVERAGE TEMP.	MATERIAL CODE
TRANSITION CYL.	2	68.9375	6.6250	6.6250	2.500	2.861E+07	.730E-05	397.000	12
TRANSITION CYL.	4	59.5313	8.0000	8.0000	2.500	2.861E+07	.730E-05	398.000	12
SPHERICAL SEG.	3	59.5313	8.0000	------	------	2.872E+07	.675E-05	379.000	2
RING	5	57.4713	18.0913	10.0601	24.000	2.820E+07	.736E-05	473.000	12
		OUTSIDE RADIUS	THICKNESS						
PLATE ON ELASTIC FOUNDATION	6	57.4713	24.0000			6.158E+06	.718E-05	278.002	12

PRIMARY PRESSURE	2050.0 PSI
SECONDARY PRESSURE	140.0 PSI
POISSONS RATIO	.300
HALF-ANGLE OPENING OF CAP (DEG)	90.000
TYPE OF TAPER ON ELEMENT 2 IS	0
TYPE OF TAPER ON ELEMENT 4 IS	0
LOCAL FLEXIBILITY THICKNESS AT JUNCTURE 2 IS	7.375
LOCAL FLEXIBILITY THICKNESS AT JUNCTURE 4 IS	8.750

LEW
55-1100-020
6/78
116

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

INPUT DATA

SUBDIVISIONS OF LONG CYLINDER - ELEMENT 1

SECTION NO.	MATERIAL CODE	INSIDE RADIUS	THICKNESS	LENGTH	YOUNGS MODULUS	AVERAGE TEMP.	ALPHA
1	1	68.9375	6.6250	51.5475	2.657E+07	545.8	.716E-05
2	1	68.9375	4.1875	304.5925	2.657E+07	545.8	.716E-05
3	1	68.9375	6.6250	120.5950	2.657E+07	545.8	.716E-05
4	1	68.9375	4.1875	91.4875	2.657E+07	545.8	.716E-05
5	1	68.9375	6.6250	54.9475	2.657E+07	545.8	.716E-05

TOTAL LENGTH (L) OF LONG CYLINDER 622.270
EFFECTIVE LENGTH (L - LENGTH OF ELEMENT 2) 619.770
EFFECTIVE HALF-LENGTH OF ELEMENT 1 309.885
AVERAGE YOUNGS MODULUS 2.657E+07
AVERAGE THERMAL EXPANSION COEFFICIENT .716E-05

LEW
620-0011-55
6/78
1/17

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

INPUT DATA

SUBDIVISIONS OF RING - ELEMENT 5

SECTION NO.	DISTANCE TO TOP	DISTANCE TO BOTTOM	OUTSIDE RADIUS	INSIDE RADIUS	CODE NO.
1	10.7500	0.0000	67.5313	57.4713	1
2	24.0000	10.7500	75.5625	57.4713	1
3	10.7500	0.0000	75.5625	67.5313	2

TUBESHEET DATA

TUBE PATTERN DIMENSIONS (IN)

PITCH		TUBE HOLE DIAM	
NOM	MIN	NOM	MAX
.8750	.8650	.6350	.6410

LIGAMENT EFFICIENCY OF TUBESHEET	.274
EFFECTIVE POISSONS RATIO OF TUBESHEET	.4010
THERMAL EXPANSION COEFFICIENT	.7182E-05
EFFECTIVE YOUNGS MODULUS	.616E+07
MATERIAL CODE FOR TUBESHEET	12

TUBE DATA

TUBE TEMPERATURE	359.80
THERMAL EXPANSION COEFFICIENT	.764E-05
YOUNGS MODULUS	2.989E+07
TUBE WALL THICKNESS	.0340
NUMBER OF TUBES	15457.
LENGTH OF TUBES BETWEEN PRIMARY FACES	673.25
FREE LENGTH OF TUBES	669.25
ELASTIC FOUNDATION MODULUS	8400.0
MATERIAL CODE FOR TUBES	5
TUBE OUTSIDE DIAMETER	.625

LEW
620-0011-53
6/78
1/8

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

TEMPERATURES THRU TUBESHEET

TS	T1	T2	T3	T4	T5	T6	T7	T8
278.24	278.15	278.06	278.02	278.01	278.00	278.00	278.00	278.00
T9	T10	T11	T12	T13	T14	T15	TP	TA
278.00	278.00	278.00	278.00	278.00	278.00	278.00	278.00	70.00

FREEBODY THERMAL MOTIONS

		LONG CYLINDER	TRANS. CYLINDER	RING	TRANS. CYLINDER	SPHERICAL SEGMENT	PLATE
JUNCTURE 1	ROT.	.1127E-03	-.5439E-02				
	DEFL.	.1473E+00	.1661E+00				
JUNCTURE 2	ROT.		-.5161E-02	-.2616E-02			
	DEFL.		.1793E+00	.1626E+00			
JUNCTURE 3	ROT.				.2917E-02	-.2418E-02	
	DEFL.				.1524E+00	.1179E+00	
JUNCTURE 4	ROT.			.3927E-03	.2478E-02		
	DEFL.			.1725E+00	.1591E+00		
JUNCTURE 5	ROT.			-.1384E-02			.2251E-06
	DEFL.			.1509E+00			.8586E-01

SIGN CONVENTION- DEFLECTION OUTWARD FROM THE CENTERLINE IS POSITIVE
ROTATION COUNTERCLOCKWISE ON AN UPPER RIGHTHAND VIEW IS POSITIVE

THERMAL MOMENT DUE TO TEMPERATURE DISTRIBUTION (IN*LB/RAD) .2872E+04
(POSITIVE IN SAME DIRECTION AS MS)

LEW
620-0011-55
6/78
119

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

ELEMENT NO. 1 LONG CYLINDER

FLEXIBILITY MATRIX

	M1	Q1	V
ROTATION	.33299876E-09	-.28338954E-08	0.
HORIZONTAL DEFLECTION	-.28338954E-08	.48234194E-07	.17044319E-08
VERTICAL DEFLECTION	0.	.17044319E-08	.33817592E-07

ELEMENT NO. 2 SHORT CYLINDER

FLEXIBILITY MATRIX

	M1	Q1	M2	Q2	V
ROTATION	.29274323E-06	.36591390E-06	-.29272053E-06	-.36590444E-06	0.
HORIZONTAL DEFLECTION	.36591390E-06	.60984930E-06	-.36590444E-06	-.30492127E-06	-.15826469E-08
ROTATION	-.29272053E-06	-.36590444E-06	.29274323E-06	.36591390E-06	0.
HORIZONTAL DEFLECTION	-.36590444E-06	-.30492127E-06	.36591390E-06	.60984930E-06	-.15826469E-08
VERTICAL DEFLECTION	0.	-.15826469E-08	0.	-.15826469E-08	.18254289E-09

ELEMENT NO. 3 SPHERICAL SEGMENT

FLEXIBILITY MATRIX

	M3	Q3	V
ROTATION	.20177732E-09	-.17694592E-08	0.
HORIZONTAL DEFLECTION	-.17694592E-08	.31034066E-07	0.
VERTICAL DEFLECTION	0.	0.	0.

LEW
5-1100-029
6/78
120

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

ELEMENT NO. 4 SHORT CYLINDER

FLEXIBILITY MATRIX

	M3	Q3	M4	Q4	V
ROTATION	.21321005E-06	.26650278E-06	-.21319538E-06	-.26649667E-06	0.
HORIZONTAL DEFLECTION	.26650278E-06	.44416665E-06	-.26649667E-06	-.22208114E-06	0.
ROTATION	-.21319538E-06	-.26649667E-06	.21321005E-06	.26650278E-06	0.
HORIZONTAL DEFLECTION	-.26649667E-06	-.22208114E-06	.26650278E-06	.44416665E-06	0.
VERTICAL DEFLECTION	0.	0.	0.	0.	0.

ELEMENT NO. 5 RING

FLEXIBILITY MATRIX

	M2	U2	M4	U4	M5	Q5	V
ROTATION	.1860287E-09	-.1575914E-08	-.1338090E-09	.1717855E-08	-.1338090E-09	.1121469E-09	-.1977530E-08
HORIZONTAL DEFL.	-.1575914E-08	.2501659E-07	.1493562E-08	-.1320671E-07	.1493562E-08	.4716032E-08	.2207297E-07
ROTATION	-.1338090E-09	.1493562E-08	.1757974E-09	-.1795793E-08	.1338090E-09	-.1121469E-09	.1977530E-08
HORIZONTAL DEFL.	.1717855E-08	-.1320671E-07	-.1795793E-08	.3051150E-07	-.1717855E-08	.7407557E-08	-.2538775E-07
ROTATION	-.1338090E-09	.1493562E-08	.1338090E-09	-.1717855E-08	.1338090E-09	-.1121469E-09	.1977530E-08
HORIZONTAL DEFL.	.1121469E-09	.4716032E-08	-.1121469E-09	.7407557E-08	-.1121469E-09	.6061794E-08	-.1657391E-08
VERTICAL DEFL.	-.1977530E-08	.2207297E-07	.1977530E-08	-.2538775E-07	.1977530E-08	-.1657391E-08	.2922543E-07

ELEMENT NO. 6 FLAT PLATE ON ELASTIC FOUNDATION

FLEXIBILITY MATRIX

	M	Q	V
ROTATION	.78398730E-10	0.	-.10959607E-08
HORIZONTAL DEFLECTION	0.	.40528815E-08	0.
VERTICAL DEFLECTION	-.10959607E-08	0.	.91303229E-07

LEW
620-0011-55
6/78
121

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

FREEBODY PRESSURE MOTIONS

		LONG CYLINDER	TRANS. CYLINDER	RING	TRANS. CYLINDER	SPHERICAL SEGMENT	PLATE
JUNCTURE 1	ROT.	0.	0.				
	DEFL.	.1933E-02	-.1795E-02				
JUNCTURE 2	ROT.		0.	-.3906E-02			
	DEFL.		-.1795E-02	.4620E-01			
JUNCTURE 3	ROT.				0.	-.8528E-08	
	DEFL.				.2966E-01	-.1146E-01	
JUNCTURE 4	ROT.			.3906E-02	0.		
	DEFL.			-.4755E-01	.2966E-01		
JUNCTURE 5	ROT.			.3906E-02			0.
	DEFL.			-.6714E-03			.1237E-02

SIGN CONVENTION- SAME AS PROGRAM 91060

221
6/78
55-1100-029
LEW

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

*** VERTICAL FREE BODY MOTIONS ***

VERTICAL LOOP (SHELL LEG)		VERTICAL LOOP (TUBE LEG)	
MOTIONS OF THE SHELL AND RING ELEMENTS		MOTIONS OF THE TUBES AND TUBESHEET	
PRESSURE ELONGATION		PRESSURE ELONGATION	
LONG CYLINDER	.1111712	TUBE AND TUBESHEET AXIAL ELONGATION AT JUNCTURE 5	-.1919730
TRANS. CYLINDER	.0006001		
RING	.0593106		
	---------		---------
SUBTOTAL	.1710919	SUBTOTAL	-.1919730
TEMPERATURE ELONGATION		TEMPERATURE ELONGATION	
LONG CYLINDER	1.0558195	TUBE AND TUBESHEET AXIAL ELONGATION AT JUNCTURE 5	.7261914
TRANS. CYLINDER	.0059661		
RING	.0356113		
	---------		---------
SUBTOTAL	1.0973969	SUBTOTAL	.7261914
TOTAL ELONGATION (SHELL LEG)	1.2684788	TOTAL ELONGATION (TUBE LEG)	.5342185

VERTICAL MISMATCH ACROSS JUNCTURE 5
(TUBE LEG - SHELL LEG)

-.734260

NOTE- POSITIVE NUMBERS INDICATE ELONGATIONS.
NEGATIVE NUMBERS INDICATE CONTRACTIONS.
ELONGATIONS OF THE TUBES AND LONG CYLINDER ARE

123
6/78
55-1100-029
LEW

ELEMENTS (NEAR THE MIDPOINT OF THE VESSEL).

LEW
620-0011-55
6/78
124

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

TOTAL MATRIX

.293076E-06 0.	.363080E-06 0.	-.292721E-06 0.	-.365904E-06 0.	0. 0.	0.	.555170E-02
.363080E-06 0.	.658083E-06 0.	-.365904E-06 0.	-.304921E-06 0.	0. .121785E-09	0.	-.189381E-01
-.292721E-06 -.133809E-09	-.365904E-06 .171786E-08	.292929E-06 -.133809E-09	.364338E-06 .112147E-09	0. -.197753E-08	0.	.136121E-02
-.365904E-06 .149356E-08	-.304921E-06 -.132067E-07	.364338E-06 .149356E-08	.634866E-06 .471603E-08	0. .204903E-07	0.	-.611084E-01
0. -.213195E-06	0. -.266497E-06	0. 0.	0. 0.	.213412E-06 0.	.264733E-06	.533501E-02
0. -.266497E-06	0. -.222081E-06	0. 0.	0. 0.	.264733E-06 0.	.475201E-06	-.527021E-01
0. .213385E-06	0. .264706E-06	-.133809E-09 .133809E-09	.149356E-08 -.112147E-09	-.213195E-06 .197753E-08	-.266497E-06	-.599151E-02
0. .264705E-06	0. .474678E-06	.171786E-08 -.171786E-08	-.132067E-07 .740756E-08	-.266497E-06 -.253878E-07	-.222081E-06	.312821E-01
0. .133809E-09	0. -.171786E-08	-.133809E-09 .212198E-09	.149356E-08 -.112147E-09	0. .891570E-09	0.	-.529043E-02
0. -.112147E-09	0. .740756E-08	.112147E-09 -.112147E-09	.471603E-08 .101147E-07	0. -.165739E-08	0.	.644779E-01
0. .197753E-08	.121785E-09 -.253878E-07	-.197753E-08 .891570E-09	.204903E-07 -.165739E-08	0. .154524E-06	0.	-.734260E+00

SIGN CONVENTION< SAME AS PROGRAM 91060

LEW
620-0011-55
6/78
125

SOLUTION CHECK FOR TOTAL MATRIX

CALC. RHS	GIVEN RHS	PCT. DEVIATION
.55517E-02	.55517E-02	.000
-.18938E-01	-.18938E-01	-.000
.13612E-02	.13612E-02	-.000
-.61108E-01	-.61108E-01	.000
.53350E-02	.53350E-02	.000
-.52702E-01	-.52702E-01	-.000
-.59915E-02	-.59915E-02	.000
.31282E-01	.31282E-01	-.000
-.52904E-02	-.52904E-02	-.000
.64478E-01	.64478E-01	0.000
-.73426E+00	-.73426E+00	-.000

LEW
620-0011-55
6/78
126

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

REDUNDANTS

SHEARS AND MOMENTS AT JUNCTURES 1, 2, 3, 4, AND 5

M1	Q1	M2	Q2	M3	Q3
-.208205E+07	-.341447E+08	-.283634E+07	.247424E+08	.376647E+08	.266252E+07

M4	Q4	M5	Q5
.451145E+08	-.330427E+07	-.566067E+08	.767623E+07

VERTICAL LOADS IMPOSED AT JUNCTURES 1, 2, AND 5

V1	V2	V5
-.204840E+07	-.204840E+07	-.553538E+07

VALUES ARE ON A LOAD PER RADIAN BASIS

127
6/19
55-1100-029
REW

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

FINAL MOTIONS

		LONG CYLINDER	TRANS. CYLINDER	RING	TRANS. CYLINDER	SPHERICAL SEGMENT	PLATE
JUNCTURE 1	ROT.	.1616E-03	-.1616E-03				
	DEFL.	-.1654E+00	.1654E+00				
JUNCTURE 2	ROT.		-.2290E-03	.2290E-03			
	DEFL.		.1652E+00	-.1652E+00			
JUNCTURE 3	ROT.				-.4707E-03	.4707E-03	
	DEFL.				.1134E+00	-.1134E+00	
JUNCTURE 4	ROT.			-.1242E-02	.1242E-02		
	DEFL.			-.1154E+00	.1154E+00		
JUNCTURE 5	ROT.			-.1829E-02			.1629E-02
	DEFL.			-.1182E+00			.1182E+00

SIGN CONVENTIONS SAME AS PROGRAM 91060

LEW
620-0011-55
6/78
128

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

ELEMENT 1 LONG CYLINDER

PRINCIPAL STRESSES (KSI)

LOCATION MEASURED ALONG ELEMENT 1 FROM BOTTOM (INCHES)	CIRCUMFERENTIAL INSIDE	CIRCUMFERENTIAL OUTSIDE	LONGITUDINAL INSIDE	LONGITUDINAL OUTSIDE	RADIAL INSIDE	RADIAL OUTSIDE
0.00	4.2	6.5	-8.2	-.3	-.1	0.0
3.83	4.4	5.3	-6.1	-2.5	-.1	0.0
7.66	4.3	4.3	-4.6	-4.0	-.1	0.0
11.49	4.0	3.4	-3.6	-5.0	-.1	0.0
15.31	3.6	2.7	-3.0	-5.5	-.1	0.0
19.14	3.2	2.1	-2.8	-5.8	-.1	0.0
22.97	2.8	1.7	-2.7	-5.8	-.1	0.0
26.80	2.4	1.4	-2.8	-5.7	-.1	0.0
30.63	2.1	1.2	-3.0	-5.6	-.1	0.0
34.46	1.9	1.1	-3.2	-5.3	-.1	0.0
38.29	1.7	1.1	-3.4	-5.1	-.1	0.0

STRESS INTENSITY (KSI)

	INSIDE C-L	INSIDE L-R	INSIDE R-C	OUTSIDE C-L	OUTSIDE L-R	OUTSIDE R-C
0.00	12.5	-8.1	-4.4	6.8	-.3	-6.5
3.83	10.5	-5.9	-4.5	7.8	-2.5	-5.3
7.66	9.9	-4.4	-4.5	8.3	-4.0	-4.3
11.49	7.6	-3.5	-4.1	8.4	-5.0	-3.4
15.31	6.6	-2.9	-3.7	8.2	-5.5	-2.7
19.14	5.9	-2.6	-3.3	7.9	-5.8	-2.1
22.97	5.5	-2.6	-2.9	7.5	-5.8	-1.7
26.80	5.2	-2.7	-2.5	7.1	-5.7	-1.4
30.63	5.1	-2.9	-2.3	6.8	-5.6	-1.2
34.46	5.1	-3.1	-2.0	6.4	-5.3	-1.1
38.29	5.1	-3.3	-1.8	6.2	-5.1	-1.1

LEW
620-0011-55
6/78
129

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

ELEMENT 2 SHORT CYLINDER

LOCATION	PRINCIPAL STRESSES (KSI)					
MEASURED ALONG ELEMENT 2 FROM BOTTOM (INCHES)	CIRCUMFERENTIAL INSIDE	CIRCUMFERENTIAL OUTSIDE	LONGITUDINAL INSIDE	LONGITUDINAL OUTSIDE	RADIAL INSIDE	RADIAL OUTSIDE
0.00	-8.4	-5.2	-9.6	1.1	-.1	0.0
.25	-7.8	-4.7	-9.5	1.0	-.1	0.0
.50	-7.3	-4.2	-9.4	.8	-.1	0.0
.75	-5.7	-3.7	-9.3	.7	-.1	0.0
1.00	-5.1	-3.2	-9.1	.6	-.1	0.0
1.25	-5.6	-2.7	-9.0	.4	-.1	0.0
1.50	-5.0	-2.3	-8.8	.3	-.1	0.0
1.75	-4.4	-1.9	-8.7	.1	-.1	0.0
2.00	-3.8	-1.3	-8.5	-.0	-.1	0.0
2.25	-3.3	-.8	-8.4	-.2	-.1	0.0
2.50	-2.7	-.4	-9.2	-.3	-.1	0.0

STRESS INTENSITY (KSI)

	INSIDE C-L	INSIDE L-R	INSIDE R-C	OUTSIDE C-L	OUTSIDE L-R	OUTSIDE R-C
0.00	1.2	-9.5	8.3	-6.3	1.1	5.2
.25	1.7	-9.4	7.7	-5.7	1.0	4.7
.50	2.1	-9.3	7.1	-5.1	.8	4.2
.75	2.6	-9.1	6.6	-4.4	.7	3.7
1.00	3.0	-9.0	6.0	-3.8	.6	3.2
1.25	3.4	-8.8	5.4	-3.2	.4	2.7
1.50	3.9	-8.7	4.8	-2.5	.3	2.3
1.75	4.3	-9.6	4.3	-1.9	.1	1.8
2.00	4.7	-8.4	3.7	-1.3	-.0	1.3
2.25	5.1	-8.2	3.1	-.7	-.2	.8
2.50	5.5	-8.1	2.6	-.0	-.3	.4

55-1100-029
6/78
LEW
130

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

ELEMENT 4 SHORT CYLINDER

PRINCIPAL STRESSES (KSI)

LOCATION MEASURED ALONG ELEMENT 4 FROM TOP (INCHES)	CIRCUMFERENTIAL INSIDE	CIRCUMFERENTIAL OUTSIDE	LONGITUDINAL INSIDE	LONGITUDINAL OUTSIDE	RADIAL INSIDE	RADIAL OUTSIDE
0.00	1.0	-36.8	73.7	-59.4	-2.1	0.0
.25	.8	-36.3	72.5	-58.2	-2.1	0.0
.50	.6	-35.8	71.3	-57.0	-2.1	0.0
.75	.5	-35.3	70.2	-55.9	-2.1	0.0
1.00	.3	-34.8	69.0	-54.7	-2.1	0.0
1.25	.2	-34.2	67.9	-53.6	-2.1	0.0
1.50	.1	-33.7	66.8	-52.5	-2.1	0.0
1.75	.0	-33.2	65.8	-51.5	-2.1	0.0
2.00	-.0	-32.6	64.7	-50.4	-2.1	0.0
2.25	-.0	-32.1	63.7	-49.4	-2.1	0.0
2.50	-.1	-31.5	62.7	-48.4	-2.1	0.0

STRESS INTENSITY (KSI)

	INSIDE C-L	INSIDE L-R	INSIDE R-C	OUTSIDE C-L	OUTSIDE L-R	OUTSIDE R-C
0.00	-72.7	75.8	-3.1	22.6	-59.4	36.8
.25	-71.7	74.6	-2.9	21.9	-58.2	36.3
.50	-70.7	73.4	-2.7	21.2	-57.0	35.8
.75	-69.7	72.2	-2.5	20.6	-55.9	35.3
1.00	-69.7	71.1	-2.4	20.0	-54.7	34.9
1.25	-67.7	70.0	-2.3	19.4	-53.6	34.2
1.50	-65.7	68.9	-2.2	18.9	-52.5	33.7
1.75	-65.7	67.8	-2.1	18.3	-51.5	33.2
2.00	-64.7	66.8	-2.0	17.8	-50.4	32.6
2.25	-63.8	65.8	-2.0	17.3	-49.4	32.1
2.50	-62.8	64.8	-2.0	16.9	-48.4	31.5

620-0011-55
6/78
LEW
131

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

ELEMENT 3 SPHERICAL HEAD SEGMENT

PRINCIPAL STRESSES (KSI)

LOCATION MEASURED ALONG ELEMENT 3 FROM TOP (DEGREES)	CIRCUMFERENTIAL INSIDE	CIRCUMFERENTIAL OUTSIDE	LONGITUDINAL INSIDE	LONGITUDINAL OUTSIDE	RADIAL INSIDE	RADIAL OUTSIDE
0.00	17.0	-17.3	63.3	-48.9	-2.1	0.0
4.50	7.1	-16.3	44.7	-31.0	-2.1	0.0
9.00	1.6	-12.9	29.6	-16.3	-2.1	0.0
13.50	-.8	-8.6	18.4	-5.2	-2.1	0.0
18.00	-1.1	-4.3	10.8	2.6	-2.1	0.0
22.50	-.2	-.5	6.1	7.5	-2.1	0.0
27.00	1.3	2.5	3.7	10.2	-2.1	0.0
31.50	2.9	4.7	2.9	11.4	-2.1	0.0
36.00	4.4	6.2	3.0	11.5	-2.1	0.0
40.50	5.6	7.1	3.7	11.0	-2.1	0.0
45.00	5.6	7.6	4.6	10.2	-2.1	0.0

STRESS INTENSITY (KSI)

	INSIDE C-L	INSIDE L-R	INSIDE R-C	OUTSIDE C-L	OUTSIDE L-R	OUTSIDE R-C
0.00	-45.2	65.3	-19.1	31.6	-48.9	17.3
4.50	-37.5	46.7	-9.2	14.7	-31.0	16.3
9.00	-29.0	31.7	-3.7	3.4	-16.3	12.9
13.50	-19.2	20.4	-1.3	-3.4	-5.2	8.6
18.00	-11.9	12.8	-.9	-6.9	2.6	4.3
22.50	-5.3	8.2	-1.9	-4.0	7.5	.5
27.00	-2.5	5.8	-3.3	-7.7	10.2	-2.5
31.50	-.0	4.9	-4.9	-6.7	11.4	-4.7
36.00	1.3	5.1	-6.4	-5.3	11.5	-6.2
40.50	1.9	5.8	-7.7	-3.9	11.0	-7.1
45.00	2.0	6.7	-8.7	-2.7	10.2	-7.6

LEW
620-0011-55
6/78
132

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

STRESSES IN TUBESHEET (KSI)

EQUIVALENT SOLID PLATE STRESSES

TUBESHEET RADIUS	RADIAL SECONDARY SIDE	RADIAL PRIMARY SIDE	CIRCUMFERENTIAL SECONDARY SIDE	CIRCUMFERENTIAL PRIMARY SIDE	LONGITUDINAL SECONDARY SIDE	LONGITUDINAL PRIMARY SIDE
0.00	19.3	-6.9	18.3	-6.9	-.1	-2.1
5.75	19.0	-6.7	18.1	-6.8	-.1	-2.1
11.49	17.4	-6.1	17.7	-6.4	-.1	-2.1
17.24	15.4	-5.1	17.0	-5.7	-.1	-2.1
22.99	14.9	-3.6	16.1	-4.8	-.1	-2.1
28.74	13.0	-1.6	14.8	-3.5	-.1	-2.1
34.49	10.5	.8	13.3	-1.9	-.1	-2.1
40.23	7.6	3.8	11.4	-.1	-.1	-2.1
45.98	4.1	[illegible]	9.2	2.2	-.1	-2.1
51.72	.0	11.3	6.6	4.7	-.1	-2.1
57.47	-4.6	15.9	3.6	7.7	-.1	-2.1

AVE. LIGAMENT STRESS INTENSITY **

	SECONDARY SIDE S12	SECONDARY SIDE S23	SECONDARY SIDE S31	PRIMARY SIDE S12	PRIMARY SIDE S23	PRIMARY SIDE S31
0.00	65.7	66.7	0.0	-23.2	-23.2	0.0
5.75	65.0	66.3	0.0	-22.5	-22.7	0.0
11.49	63.8	64.9	0.0	-20.2	-21.3	0.0
17.24	60.1	62.5	0.0	-16.5	-18.9	0.0
22.99	54.7	59.1	0.0	-11.0	-15.4	0.0
28.74	47.7	54.6	0.0	-4.0	-11.0	0.0
34.49	39.8	48.9	0.0	6.3	-8.3	0.0
40.23	29.0	42.0	0.0	18.0	1.8	0.0
45.98	15.4	34.3	0.0	29.6	10.3	0.0
51.72	.3	27.9	0.0	44.2	19.7	0.0
57.47	-30.1	24.2	0.0	61.1	30.5	0.0

TUBESHEET FREEBODY THERMAL STRESS SECONDARY SIDE	TUBESHEET FREEBODY THERMAL STRESS PRIMARY SIDE	AVE. LIGAMENT PRIMARY MEMBRANE STRESS INTENSITY R = 57.47	PEAK RIM STRESS INTENSITY SECONDARY SIDE	PEAK RIM STRESS INTENSITY PRIMARY SIDE
-.0	-.0	20.8	5.0	-95.8

133
55-1100-020
6/78
LEW

** SEE USERS GUIDE FOR DERIVATION OF STRESS INTENSITIES

LEW
620-0011-55
6/78
134

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

TUBE LOADS

TUBESHEET RADIUS	TUBESHEET DEFLECTION	TUBE AXIAL DEFLECTION	LONGITUDINAL TUBE STRESS	TUBE LOAD LB.
0.00	.8686	.1910	17.06	1077.0
5.75	.8703	.1927	17.21	1086.4
11.49	.8752	.1976	17.65	1114.5
17.24	.8833	.2057	18.37	1159.9
22.99	.8941	.2165	19.34	1220.8
28.74	.9071	.2295	20.50	1294.3
34.48	.9218	.2442	21.81	1376.9
40.23	.9372	.2596	23.19	1463.9
45.98	.9525	.2749	24.55	1549.9
51.72	.9664	.2888	25.79	1628.3
57.47	.9776	.3000	26.80	1691.5

TUBESHEET DEFLECTION TO PRIMARY SIDE IS POSITIVE

VERTICAL FORCE BALANCE FOR TUBESHEET (KIP/RAD BASIS)

VERTICAL REDUNDANT (V5)	CALCULATED VERTICAL LOAD	PERCENT DEVIATION
-5535.4	-5533.3	.0

NOTE* THE CALCULATED VERTICAL LOAD CONSISTS OF THE AREA-CORRECTED PRESSURE LOADS ON THE TUBESHEET FACES PLUS A RADIUS-WEIGHTED SUMMATION OF THE TUBE STRAINS AT THE TABULATED RADII.

LEW
620-0011-55
6/78

135

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

CALCULATION RADIUS 0.00

PEAK STRESS INTENSITIES (KSI)

	PRIMARY SIDE				SECONDARY SIDE			
	CASE 1	CASE 2	CASE 3	CASE 4	CASE 1	CASE 2	CASE 3	CASE 4
0	-20.7	-20.7	-20.7	-20.7	60.0	60.0	60.0	60.0
5	-20.7	-20.7	-20.7	-20.7	60.0	60.0	60.0	60.0
10	-21.9	-21.9	-21.9	-21.9	63.3	63.3	63.3	63.3
15	-23.2	-23.2	-25.7	-25.7	66.6	66.6	73.3	73.3
20	-27.0	-27.0	-25.7	-25.7	76.6	76.6	73.3	73.3
25	-28.2	-28.2	-27.0	-27.0	79.9	79.9	76.6	76.6
30	-29.2	-29.2	-28.2	-28.2	79.9	79.9	79.9	79.9
35	-24.4	-24.4	-28.2	-28.2	70.0	70.0	79.9	79.9
40	-24.4	-24.4	-25.7	-25.7	70.0	70.0	73.3	73.3
45	-23.2	-23.2	-23.2	-23.2	66.6	66.6	66.6	66.6
50	-23.2	-23.2	-21.9	-21.9	66.6	66.6	63.3	63.3
55	-20.7	-20.7	-19.4	-19.4	60.0	60.0	56.7	56.7
60	-20.7	-20.7	-18.1	-18.1	60.0	60.0	53.3	53.3
65	-20.7	-20.7	-19.4	-19.4	60.0	60.0	56.7	56.7
70	-21.9	-21.9	-21.9	-21.9	63.3	63.3	63.3	63.3
75	-23.2	-23.2	-23.2	-23.2	66.6	66.6	66.6	66.6
80	-25.7	-25.7	-25.7	-25.7	73.3	73.3	73.3	73.3
85	-27.0	-27.0	-28.2	-28.2	76.6	76.6	79.9	79.9
90	-27.0	-27.0	-28.2	-28.2	76.6	76.6	79.9	79.9
95	-27.0	-27.0	-27.0	-27.0	76.6	76.6	76.6	76.6
100	-25.7	-25.7	-25.7	-25.7	73.3	73.3	73.3	73.3
105	-23.2	-23.2	-25.7	-25.7	66.6	66.6	73.3	73.3
110	-21.9	-21.9	-21.9	-21.9	63.3	63.3	63.3	63.3
115	-20.7	-20.7	-20.7	-20.7	60.0	60.0	60.0	60.0
120	-20.7	-20.7	-20.7	-20.7	60.0	60.0	60.0	60.0
125	-20.7	-20.7	-23.2	-23.2	60.0	60.0	66.6	66.6
130	-23.2	-23.2	-21.9	-21.9	66.6	65.6	63.3	63.3
135	-23.2	-23.2	-21.9	-21.9	66.6	66.6	63.3	63.3
140	-24.4	-24.4	-25.7	-25.7	70.0	70.0	73.3	73.3
145	-24.4	-24.4	-28.2	-28.2	70.0	70.0	79.9	79.9
150	-29.2	-29.2	-30.8	-30.8	79.9	79.9	86.6	86.6
155	-29.2	-29.2	-28.2	-28.2	79.9	79.9	79.9	79.9
160	-27.0	-27.0	-25.7	-25.7	76.6	76.6	73.3	73.3
165	-23.2	-23.2	-21.9	-21.9	66.6	66.6	63.3	63.3
170	-21.9	-21.9	-21.9	-21.9	63.3	63.3	63.3	63.3
175	-20.7	-20.7	-23.2	-23.2	60.0	60.0	66.6	66.6
180	-20.7	-20.7	-20.7	-20.7	60.0	60.0	60.0	60.0

LEW 6/78 620-0011-55 136

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

CALCULATION RADIUS 5.75

PEAK STRESS INTENSITIES (KSI)

	PRIMARY SIDE				SECONDARY SIDE			
	CASE 1	CASE 2	CASE 3	CASE 4	CASE 1	CASE 2	CASE 3	CASE 4
0	-19.6	-20.6	-19.7	-20.5	59.0	59.9	59.0	59.8
5	-19.5	-20.6	-19.7	-20.5	59.0	59.9	59.0	59.8
10	-20.9	-21.8	-21.0	-21.7	62.3	63.2	62.4	63.1
15	-22.2	-23.0	-24.7	-25.3	65.6	66.4	72.3	72.9
20	-25.0	-25.6	-24.8	-25.3	75.6	76.2	72.3	72.9
25	-27.3	-27.7	-26.1	-25.5	79.0	79.4	75.7	76.1
30	-27.4	-27.6	-27.3	-27.6	79.1	79.3	79.0	79.3
35	-23.8	-23.8	-27.4	-27.6	69.4	69.3	79.1	79.3
40	-23.9	-23.7	-25.0	-25.1	69.4	69.2	72.6	72.6
45	-22.8	-22.4	-22.5	-22.5	66.2	65.8	66.0	66.0
50	-22.8	-22.3	-21.4	-21.3	66.3	65.8	62.7	62.7
55	-20.4	-19.9	-18.9	-19.9	59.7	59.2	56.2	56.1
60	-20.3	-19.9	-17.5	-17.6	59.7	59.2	52.8	52.8
65	-20.3	-19.9	-18.3	-19.9	59.7	59.2	56.1	56.2
70	-21.5	-21.1	-21.3	-21.4	62.9	62.5	62.7	62.7
75	-22.8	-22.4	-22.5	-22.5	66.2	65.8	66.0	66.0
80	-25.2	-24.9	-25.1	-25.0	72.8	72.4	72.6	72.6
85	-25.4	-25.1	-27.5	-27.4	75.1	75.7	79.3	79.1
90	-25.4	-25.1	-27.5	-27.3	76.1	75.7	79.3	79.0
95	-25.4	-26.1	-26.5	-25.1	76.1	75.7	76.1	75.7
100	-25.2	-24.9	-25.3	-24.8	72.8	72.4	72.9	72.3
105	-22.8	-22.4	-25.3	-24.7	66.2	65.8	72.9	72.3
110	-21.5	-21.1	-21.7	-21.0	62.9	62.5	63.1	62.4
115	-20.3	-19.9	-20.5	-19.7	59.7	59.2	59.8	59.0
120	-20.3	-19.9	-20.5	-19.7	59.7	59.2	59.8	59.0
125	-20.4	-19.9	-23.0	-22.2	59.7	59.2	66.4	65.6
130	-22.8	-22.3	-21.7	-21.0	66.3	65.8	63.1	62.3
135	-22.9	-22.4	-21.7	-21.0	66.2	65.8	63.1	62.4
140	-23.9	-23.7	-25.3	-24.8	69.4	69.2	72.9	72.4
145	-23.8	-23.8	-27.5	-27.4	69.4	69.3	79.3	79.1
150	-27.4	-27.6	-30.0	-30.0	79.1	79.3	85.8	85.8
155	-27.3	-27.7	-27.4	-27.6	79.0	79.4	79.1	79.3
160	-25.0	-26.6	-24.9	-25.3	75.6	76.2	72.4	72.9
165	-22.2	-23.0	-21.0	-21.7	65.6	66.4	62.4	63.1
170	-20.9	-21.8	-21.0	-21.7	62.3	63.2	62.3	63.1
175	-19.6	-20.5	-22.2	-23.0	59.0	59.9	65.6	66.4
180	-19.6	-20.6	-19.7	-20.5	59.0	59.9	59.0	59.8

137
6/78
55-1100-020
LEW

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

CALCULATION RADIUS 11.49

PEAK STRESS INTENSITIES (KSI)

	PRIMARY SIDE				SECONDARY SIDE			
	CASE 1	CASE 2	CASE 3	CASE 4	CASE 1	CASE 2	CASE 3	CASE 4
0	-15.5	-20.3	-16.9	-20.1	55.8	59.7	56.1	59.4
5	-15.6	-20.3	-16.9	-20.0	55.9	59.6	56.2	59.3
10	-17.8	-21.3	-18.1	-21.0	59.2	62.7	59.5	62.4
15	-19.2	-22.2	-21.7	-24.3	62.6	65.7	69.3	71.8
20	-22.9	-25.4	-21.9	-24.0	72.5	75.0	69.5	71.6
25	-24.4	-25.1	-23.3	-24.9	76.1	77.8	72.9	74.6
30	-24.9	-25.6	-24.7	-25.8	76.6	77.3	76.4	77.5
35	-22.0	-21.7	-24.9	-25.6	67.5	67.2	76.6	77.3
40	-22.4	-21.3	-22.9	-23.1	67.9	66.8	70.4	70.7
45	-21.5	-19.9	-20.9	-20.7	65.0	63.4	64.2	64.1
50	-21.7	-19.8	-19.5	-19.5	65.1	63.2	61.0	60.9
55	-19.4	-17.4	-17.4	-17.2	58.8	56.7	54.6	54.5
60	-19.4	-17.5	-16.2	-16.2	58.7	56.8	51.4	51.4
65	-19.3	-17.5	-17.2	-17.4	58.7	55.8	54.5	54.6
70	-20.4	-19.7	-19.5	-19.6	61.8	60.1	60.9	61.0
75	-21.4	-20.0	-20.7	-20.8	64.9	63.4	64.1	64.2
80	-23.7	-22.3	[illegible]	-22.9	71.2	69.9	70.7	70.4
85	-24.8	-23.5	-25.5	-24.9	74.4	73.1	77.3	76.6
90	-24.8	-23.5	-25.9	-24.7	74.4	73.1	77.5	76.4
95	-24.8	-23.5	-24.9	-23.3	74.4	73.1	74.6	72.9
100	-23.7	-22.3	-24.0	-21.9	71.2	69.9	71.6	69.5
105	-21.4	-20.0	-24.3	-21.7	64.9	63.4	71.8	69.3
110	-20.4	-18.7	-21.0	-19.1	61.8	60.1	62.4	59.5
115	-19.3	-17.5	-20.0	-15.9	58.7	56.6	59.3	56.2
120	-19.4	-17.5	-20.1	-15.8	58.7	56.8	59.4	56.1
125	-19.4	-17.4	-22.3	-19.1	58.8	56.7	65.7	62.6
130	-21.7	-19.8	-21.1	-19.1	65.1	63.2	62.5	59.4
135	-21.5	-19.9	-20.9	-19.2	65.0	63.4	62.3	59.6
140	-22.4	-21.3	-24.0	-22.0	67.9	66.8	71.6	69.5
145	-22.0	-21.7	-25.9	-24.7	67.5	67.2	77.5	76.4
150	-24.9	-25.6	-27.5	-27.5	76.6	77.3	83.4	83.4
155	-24.4	-26.1	-24.7	-25.8	76.1	77.8	76.4	77.5
160	-22.9	-25.4	-22.0	-24.0	72.5	75.0	69.5	71.6
165	-19.2	-22.2	-18.2	-20.9	62.6	65.7	59.6	62.3
170	-17.8	-21.3	-18.1	-21.1	59.2	62.7	59.4	62.5
175	-15.6	-20.3	-19.1	-22.3	55.9	59.6	62.6	65.7
180	-15.5	-20.3	-16.9	-20.1	55.8	59.7	56.1	59.4

138
6/78
55-1100-029
LEW

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

CALCULATION RADIUS 17.24

PEAK STRESS INTENSITIES (KSI)

	PRIMARY SIDE				SECONDARY SIDE			
	CASE 1	CASE 2	CASE 3	CASE 4	CASE 1	CASE 2	CASE 3	CASE 4
0	-11.3	-19.9	-11.9	-19.3	50.6	59.3	51.2	58.7
5	-11.4	-19.8	-12.1	-19.1	50.7	59.1	51.4	58.4
10	-12.7	-20.5	-13.3	-19.9	54.1	61.9	54.7	61.3
15	-14.1	-21.1	-16.5	-22.4	57.5	64.5	64.2	70.0
20	-17.7	-23.3	-17.1	-21.9	67.3	73.0	64.7	69.5
25	-19.6	-23.4	-18.5	-22.4	71.3	75.1	68.3	72.0
30	-20.8	-22.2	-20.2	-22.8	72.5	73.9	71.9	74.5
35	-19.0	-18.1	-20.9	-22.2	64.5	63.6	72.5	73.9
40	-19.8	-17.3	-19.3	-19.8	65.3	62.8	66.9	67.3
45	-19.4	-15.8	-17.7	-17.5	62.8	59.2	61.1	60.9
50	-19.7	-15.4	-16.3	-16.4	63.2	58.9	58.2	57.8
55	-17.9	-13.3	-14.9	-14.4	57.2	52.6	52.1	51.7
60	-17.8	-13.4	-13.5	-13.6	57.1	52.8	48.8	48.8
65	-17.7	-13.6	-14.4	-14.8	57.0	52.9	51.7	52.1
70	-19.5	-14.7	-16.4	-15.8	59.8	56.1	57.8	58.2
75	-19.3	-15.9	-17.5	-17.7	62.7	59.3	60.9	61.1
80	-21.1	-19.0	-19.3	-19.3	68.7	65.5	67.3	66.9
85	-22.0	-19.0	-22.2	-20.8	71.7	68.6	73.9	72.5
90	-22.0	-19.0	-22.9	-20.2	71.7	68.6	74.5	71.9
95	-22.0	-19.0	-22.4	-18.6	71.7	68.6	72.0	68.3
100	-21.1	-19.0	-21.9	-17.1	68.7	65.5	69.5	64.7
105	-19.3	-15.9	-22.4	-16.6	62.7	59.3	70.0	64.2
110	-19.5	-14.7	-19.9	-13.3	59.8	56.1	61.3	54.7
115	-17.7	-13.6	-19.1	-12.1	57.0	52.9	58.4	51.4
120	-17.8	-13.4	-19.3	-11.9	57.1	52.8	58.7	51.2
125	-17.9	-13.3	-21.2	-14.0	57.2	52.6	64.6	57.4
130	-19.7	-15.4	-20.0	-13.2	63.2	58.9	61.4	54.5
135	-19.4	-15.8	-19.7	-13.5	62.8	59.2	61.0	54.9
140	-19.8	-17.3	-21.8	-17.2	65.3	62.8	69.4	64.8
145	-19.0	-18.1	-22.7	-20.3	64.5	63.6	74.4	72.0
150	-20.8	-22.2	-23.5	-23.5	72.5	73.9	79.3	79.3
155	-19.6	-23.4	-20.3	-22.7	71.3	75.1	72.0	74.4
160	-17.7	-23.3	-17.2	-21.8	67.3	73.0	64.8	69.4
165	-14.1	-21.1	-13.5	-19.7	57.5	64.5	54.9	61.0
170	-12.7	-20.5	-13.2	-20.0	54.1	61.9	54.5	61.4
175	-11.4	-19.8	-14.0	-21.2	50.7	59.1	57.4	64.6
180	-11.3	-19.9	-11.9	-19.3	50.6	59.3	51.2	58.7

139 6/78 620-0011-55

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

CALCULATION RADIUS 22.99

PEAK STRESS INTENSITIES (KSI)

	PRIMARY SIDE				SECONDARY SIDE			
	CASE 1	CASE 2	CASE 3	CASE 4	CASE 1	CASE 2	CASE 3	CASE 4
0	-3.8	-19.4	-4.9	-18.3	43.1	58.7	44.2	57.6
5	-4.0	-19.2	-5.3	-17.9	43.3	58.5	44.6	57.2
10	-5.3	-19.4	-6.4	-18.3	46.7	60.8	47.8	59.7
15	-5.8	-19.4	-9.4	-19.8	50.3	62.8	57.0	67.4
20	-10.3	-20.5	-10.3	-19.0	59.9	70.1	57.9	66.5
25	-12.7	-19.6	-12.0	-19.8	64.4	71.3	61.7	68.4
30	-14.9	-17.5	-13.9	-18.5	66.6	69.2	65.5	70.2
35	-14.6	-13.1	-14.9	-17.5	69.1	58.6	66.6	69.2
40	-15.2	-11.6	-14.2	-15.1	61.7	57.1	61.8	62.6
45	-15.4	-9.9	-13.3	-12.9	59.8	53.3	56.8	56.4
50	-17.0	-9.2	-12.7	-12.0	60.5	52.7	54.1	53.4
55	-15.7	-7.5	-11.2	-10.5	55.0	46.8	48.4	47.8
60	-15.5	-7.7	-10.1	-10.1	54.8	47.0	45.3	45.3
65	-15.3	-7.9	-10.5	-11.2	54.6	47.2	47.8	48.4
70	-15.7	-9.0	-12.0	-12.7	57.1	50.4	53.4	54.1
75	-15.2	-10.1	-12.9	-13.3	59.6	53.5	56.4	56.8
80	-17.5	-11.8	-15.1	-14.2	65.0	59.4	62.6	61.8
85	-19.1	-12.7	-17.2	-14.9	67.7	62.3	69.2	66.6
90	-19.1	-12.7	-18.5	-13.8	67.7	62.3	70.2	65.5
95	-19.1	-12.7	-18.9	-12.0	67.7	62.3	68.4	61.7
100	-17.5	-11.8	-19.0	-10.3	65.0	59.4	66.5	57.9
105	-15.2	-10.1	-19.9	-9.4	59.6	53.5	67.4	57.0
110	-15.7	-9.0	-18.3	-5.4	57.1	50.4	59.7	47.8
115	-15.3	-7.9	-17.9	-5.3	54.6	47.2	57.2	44.6
120	-15.5	-7.7	-18.3	-4.9	54.8	47.0	57.6	44.2
125	-15.7	-7.5	-19.5	-5.6	55.0	46.8	63.1	50.1
130	-17.0	-9.2	-18.5	-5.2	60.5	52.7	59.9	47.6
135	-15.4	-9.9	-17.9	-5.8	59.8	53.3	59.3	48.2
140	-15.2	-11.6	-18.9	-10.5	61.7	57.1	66.3	58.1
145	-14.6	-13.1	-18.3	-14.0	60.1	58.6	70.0	65.7
150	-14.9	-17.5	-17.7	-17.7	66.6	69.2	73.5	73.5
155	-12.7	-19.6	-14.0	-19.3	64.4	71.3	65.7	70.0
160	-10.3	-20.5	-10.5	-19.8	59.9	70.1	58.1	66.3
165	-5.8	-19.4	-6.9	-17.9	50.3	62.8	48.2	59.3
170	-5.3	-19.4	-6.2	-19.5	46.7	60.8	47.6	[illegible]
175	-4.0	-19.2	-6.5	-19.5	43.3	58.5	50.1	[illegible]
180	-3.8	-19.4	-4.9	-18.3	43.1	58.7	44.2	[illegible]

140
55-1100-020 6/78
LEW

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

CALCULATION RADIUS 28.74

PEAK STRESS INTENSITIES (KSI)

	PRIMARY SIDE				SECONDARY SIDE			
	CASE 1	CASE 2	CASE 3	CASE 4	CASE 1	CASE 2	CASE 3	CASE 4
0	5.0	-18.7	4.3	-17.0	33.3	58.0	35.0	56.3
5	5.6	-18.4	3.5	-16.3	33.7	57.7	35.7	55.6
10	4.3	-19.0	2.5	-16.3	37.1	59.4	38.8	57.6
15	2.7	-17.2	.0	-16.5	40.8	60.7	47.6	64.0
20	-.6	-16.8	-1.4	-15.1	50.3	66.4	48.9	62.7
25	-3.7	-14.7	-3.4	-14.0	55.4	66.3	53.0	63.6
30	-7.1	-11.2	-5.4	-12.9	58.8	62.9	57.1	64.6
35	-9.0	-6.6	-7.1	-11.2	54.5	52.1	58.8	62.9
40	-11.4	-4.2	-7.5	-8.9	56.9	49.7	55.1	56.5
45	-12.4	-2.1	-7.5	-7.0	55.9	45.6	51.1	50.4
50	-13.5	-1.1	-7.3	-5.3	56.9	44.6	46.7	47.7
55	-12.9	.2	-6.4	-5.4	52.2	39.2	43.7	42.6
60	-12.5	-.2	-5.4	-5.4	51.9	39.5	40.6	40.6
65	-12.2	-.5	-5.4	-5.4	51.5	39.9	42.6	43.7
70	-12.1	-1.5	-6.3	-7.3	53.5	42.9	47.7	48.7
75	-12.1	-2.5	-7.0	-7.5	55.5	45.9	50.4	51.1
80	-12.7	-3.8	-8.2	-7.5	60.3	51.3	56.5	55.1
85	-13.0	-4.4	-11.2	-7.1	62.6	54.0	62.9	58.8
90	-13.0	-4.4	-12.9	-5.4	62.6	54.0	64.6	57.1
95	-13.0	-4.4	-14.0	-3.4	62.6	54.0	63.6	53.0
100	-12.7	-3.8	-15.1	-1.4	60.3	51.3	62.7	48.9
105	-12.1	-2.5	-16.3	.0	55.5	45.9	64.0	47.6
110	-12.1	-1.5	-16.3	2.6	53.5	42.9	57.6	38.8
115	-12.2	-.5	-16.3	3.6	51.5	39.9	55.6	35.7
120	-12.5	-.2	-17.0	4.3	51.9	39.5	56.3	35.0
125	-12.9	.2	-17.5	3.0	52.2	39.2	61.0	40.5
130	-13.5	-1.1	-16.5	2.9	56.9	44.6	58.0	38.4
135	-12.4	-2.1	-15.5	1.9	55.9	45.6	57.0	39.5
140	-11.4	-4.2	-14.7	-1.7	56.9	49.7	62.3	49.3
145	-9.0	-6.6	-12.5	-5.7	54.5	52.1	64.3	57.4
150	-7.1	-11.2	-10.1	-10.1	58.8	62.9	65.9	65.9
155	-3.7	-14.7	-5.7	-12.5	55.4	66.3	57.4	64.3
160	-.6	-16.8	-1.7	-14.7	50.3	66.4	49.3	62.3
165	2.7	-17.2	1.7	-15.6	40.8	60.7	39.5	57.0
170	4.3	-19.0	2.9	-16.6	37.1	59.4	38.4	58.0
175	5.6	-18.4	3.0	-17.5	33.7	57.7	40.5	61.0
180	5.0	-18.7	4.3	-17.0	33.3	58.0	35.0	56.3

55-1100-020
6/78
LEW

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

CALCULATION RADIUS 34.48

PEAK STRESS INTENSITIES (KSI)

	PRIMARY SIDE				SECONDARY SIDE			
	CASE 1	CASE 2	CASE 3	CASE 4	CASE 1	CASE 2	CASE 3	CASE 4
0	19.3	-17.9	15.7	-15.4	21.1	57.2	23.6	54.7
5	17.7	-17.4	14.7	-14.4	21.6	56.7	24.6	53.7
10	15.4	-16.2	13.9	-13.7	25.0	57.6	27.5	55.1
15	14.5	-14.6	11.9	-12.3	28.9	58.0	35.8	59.8
20	11.5	-12.1	9.9	-10.3	38.2	61.8	37.8	57.8
25	7.6	-8.5	7.4	-8.1	44.1	60.2	42.2	57.7
30	2.5	-3.4	5.1	-6.0	49.1	55.1	46.6	57.7
35	-1.9	1.6	2.5	-3.4	47.4	43.9	49.1	55.1
40	-5.4	5.1	.9	-1.2	50.9	40.4	46.8	48.8
45	-7.5	7.5	-.5	.5	51.0	35.9	44.0	43.0
50	-9.1	9.0	-.7	.8	52.5	34.4	42.1	40.5
55	-9.3	9.7	-.5	1.0	48.7	29.6	37.7	36.2
60	-9.4	9.2	.4	.4	48.2	30.1	34.8	34.8
65	-9.3	8.7	1.0	-.5	47.7	30.6	36.2	37.7
70	-7.7	7.9	.9	-.7	49.1	33.5	40.5	42.1
75	-7.0	7.0	.5	-.5	50.5	36.4	43.0	44.0
80	-5.8	6.3	-1.2	.8	54.3	41.3	48.8	46.8
85	-5.6	5.9	-3.4	2.6	56.2	43.7	55.1	49.1
90	-5.6	5.9	-6.0	5.1	56.2	43.7	57.7	46.6
95	-5.6	5.9	-8.1	7.4	56.2	43.7	57.7	42.2
100	-5.8	5.3	-10.3	9.8	54.3	41.3	57.8	37.8
105	-7.0	7.0	-12.3	11.8	50.5	35.4	59.8	35.8
110	-7.7	7.9	-13.7	13.9	49.1	33.5	55.1	27.5
115	-9.3	8.7	-14.4	14.7	47.7	30.6	53.7	24.6
120	-9.8	9.2	-15.4	15.7	48.2	30.1	54.7	23.6
125	-9.3	9.7	-15.1	15.0	48.7	29.6	58.5	28.4
130	-9.1	9.0	-14.2	14.4	52.5	34.4	55.6	27.0
135	-7.5	7.5	-12.7	12.9	51.0	35.9	54.1	28.5
140	-5.4	5.1	-9.9	9.3	50.9	40.4	57.3	38.3
145	-1.9	1.6	-5.5	4.6	47.4	43.9	57.2	47.1
150	2.6	-3.4	-.5	-.6	49.1	55.1	56.5	56.5
155	7.6	-8.5	4.5	-5.5	44.1	60.2	47.1	57.2
160	11.5	-12.1	9.3	-9.8	38.2	61.8	38.3	57.3
165	14.5	-14.6	12.9	-12.7	28.9	58.0	28.5	54.1
170	15.4	-16.2	14.4	-14.2	25.0	57.6	27.0	55.6
175	17.7	-17.4	15.0	-15.1	21.6	56.7	26.4	58.5
180	19.3	-17.9	15.7	-15.4	21.1	57.2	23.6	54.7

55-1100-029
6/78
LEW
142

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

CALCULATION RADIUS 40.23

PEAK STRESS INTENSITIES (KSI)

	PRIMARY SIDE				SECONDARY SIDE			
	CASE 1	CASE 2	CASE 3	CASE 4	CASE 1	CASE 2	CASE 3	CASE 4
0	33.1	-16.9	29.5	-13.4	6.2	56.2	9.7	52.8
5	32.4	-16.2	28.3	-12.1	6.9	55.5	11.1	51.4
10	31.0	-14.2	27.5	-10.7	10.4	55.5	13.8	52.1
15	29.9	-11.4	26.1	-7.2	14.5	54.8	21.4	54.8
20	25.1	-6.5	23.3	-4.5	23.5	56.2	24.2	52.0
25	21.2	-1.0	20.5	-1.0	30.5	52.7	29.1	50.6
30	14.3	5.9	17.9	2.5	37.4	45.7	33.9	49.2
35	5.7	11.5	14.3	5.9	39.8	34.0	37.4	45.7
40	1.8	16.4	10.9	8.1	43.7	29.1	36.7	39.5
45	-1.7	19.2	8.1	9.5	45.1	24.2	35.4	34.0
50	-3.7	21.3	7.4	9.5	47.2	22.2	34.0	31.9
55	-5.1	21.3	6.7	8.8	44.4	18.0	30.5	28.4
60	-4.4	20.6	7.4	7.4	43.7	18.7	27.8	27.8
65	-3.7	19.9	8.9	6.7	43.0	19.4	28.4	30.5
70	-2.3	19.2	9.5	7.4	43.7	22.2	31.9	34.0
75	-1.0	19.5	9.5	8.1	44.4	24.9	34.0	35.4
80	.4	18.5	8.1	10.8	47.2	29.1	39.5	36.7
85	1.1	18.5	5.9	14.3	48.5	31.2	45.7	37.4
90	1.1	18.5	2.5	17.8	48.5	31.2	49.2	33.9
95	1.1	18.5	-1.0	20.6	48.5	31.2	50.6	29.1
100	.4	18.5	-4.5	23.3	47.2	29.1	52.0	24.2
105	-1.0	18.5	-7.2	25.1	44.4	24.9	54.8	21.4
110	-2.3	19.2	-10.7	27.6	43.7	22.2	52.1	13.8
115	-3.7	19.9	-12.1	28.3	43.0	19.4	51.4	11.1
120	-4.4	20.6	-13.4	29.6	43.7	18.7	52.8	9.7
125	-5.1	21.3	-12.1	27.6	44.4	18.0	55.5	13.8
130	-3.7	21.3	-11.4	28.2	47.2	22.2	52.8	13.1
135	-1.7	19.2	-9.3	25.2	45.1	24.2	50.7	15.2
140	1.8	15.4	-3.9	22.7	43.7	29.1	51.3	24.9
145	5.7	11.5	3.2	17.1	39.8	34.0	48.5	34.6
150	14.3	5.9	10.9	10.8	37.4	45.7	45.0	45.0
155	21.2	-1.0	17.1	3.2	30.5	52.7	34.6	48.5
160	25.1	-6.5	22.7	-3.8	23.5	56.2	24.9	51.3
165	28.9	-11.4	26.2	-9.3	14.5	54.8	15.2	50.7
170	31.0	-14.2	28.3	-11.4	10.4	55.5	13.1	52.8
175	32.4	-16.2	29.5	-12.1	5.9	55.5	13.8	55.5
180	33.1	-15.9	29.5	-13.4	6.2	56.2	9.7	52.8

143
6/78
5-1100-029
REV 7

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

CALCULATION RADIUS 45.98

PEAK STRESS INTENSITIES (KSI)

	PRIMARY SIDE				SECONDARY SIDE			
	CASE 1	CASE 2	CASE 3	CASE 4	CASE 1	CASE 2	CASE 3	CASE 4
0	50.8	-15.8	46.1	-11.2	-11.4	55.2	-6.8	50.5
5	49.8	-14.9	44.3	-9.4	-10.5	54.2	-5.0	48.7
10	49.4	-11.7	43.9	-7.1	-7.0	53.1	-2.4	48.5
15	45.0	-7.6	43.1	-1.3	-2.6	51.1	4.5	48.9
20	43.5	.0	39.4	2.4	5.2	49.6	8.2	45.2
25	37.4	7.8	36.1	7.4	14.3	43.9	13.6	42.2
30	29.2	17.1	32.9	12.4	23.5	34.6	18.9	39.3
35	15.8	23.3	28.2	17.1	28.7	22.2	23.5	34.6
40	10.3	29.7	22.7	19.0	35.2	15.8	24.8	28.5
45	5.3	33.1	18.3	20.1	38.1	10.4	25.2	23.3
50	2.5	35.8	16.9	19.7	40.9	7.6	24.5	21.7
55	-.1	35.0	15.2	18.0	39.4	4.3	22.0	19.3
60	.8	34.1	15.8	12.8	38.5	5.2	19.4	19.4
65	1.7	33.2	18.0	15.2	37.6	6.1	19.3	22.0
70	4.0	32.7	19.7	16.9	37.4	8.7	21.7	24.5
75	5.2	32.1	20.1	18.3	37.2	11.3	23.3	25.2
80	9.9	32.9	19.0	22.7	38.7	14.7	28.5	24.8
85	10.2	33.3	17.1	28.2	39.5	16.3	34.6	23.5
90	10.2	33.3	12.4	32.8	39.5	16.3	39.3	18.9
95	10.2	33.3	7.4	35.1	39.5	16.3	42.2	11.6
100	9.9	32.9	2.4	39.4	38.7	14.7	45.2	8.2
105	5.2	32.1	-1.3	43.1	37.2	11.3	48.9	4.5
110	4.0	32.7	-7.1	43.8	37.4	8.7	48.5	-2.4
115	1.7	33.2	-9.4	44.3	37.6	6.1	48.7	-5.0
120	.8	34.1	-11.2	45.1	38.5	5.2	50.5	-6.8
125	-.1	35.0	-8.5	45.9	39.4	4.3	52.0	-3.5
130	2.5	35.8	-8.0	44.7	40.9	7.6	49.4	-3.3
135	5.3	33.1	-5.3	41.9	38.1	10.4	46.7	-.5
140	10.3	29.7	3.3	38.5	35.2	15.8	44.3	9.1
145	15.8	23.3	13.4	31.9	28.7	22.2	38.3	19.8
150	29.2	17.1	24.3	24.3	23.5	34.6	31.5	31.5
155	37.4	7.8	31.9	13.4	14.3	43.9	19.8	38.3
160	43.5	.0	38.5	3.3	6.2	49.6	9.1	44.3
165	45.0	-7.6	41.9	-3.3	-2.6	51.1	-.5	46.7
170	49.4	-11.7	44.7	-4.0	-7.0	53.1	-3.3	49.4
175	49.8	-14.9	46.9	-8.6	-10.5	54.2	-3.5	52.0
180	50.8	-15.8	46.1	-11.2	-11.4	55.2	-6.8	50.5

144
6/78
LEW
620-0011-55

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

CALCULATION RADIUS 51.72

PEAK STRESS INTENSITIES (KSI)

	PRIMARY SIDE				SECONDARY SIDE			
	CASE 1	CASE 2	CASE 3	CASE 4	CASE 1	CASE 2	CASE 3	CASE 4
0	71.3	-14.6	65.3	-9.7	-32.0	53.9	-26.0	48.0
5	70.1	-13.4	62.9	-6.3	-30.8	52.8	-23.6	45.6
10	69.6	-9.0	62.5	-3.0	-27.2	50.4	-21.2	44.4
15	65.9	-3.3	62.8	5.5	-22.4	46.8	-15.3	42.0
20	63.7	7.6	58.1	10.3	-14.1	42.0	-10.5	37.3
25	55.2	18.0	54.1	17.1	-4.5	33.7	-4.5	32.5
30	44.3	29.9	50.2	24.0	7.4	21.8	1.5	27.7
35	29.5	36.9	44.3	29.9	17.0	8.6	7.4	21.8
40	20.2	45.3	36.5	31.8	25.3	.3	11.0	15.8
45	13.4	49.2	30.1	32.5	30.1	-5.7	13.4	11.0
50	9.8	52.7	28.0	31.6	33.7	-9.3	13.4	9.8
55	5.7	51.0	25.1	29.7	33.7	-11.7	12.2	8.6
60	5.9	49.8	25.4	25.4	32.5	-10.5	9.8	9.8
65	9.1	48.6	28.7	25.1	31.3	-9.3	8.6	12.2
70	11.3	48.3	31.5	29.0	30.1	-6.9	9.8	13.4
75	14.6	48.0	32.5	30.1	28.9	-4.5	11.0	13.4
80	19.7	49.7	31.9	35.6	28.9	-2.1	15.8	11.0
85	20.7	50.6	29.9	44.3	28.9	-.9	21.8	7.4
90	20.7	50.6	24.0	50.2	28.9	-.9	27.7	1.5
95	20.7	50.6	17.1	54.1	28.9	-.9	32.5	-4.5
100	19.7	49.7	10.3	59.1	28.9	-2.1	37.3	-10.5
105	14.6	48.0	5.5	62.8	28.9	-4.5	42.0	-15.3
110	11.3	48.3	-3.0	62.6	30.1	-6.9	44.4	-21.2
115	9.1	48.6	-6.3	62.9	31.3	-9.3	45.6	-23.6
120	5.9	49.8	-8.7	65.3	32.5	-10.5	48.0	-26.0
125	5.7	51.0	-4.5	67.1	33.7	-11.7	48.0	-23.6
130	9.8	52.7	-4.2	63.8	33.7	-9.3	45.6	-22.4
135	13.4	49.2	-.5	[illegible]	30.1	-5.7	42.0	-18.8
140	20.2	45.3	11.5	56.9	25.3	.3	30.1	-9.3
145	29.5	35.9	25.2	49.0	17.0	8.6	26.5	2.7
150	44.3	29.9	40.0	40.0	7.4	21.8	15.8	15.8
155	55.2	18.0	49.0	25.2	-4.5	33.7	2.7	26.5
160	63.7	7.6	56.9	11.5	-14.1	42.0	-9.3	36.1
165	65.9	-3.3	60.2	-.5	-22.4	46.8	-18.8	42.0
170	69.6	-9.0	63.3	-4.2	-27.2	50.4	-22.4	45.6
175	70.1	-13.4	67.1	-4.5	-30.8	52.8	-23.6	48.0
180	71.3	-14.6	65.3	-9.7	-32.0	53.9	-26.0	48.0

620-0011-55
6/78
LEW
145

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN -- LWR T.S. ANALYSIS --- BY L. WHITE - ITER 72

CALCULATION RADIUS 57.47

PEAK STRESS INTENSITIES (KSI)

	PRIMARY SIDE				SECONDARY SIDE			
	CASE 1	CASE 2	CASE 3	CASE 4	CASE 1	CASE 2	CASE 3	CASE 4
0	94.9	-13.3	87.4	-5.8	-55.5	52.6	-48.0	45.1
5	93.4	-11.8	84.4	-2.8	-54.0	51.1	-45.0	42.1
10	91.8	-5.9	84.3	1.6	-50.4	47.3	-42.9	39.8
15	88.7	1.5	85.4	13.3	-45.2	41.9	-37.9	34.2
20	85.9	16.3	79.4	19.4	-37.2	33.4	-31.9	28.2
25	77.7	29.7	74.9	29.3	-26.0	22.0	-25.2	21.4
30	62.7	44.7	70.2	37.2	-11.0	7.0	-18.5	14.5
35	42.0	52.5	62.7	44.7	3.5	-7.0	-11.0	7.0
40	31.5	63.0	52.4	46.4	14.0	-17.5	-4.8	1.2
45	22.6	67.6	43.5	45.6	20.9	-24.2	-.1	-3.1
50	19.1	72.1	40.7	45.2	25.4	-28.7	.7	-3.8
55	12.2	69.3	36.6	40.9	27.1	-30.0	.9	-3.6
60	13.8	67.8	35.5	35.5	25.6	-28.5	-1.3	-1.3
65	15.3	66.3	40.9	35.4	24.1	-27.0	-3.6	.9
70	19.7	65.2	45.2	40.7	21.7	-24.8	-3.8	.7
75	24.1	66.1	46.5	43.6	19.4	-22.7	-3.1	-.1
80	29.9	69.9	46.4	52.4	17.7	-21.4	1.2	-4.8
85	32.8	70.3	44.7	62.7	16.9	-20.7	7.0	-11.0
90	32.9	70.3	37.2	70.2	16.9	-20.7	14.5	-18.5
95	32.8	70.3	28.3	74.8	16.9	-20.7	21.4	-25.2
100	29.9	68.9	19.4	79.4	17.7	-21.4	28.2	-31.9
105	24.1	65.1	13.3	85.4	19.4	-22.7	34.2	-37.9
110	19.7	66.2	1.5	84.3	21.7	-24.8	39.8	-42.9
115	15.3	66.3	-2.9	84.4	24.1	-27.0	42.1	-45.0
120	13.8	67.8	-5.8	87.4	25.6	-28.5	45.1	-48.0
125	12.2	69.3	.0	90.2	27.1	-30.0	43.4	-46.7
130	19.1	72.1	.1	85.8	25.4	-28.7	41.3	-44.4
135	22.5	67.6	4.5	81.2	20.9	-24.2	36.7	-39.9
140	31.5	63.0	20.9	77.9	14.0	-17.5	26.7	-30.4
145	42.0	52.5	38.7	68.7	3.5	-7.0	13.0	-17.0
150	62.7	44.7	58.0	58.0	-11.0	7.0	-2.2	-2.2
155	77.7	29.7	68.7	39.7	-26.0	22.0	-17.0	13.0
160	85.9	16.3	77.9	20.9	-37.2	33.4	-30.4	26.7
165	88.7	1.5	81.2	4.6	-45.2	41.9	-39.9	36.7
170	91.9	-5.9	85.9	.1	-50.4	47.3	-44.4	41.3
175	93.4	-11.8	90.2	.0	-54.0	51.1	-46.7	43.4
180	94.9	-13.3	87.4	-5.8	-55.5	52.6	-48.0	45.1

146
6/78
55-1100-029

STRESS CONCENTRATION

The Stress Concentration factors are taken from Page B-13-1 of Reference 2. These are, of course, still appropriate since the geometry analyzed is the same.

	K_T		K_B	
JUNCTURE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
1	1.0	1.0	1.0	1.0
2	2.75	1.0	2.31	1.0
3	1.0	1.0	1.0	1.0
4	3.39	1.0	2.94	1.0

INTERACTION JUNCTURE STRESS SUMMARY

To evaluate the interaction junctures, the appropriate stress concentration factors were input, along with the sum of the free-body thermal and 91249 interaction stresses, into B&W Program 91076 'Stress Summary Program'. This program calculates stress intensities and ranges for both primary plus secondary and peak classifications. These values will be used in meeting the stress and fatigue requirements of the Design Code.

It should be noted that there is a slight difference in the classification of stresses between the original analysis (ASME Code, Section III, 1965 Edition - Ref. 1) and this analysis (ASME Code, Section III, 1977 Edition).

More specifically, the 1965 code classified the thermal stress due to the equivalent linear portion of the radial gradient as 'Peak Stress'. However, the 1977 code designates this thermal stress as 'Secondary'.

Therefore, the primary + secondary stresses input into Program 91076 are actually the sum of the 91249 stresses (Example Page 132) and the 91206 stresses (Pri. + Sec. Free-Body Thermal Stresses - Page 88 that include the effect of the linear portion of the thermal radial gradient).

Consequently, the 'Peak Increment Free-Body Thermal Stresses' (Page 93 Example) includes the thermal stress resulting from the total radial gradient minus equivalent linear portion mentioned above. These were input into 91076 Program as peak free-body thermal stresses.

In essence, the above discussion means that the classifications of the 'Primary + Secondary' 91076 stresses are conservative compared to the original analysis and the classification of the total pri. + sec. + peak stresses have not changed.

The following pages are the total computer output from Program 91076.

**** FULL CERTIFICATION **** **** FULL CERTIFICATION **** **** FULL CERTIFICATION **** .91CC6D

SMUD RAPID COOLDOWN---STRESS SUMMARY FOR LOWER TUBESHEET ANALYSIS---BY L. WHITE 05/16/78

INPUT DATA

JUNCTURE NO. 1

STRESS CONCENTRATION FACTORS

INSIDE		OUTSIDE	
BENDING	TENSION	BENDING	TENSION
1.000	1.000	1.000	1.000

INPUT STRESSES (IN KSI)

ITER	LONGITUDINAL		CIRCUMFERENTIAL		RADIAL		LONGITUDINAL FREE THERMAL		CIRCUMFERENTIAL FREE THERMAL	
	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
26	7.	6.	11.	9.	-1.	0.	0.	0.	0.	0.
39	9.	-1.	35.	-4.	0.	0.	39.	10.	38.	11.
45	11.	-5.	45.	-4.	0.	0.	15.	6.	14.	7.
49	15.	-4.	33.	7.	-1.	0.	-31.	-4.	-31.	-5.
72	-8.	0.	12.	-2.	0.	0.	5.	2.	5.	2.

LEW
620-0011-55
6/78
149

**** FULL CERTIFICATION **** **** FULL CERTIFICATION **** **** FULL CERTIFICATION **** LRICC6D

STRESS INTENSITY PROGRAM OUTPUT (IN KSI)

JUNCTURE NO. 1

ITER	PRIMARY + SECONDARY STRESS INTENSITIES						PEAK STRESS INTENSITIES					
	L - M		M - R		R - L		L - R		M - R		R - L	
	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
26	-4.	-3.	12.	9.	-8.	-6.	-4.	-3.	12.	9.	-8.	-6.
39	-26.	3.	35.	-4.	-9.	1.	-25.	2.	73.	7.	-48.	-9.
45	-34.	-1.	45.	-4.	-11.	5.	-33.	-2.	59.	3.	-26.	-1.
49	-18.	-11.	34.	7.	-16.	4.	-18.	-10.	3.	2.	15.	8.
72	-20.	2.	12.	-2.	8.	0.	-20.	2.	17.	0.	3.	-2.

STRESS OUTPUT ANALYSIS

STRESS	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
MAXIMUM	0.0	3.0	45.0	9.0	8.0	5.0	0.0	2.0	73.0	9.0	15.0	8.0
MINIMUM	-34.0	-11.0	0.0	-4.0	-16.0	-6.0	-33.0	-10.0	0.0	0.0	-48.0	-9.0
RANGE	34.0	14.0	45.0	13.0	24.0	11.0	33.0	12.0	73.0	9.0	63.0	17.0
MEAN	-17.0	-4.0	22.5	2.5	-4.0	-.5	-16.5	-4.0	36.5	4.5	-16.5	-.5
ALTERNAT	17.0	7.0	22.5	6.5	12.0	5.5	15.5	6.0	35.5	4.5	31.5	8.5

LEW
620-0011-55
6/78
150

SMUD RAPID COOLDOWN---STRESS SUMMARY FOR LOWER TUBESHEET ANALYSIS---BY L. WHITE 05/16/78

INPUT DATA

JUNCTURE NO. 2

STRESS CONCENTRATION FACTORS

INSIDE		OUTSIDE	
BENDING	TENSION	BENDING	TENSION
2.310	2.750	1.000	1.000

INPUT STRESSES (IN KSI)

ITER	LONGITUDINAL		CIRCUMFERENTIAL		RADIAL		LONGITUDINAL FREE THERMAL		CIRCUMFERENTIAL FREE THERMAL	
	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
26	7.	6.	8.	6.	-1.	0.	1.	-2.	-1.	-2.
30	5.	4.	22.	-7.	0.	0.	47.	10.	45.	11.
45	6.	1.	24.	-10.	0.	0.	27.	-15.	27.	-18.
40	15.	-3.	23.	-3.	-1.	0.	-27.	-16.	-26.	-17.
72	-10.	1.	0.	-17.	0.	0.	8.	3.	7.	3.

151
6/78
SS-1100-020
CEW

**** FULL CERTIFICATION **** **** FULL CERTIFICATION **** **** FULL CERTIFICATION **** LRICC6D

STRESS INTENSITY PROGRAM OUTPUT (IN KSI)

JUNCTURE NO. 2

ITER	PRIMARY + SECONDARY STRESS INTENSITIES						PEAK STRESS INTENSITIES					
	L - H		H - R		R - L		L - H		H - R		R - L	
	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
26	-1.	0.	9.	6.	-8.	-6.	13.	0.	8.	4.	-21.	-4.
39	-15.	11.	22.	-7.	-6.	-4.	-4.	10.	67.	4.	-63.	-14.
45	-23.	11.	29.	-19.	-6.	-1.	-15.	14.	57.	-28.	-42.	14.
49	-8.	0.	24.	-3.	-16.	3.	10.	1.	2.	-20.	-11.	19.
72	-10.	18.	0.	-17.	10.	-1.	-22.	18.	5.	-14.	17.	-4.

STRESS OUTPUT ANALYSIS

STRESS	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
MAXIMUM	0.0	18.0	29.0	6.0	10.0	3.0	12.8	18.0	67.4	4.0	17.1	19.0
MINIMUM	-23.0	0.0	0.0	-17.0	-16.0	-6.0	-21.9	0.0	0.0	-28.0	-63.1	-14.0
RANGE	23.0	18.0	29.0	23.0	26.0	9.0	34.8	18.0	67.4	32.0	80.1	33.0
MEAN	-11.5	9.0	14.5	-5.5	-3.0	-1.5	-4.5	9.0	33.7	-12.0	-23.0	2.5
ALTERNAT	11.5	9.0	14.5	11.5	13.0	4.5	17.4	9.0	33.7	16.0	40.1	16.5

CEW
55-1100-0020
6/78
152

SMJD RAPID COOLDOWN---STRESS SUMMARY FOR LOWER TUBESHEET ANALYSIS---BY L. WHITE 05/16/78

INPUT DATA

JUNCTURE NO. 3

STRESS CONCENTRATION FACTORS

INSIDE		OUTSIDE	
BENDING	TENSION	BENDING	TENSION
1.000	1.000	1.000	1.000

INPUT STRESSES (IN KSI)

ITER	LONGITUDINAL		CIRCUMFERENTIAL		RADIAL		LONGITUDINAL FREE THERMAL		CIRCUMFERENTIAL FREE THERMAL	
	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
26	4.	11.	7.	9.	-2.	0.	0.	0.	0.	0.
39	-1.	16.	3.	12.	-2.	0.	-2.	-1.	-2.	-1.
45	-2.	14.	0.	8.	-1.	0.	2.	0.	2.	0.
49	-1.	14.	3.	7.	-2.	0.	5.	1.	5.	1.
72	63.	-49.	32.	-40.	-2.	0.	7.	6.	7.	6.

LEW
620-0011-55
6/78
153

**** FULL CERTIFICATION **** **** FULL CERTIFICATION **** **** FULL CERTIFICATION **** LRICC6D

STRESS INTENSITY PROGRAM OUTPUT (IN KSI)

JUNCTURE NO. 3

ITER	PRIMARY + SECONDARY STRESS INTENSITIES						PEAK STRESS INTENSITIES					
	L - H		H - R		R - L		L - H		H - R		R - L	
	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
26	-3.	2.	9.	9.	-6.	-11.	-3.	2.	9.	9.	-6.	-11.
39	-4.	4.	5.	12.	-1.	-16.	-4.	4.	3.	11.	1.	-15.
45	-2.	6.	1.	4.	1.	-14.	-2.	6.	3.	8.	-1.	-14.
49	-6.	7.	5.	7.	1.	-14.	-6.	7.	10.	8.	-4.	-15.
72	31.	-9.	34.	-40.	-65.	49.	1.	-9.	41.	-34.	-72.	43.

STRESS OUTPUT ANALYSIS

STRESS	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
MAXIMUM	31.0	7.0	34.0	12.0	1.0	49.0	31.0	7.0	41.0	11.0	1.0	43.0
MINIMUM	-5.0	-9.0	0.0	-40.0	-65.0	-16.0	-6.0	-9.0	0.0	-34.0	-72.0	-15.0
RANGE	37.0	16.0	34.0	52.0	66.0	65.0	37.0	16.0	41.0	45.0	73.0	58.0
MEAN	12.5	-1.0	17.0	-14.0	-32.0	16.5	12.5	-1.0	20.5	-11.5	-35.5	14.0
ALTERNAT	18.5	8.0	17.0	26.0	33.0	32.5	18.5	8.0	20.5	22.5	36.5	29.0

LEW
620-0011-55
6/78
154

**** FULL CERTIFICATION **** **** FULL CERTIFICATION **** **** FULL CERTIFICATION **** .01CC60

SMUD RAPID COOLDOWN---STRESS SUMMARY FOR LOWER TUBESHEET ANALYSIS---AT L. WHITE 05/16/78

INPUT DATA

JUNCTURE NO. 4

STRESS CONCENTRATION FACTORS

INSIDE		OUTSIDE	
BENDING	TENSION	BENDING	TENSION
2.940	3.390	1.000	1.000

INPUT STRESSES (IN KSI)

ITER	LONGITUDINAL		CIRCUMFERENTIAL		RADIAL		LONGITUDINAL FREE THERMAL		CIRCUMFERENTIAL FREE THERMAL	
	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
26	4.	12.	4.	6.	-2.	0.	0.	0.	0.	0.
39	-3.	17.	1.	6.	-2.	0.	-2.	-2.	-2.	-2.
45	-3.	15.	6.	12.	-2.	0.	3.	0.	3.	0.
49	-5.	15.	6.	9.	-2.	0.	6.	2.	6.	2.
72	74.	-60.	33.	-53.	-2.	0.	7.	5.	7.	5.

55-1100-020
8/78
155

STRESS INTENSITY PROGRAM OUTPUT (IN KSI)

JUNCTURE NO. 4

ITER	PRIMARY + SECONDARY STRESS INTENSITIES						PEAK STRESS INTENSITIES					
	L - H		H - R		R - L		L - H		H - R		R - L	
	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
26	0.	6.	6.	6.	-6.	-12.	14.	6.	4.	6.	-17.	-12.
39	-4.	11.	3.	6.	1.	-17.	-1.	11.	-5.	4.	6.	-15.
45	-9.	3.	8.	12.	1.	-15.	-7.	3.	6.	12.	1.	-15.
49	-11.	5.	8.	9.	3.	-15.	-13.	6.	8.	11.	4.	-17.
72	41.	-7.	35.	-51.	-76.	60.	149.	-7.	81.	-48.	-230.	55.

STRESS OUTPUT ANALYSIS

STRESS	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
MAXIMUM	41.0	11.0	35.0	12.0	3.0	60.0	148.7	11.0	81.0	12.0	5.7	55.0
MINIMUM	-11.0	-7.0	0.0	-53.0	-76.0	-17.0	-12.6	-7.0	-4.8	-48.0	-229.7	-17.0
RANGE	52.0	18.0	35.0	65.0	79.0	77.0	161.3	18.0	85.8	60.0	235.4	72.0
MEAN	15.0	2.0	17.5	-20.5	-36.5	21.5	68.0	2.0	38.1	-18.0	-112.0	19.0
ALTERNAT	25.0	9.0	17.5	32.5	39.5	38.5	80.7	9.0	42.9	30.0	117.7	36.0

LEW
620-0011-55
6/78
156

SMUD RAPID COOLDOWN---STRESS SUMMARY FOR LOWER TUBESHEET ANALYSIS---BY L. WHITE 05/16/78

INPUT DATA

JUNCTURE NO. 5

STRESS CONCENTRATION FACTORS

INSIDE		OUTSIDE	
BENDING	TENSION	BENDING	TENSION
1.000	1.000	1.000	1.000

INPUT STRESSES (IN KSI)

ITER	LONGITUDINAL		CIRCUMFERENTIAL		RADIAL		LONGITUDINAL FREE THERMAL		CIRCUMFERENTIAL FREE THERMAL	
	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
26	-1.	-2.	-3.	2.	-4.	3.	-6.	0.	-6.	0.
39	0.	-2.	28.	3.	-6.	2.	-57.	-2.	-55.	2.
45	0.	-2.	34.	10.	-7.	3.	-70.	3.	66.	3.
43	-1.	-2.	13.	12.	-4.	4.	-35.	6.	-34.	6.
72	0.	-2.	29.	40.	-4.	16.	-4.	4.	-3.	4.

CEW
6/78
SS-1100-0029
157

STRESS INTENSITY PROGRAM OUTPUT (IN KSI)

JUNCTURE NO. 5

ITER	PRIMARY + SECONDARY STRESS INTENSITIES						PEAK STRESS INTENSITIES					
	L - H		H - R		R - L		L - H		H - R		R - L	
	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
26	2.	-4.	1.	-1.	-3.	5.	2.	-4.	-5.	-1.	3.	5.
39	-28.	-5.	34.	1.	-6.	4.	-30.	-9.	-21.	3.	51.	6.
45	-34.	-12.	41.	7.	-7.	5.	-170.	-12.	107.	10.	63.	2.
49	-14.	-14.	17.	8.	-3.	6.	-15.	-14.	-17.	14.	32.	0.
72	-29.	-42.	33.	24.	-4.	18.	-30.	-42.	30.	28.	0.	14.

STRESS OUTPUT ANALYSIS

STRESS	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
MAXIMUM	2.0	0.0	41.0	24.0	0.0	18.0	2.0	0.0	107.0	28.0	63.0	14.0
MINIMUM	-34.0	-42.0	0.0	-1.0	-7.0	0.0	-170.0	-42.0	-21.0	-1.0	0.0	0.0
RANGE	35.0	42.0	41.0	25.0	7.0	18.0	172.0	42.0	128.0	29.0	63.0	14.0
MEAN	-15.0	-21.0	20.5	11.5	-3.5	9.0	-84.0	-21.0	43.0	13.5	31.5	7.0
ALTERNAT	19.0	21.0	20.5	12.5	3.5	9.0	86.0	21.0	64.0	14.5	31.5	7.0

LEW
620-0011-55
6/78
158

INTERACTION JUNCTURE STRESS EVALUATION

By examination of the Program 91076 'Stress Summary' (preceding pages), it can be seen that the most highly stressed junctures are Junctures 2 and 4.

Therefore, to simplify the analysis, only these junctures will be evaluated.

JUNCTURE #2 EVALUATION

THE MAX. PRIMARY PLUS SECONDARY STRESS INTENSITY RANGE RESULTING FROM THE 'RAPID COOLDOWN' AND PREVIOUSLY ANALYZED TRANSIENTS IS DETERMINED IN THE TABLE BELOW.

	STRESS INTENSITY					
	L-H		H-R		R-L	
	INS.	OUT.	INS.	OUT.	INS.	OUT.
MAXIMUM	4.0 △	18.0 *	29.0 *	16.0 △	10.0 *	3.0 *
MINIMUM	-23.0 *	-9.0 △	0.0 △	-17.0 *	-16.0 *	-7.0 △
RANGE	27.0	27.0	29.0	33.0	26.0	10.0

∴ MAX. RANGE = H-R (OUT) = 33.0 KSI < $3S_m$ = 80.1 KSI

△ REF. 2, PAGE C-16-5
□ REF. 2, PAGE C-16-13
* REF. PAGE 152 OF THIS ANALYSIS

JUNCTURE #4 EVALUATION

THE MAXIMUM PRIMARY PLUS SECONDARY STRESS INTENSITY RANGE RESULTING FROM THE 'RAPID COOLDOWN' AND PREVIOUSLY ANALYZED TRANSIENTS IS DETERMINED IN THE TABLE BELOW.

	STRESS INTENSITY					
	L-H		H-R		R-L	
	INS	OUT	INS	OUT	INS	OUT
MAXIMUM	41*	11*	35*	12*	3*	60*
MINIMUM	-11*	-3*	0*	-53*	-76*	-17*
RANGE	52	14	35	65	79	77

∴ MAX. RANGE = R-L (INS) = 79 KSI < $3S_m$ = 80.1 KSI

△ REF. 2, PAGE C-16-7
□ REF. 2, PAGE C-16-17
* REF. PAGE 156 OF THIS ANALYSIS

BABCOCK & WILCOX
DEPARTMENT Mt. V-Comp. Engrg. DATE 6/78 BY LEW
JUNCTURE #4 CHECKED DATE BY
EVALUATION JOB NO. 620-0011-55

REVISION

INTERACTION JUNCTURE FATIGUE EVALUATION

Prior experience on the OTSG has shown that the crucial areas for fatigue evaluation are Junctures 2 and 4. Therefore, to simplify the analysis those areas will be justified.

The following pages demonstrate the affect of the 'Rapid Cooldown' transient on the total cumulative fatigue usage factor.

EFFECT OF 'RAPID COOLDOWN' ON JUNCTURE #2 USAGE FACTOR:

FROM REF. 2, PAGES C-17-2 AND C-17-3, THE JUNC. 2 CUMULATIVE USAGE FACTOR HAS BEEN CALCULATED TO BE 0.0.

THE ADDITIONAL CYCLE RESULTING FROM THE RAPID COOLDOWN WILL BE COMPLETED BY A NORMAL HEATUP TO FULL POWER. THE MAXIMUM PEAK STRESS INTENSITY RANGE FROM THE ADDITIONAL CYCLE IS DETERMINED FROM THE TABLE BELOW.

	PEAK STRESS INTENSITY					
	L-H		H-R		R-L	
	INS	OUT	INS	OUT	INS	OUT
MAXIMUM	13.0*	18.0*	67.0*	22.0△	17.0*	19.0*
MINIMUM	-22.0*	-9.0△	0.0*	-28.0*	-63.0*	-14.0*
RANGE	35.0	27.0	67.0	50.0	80.0	33.0

△ REF. 2, PAGE C-16-5
□ REF. 2, PAGE C-16-13
* REF. PAGE 152 OF THIS ANALYSIS

BABCOCK & WILCOX			REVISION
DEPARTMENT NE-V-COMP ENGRG.	DATE 6/78	BY LEW	
JUNCTURE #2	CHECKED DATE	BY	
EVALUATION	JOB NO. 620-0011-55		SHEET 163 OF

MAX. PEAK STRESS INTENSITY RANGE @ JUNC. #2 =

$(R\text{-}L)_{INS}$ = 80 KSI

$S_{ALT} = (80/2)\frac{E_C}{E_A} = 45.9$ KSI

FROM ASME CODE, SECT. III, FATIGUE CURVE

N = 5,500 ALLOWABLE CYCLES

$\therefore\ U_2 = 0.0 + \frac{1}{5,500} \approx 0.0$

THEREFORE, IT IS SHOWN THAT THE USAGE FACTOR FOR JUNCTURE #2 IS ESSENTIALLY UNCHANGED AND IS STILL ACCEPTABLE.

BABCOCK & WILCOX DEPARTMENT NT-V-COMP. ENGRG. DATE 6/78 BY LEW		REVISION
JUNCTURE #2	CHECKED DATE BY	
EVALUATION	JOB NO. 620-0011-55	SHEET 164 OF

EFFECT OF 'RAPID COOLDOWN' ON JUNCTURE #4 USAGE FACTOR:

FROM REF. 2, PAGES C-17-2 AND C-17-3, THE JUNC. #4 CUMULATIVE USAGE FACTOR HAS BEEN CALCULATED TO BE 0.03.

THE ADDITIONAL CYCLE RESULTING FROM THE RAPID COOLDOWN WILL BE COMPLETED BY A NORMAL HEATUP TO FULL POWER. THE MAXIMUM PEAK STRESS INTENSITY RANGE FROM THE ADDITIONAL CYCLE IS DETERMINED FROM THE TABLE BELOW.

	PEAK STRESS INTENSITY					
	L-H		H-R		R-L	
	INS	OUT	INS	OUT	INS	OUT
MAXIMUM	149*	11*	81*	12*	6*	55*
MINIMUM	-13*	-7*	-5*	-48	-230*	-17*
RANGE	162	18	86	60	236	72

△ REF. 2, PAGE C-16-9
□ REF. 2, PAGE C-16-17
* REF. PAGE 156 OF THIS ANALYSIS

BABCOCK & WILCOX DEPARTMENT NT,V - COMP. ENGRG. DATE 6/78 BY LEW		REVISION
JUNCTURE #4	CHECKED DATE BY	
EVALUATION	JOB NO. 620-0011-55	SHEET 165 OF

MAX. PEAK STRESS INTENSITY RANGE @ JUNC. #4 =

(R-L) INS = 236 KSI

$$S_{ALT} = (236/2)\frac{E_C}{E_A} = 135.7 \text{ KSI}$$

FROM ASME CODE, SECT. III, FATIGUE CURVE

N = 250 ALLOWABLE CYCLES

$$\therefore U_4 = 0.03 + \frac{1}{250} = 0.034$$

THEREFORE, IT IS SHOWN THAT THE USAGE FACTOR FOR JUNC. #4 IS ESSENTIALLY UNCHANGED AND IS STILL ACCEPTABLE.

BABCOCK & WILCOX DEPARTMENT NT. V-COMP. ENGRG. DATE 6/78 BY LEW	REVISION
JUNCTURE #4 CHECKED DATE BY	
EVALUATION JOB NO. 620-0011-55	SHEET 166 OF

TUBE STRESS EVALUATION

The critical requirement for the tubes is to assure that the tubes have not been stressed beyond the yield stress.

The following pages show the 91249 tube load output for each iteration, a tabulation of maximum tube load, and calculation of maximum tube stress.

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD STEAM GENERATOR---REACTOR TRIP TRANS. ITEM 26

TUBE LOADS

TUBESHEET RADIUS	TUBESHEET DEFLECTION	TUBE AXIAL DEFLECTION	LONGITUDINAL TUBE STRESS	TUBE LOAD LB.
0.00	1.2214	-.0259	-2.25	-141.6
5.75	1.2216	-.0256	-2.23	-140.7
11.49	1.2222	-.0250	-2.18	-137.5
17.24	1.2231	-.0241	-2.10	-132.5
22.99	1.2243	-.0229	-2.00	-126.1
28.74	1.2255	-.0216	-1.88	-119.0
34.48	1.2268	-.0204	-1.78	-112.1
40.23	1.2278	-.0193	-1.58	-106.3
45.98	1.2284	-.01[illegible]7	-1.53	-103.1
51.72	1.2283	-.0196	-1.54	-103.7
57.47	1.2272	-.0200	-1.74	-110.0

TUBESHEET DEFLECTION TO PRIMARY SIDE IS POSITIVE

VERTICAL FORCE BALANCE FOR TUBESHEET (KIP/RAD BASIS)

VERTICAL REDUNDANT (V5)	CALCULATED VERTICAL LOAD	PERCENT DEVIATION
-1156.4	-1161.0	-.4

NOTE* THE CALCULATED VERTICAL LOAD CONSISTS OF THE AREA-CORRECTED PRESSURE LOADS ON THE TUBESHEET FACES PLUS A RADIUS-WEIGHTED SUMMATION OF THE TUBE STRAINS AT THE TABULATED RADII.

LEW
620-0011-55
6/78
168

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN---LOWER TUBESHEET ANALYSIS---BY L. WHITE ITER 39

TUBE LOADS

TUBESHEET RADIUS	TUBESHEET DEFLECTION	TUBE AXIAL DEFLECTION	LONGITUDINAL TUBE STRESS	TUBE LOAD LB.
0.00	1.2229	-.0630	-5.48	-346.1
5.75	1.2230	-.0629	-5.47	-345.3
11.49	1.2234	-.0624	-5.43	-342.9
17.24	1.2241	-.0618	-5.38	-339.3
22.99	1.2249	-.0610	-5.31	-335.1
28.74	1.2256	-.0602	-5.24	-330.9
34.48	1.2262	-.0597	-5.19	-327.9
40.23	1.2264	-.0595	-5.18	-326.8
45.98	1.2259	-.0600	-5.22	-329.6
51.72	1.2244	-.0615	-5.35	-337.6
57.47	1.2217	-.0642	-5.59	-352.7

TUBESHEET DEFLECTION TO PRIMARY SIDE IS POSITIVE

VERTICAL FORCE BALANCE FOR TUBESHEET (KIP/RAD BASIS)

VERTICAL REDUNDANT (VS)	CALCULATED VERTICAL LOAD	PERCENT DEVIATION
-1268.9	-1268.2	.1

NOTE* THE CALCULATED VERTICAL LOAD CONSISTS OF THE AREA-CORRECTED PRESSURE LOADS ON THE TUBESHEET FACES PLUS A RADIUS-WEIGHTED SUMMATION OF THE TUBE STRAINS AT THE TABULATED RADII.

55-1100-029
6/78
CEW
169

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD RAPID COOLDOWN---LOWER TUBESHEET ANALYSIS---BY L. WHITE ITER 45

TUBE LOADS

TUBESHEET RADIUS	TUBESHEET DEFLECTION	TUBE AXIAL DEFLECTION	LONGITUDINAL TUBE STRESS	TUBE LOAD LB.
0.00	1.1925	-.0274	-2.39	-151.1
5.75	1.1925	-.0274	-2.39	-150.7
11.49	1.1927	-.0272	-2.37	-149.6
17.24	1.1930	-.0269	-2.35	-148.2
22.99	1.1932	-.0267	-2.33	-146.9
28.74	1.1932	-.0266	-2.32	-146.7
34.48	1.1929	-.0270	-2.35	-148.5
40.23	1.1920	-.0279	-2.43	-153.6
45.98	1.1902	-.0297	-2.59	-163.5
51.72	1.1872	-.0327	-2.85	-179.9
57.47	1.1827	-.0371	-3.24	-204.6

TUBESHEET DEFLECTION TO PRIMARY SIDE IS POSITIVE

VERTICAL FORCE BALANCE FOR TUBESHEET (KIP/RAD BASIS)

VERTICAL REDUNDANT (VS)	CALCULATED VERTICAL LOAD	PERCENT DEVIATION
-1301.3	-1300.6	.1

NOTE* THE CALCULATED VERTICAL LOAD CONSISTS OF THE AREA-CORRECTED PRESSURE LOADS ON THE TUBESHEET FACES PLUS A RADIUS-WEIGHTED SUMMATION OF THE TUBE STRAINS AT THE TABULATED RADII.

LEW
620-0011-55
6/78
170

PROGRAM NO. 91249 INTERACTION ANALYSIS OF ONCE-THROUGH STEAM GENERATORS DATE 05/16/78

SMUD STEAM GENERATOR---REACTOR TRIP TRANS.--- ITER 49

FOR ITER 72 OUTPUT
SEE PG. 135

TUBE LOADS

TUBESHEET RADIUS	TUBESHEET DEFLECTION	TUBE AXIAL DEFLECTION	LONGITUDINAL TUBE STRESS	TUBE LOAD LB.
0.00	1.2079	.0108	.94	59.6
5.75	1.2078	.0105	.93	58.7
11.49	1.2072	.0101	.88	55.8
17.24	1.2053	.0092	.80	50.7
22.99	1.2050	.0078	.69	43.3
24.74	1.2031	.0060	.52	33.0
34.48	1.2007	.0035	.31	19.5
40.23	1.1975	.0004	.03	2.0
45.98	1.1935	-.0036	-.32	-20.0
51.72	1.1886	-.0096	-.75	-47.2
57.47	1.1825	-.0146	-1.28	-80.6

TUBESHEET DEFLECTION TO PRIMARY SIDE IS POSITIVE

VERTICAL FORCE BALANCE FOR TUBESHEET (KIP/RAD BASIS)

VERTICAL REDUNDANT (V5)	CALCULATED VERTICAL LOAD	PERCENT DEVIATION
-520.3	-526.4	-1.2

NOTE* THE CALCULATED VERTICAL LOAD CONSISTS OF THE AREA-CORRECTED PRESSURE LOADS ON THE TUBESHEET FACES PLUS A RADIUS-WEIGHTED SUMMATION OF THE TUBE STRAINS AT THE TABULATED RADII.

171
55-1100-020
6/78
LEW

SUMMARY OF TUBE LOADS

ITERATION	TUBE LOAD @ R=0.0"	TUBE LOAD @ R=R*
26	-141.8	-110.0
39	-346.1	-352.7
45	-151.1	-204.6
49	59.6	-80.6
72	1077	1691.5

LOAD IN POUNDS

MAXIMUM TUBE STRESS

THE MAXIMUM TUBE LOAD FOR THE RAPID COOLDOWN IS:

$$P_{MAX} = +1691.5 \text{ POUNDS TENSILE LOAD}$$

THE TUBE CROSS-SECTIONAL AREA IS:

$$A_T = \pi (0.625 - 0.0340)(0.0340) = 0.0631 \text{ IN}^2$$

$\therefore$ MAX. TUBE STRESS = $\frac{1691.5}{0.0631} \cdot \sigma_{MAX}$

$= 26,807$ PSI

THE ALLOWABLE STRESS FOR THE TUBES IS THE YIELD STRESS AT THE TUBE TEMPERATURE

FOR SB-163 @ $\approx 360°F$, $S_y = 30,280$ PSI

SINCE σ_{MAX} (26,807 PSI) $<$ S_y (30,280 PSI)

TUBE STRESS IS ACCEPTABLE.

NON-DUCTILE FAILURE ANALYSIS

The following pages show that the temperature at which non-ductile failure would occur for a defect in the base metal is far below the actual metal temperature. Hence, no failure would occur for the postulated defect.

The analysis is based on the procedure given in Reference 4.

NON-DUCTILE FAILURE ANALYSIS

THE CRITICAL JUNCTURE FOR THIS CONSIDERATION IS JUNCTURE #3 (HEAD-TO-TUBESHEET WELD METAL).

SEE REFERENCE 4:

MAX. POSTULATED DEFECT = $\frac{1}{4}T \times 1\frac{1}{2}T$
WHERE $T = 8"$

MAX. JUNC. 3 STRESS CONDITION = LONG. STRESS

$L_{INS.} = 63.3$ KSI $\quad L_{OUT} = -48.9$ KSI
(REF. 91249 OUT. - ITER 72 - PG. 132)

$L_{MEMBRANE} = (63.3 + (-48.9))/2 = +7.2$ KSI

$L_{BENDING} = 63.3 - (+7.2) = +56.1$ KSI

THESE ARE PRI. + SEC. STRESSES

FROM FIG. G-2214-1, FOR $\sqrt{t} = 2.83$, $\sigma/\sigma_y = 1.0$;

$M_m = 2.92$; $M_b = \frac{2}{3}(2.92) = 1.95$

DETERMINE STRESS COMPONENTS FOR PARA. G-2222:

PRI. MEMBRANE $= \frac{PR}{2t} = \frac{(2.05)(59.5313)}{2(8)} = 7.63$ KSI

PRI. BENDING = ZERO FOR THIS GEOMETRY

SEC. MEMBRANE = (PRI. + SEC. MEM) − (PRI. MEM.)
= +7.2 (PREV. PG.) − 7.63
= −0.43 KSI

SEC. BENDING = (PRI. + SEC. BEND.) − (PRI. BEND.)
+56.1 (PREV. PG.) − 0
= +56.1 KSI

PER PARA. G-2222:

$2 K_{Im}$ (PRI. MEM.) + $2 K_{Ib}$ (PRI. BEND.) + K_{Im} (SEC. MEM.) + ...

..... K_{Ib} (SEC. BEND) < K_{IR}

$2[(2.92)(7.63)] + 2[(1.95)(0)] + [(2.92)(-0.43)] + \ldots$

$\ldots [(1.95)(56.1)] = 152.7$

IF WE ASSUME THIS VALUE AS K_{IR} IN FIG. G-2210-1, THEN THE QUANTITY ($T - RT_{NDT}$) EQUALS 160

FROM REFERENCE 3, PAGE 3-12, THE HIGHEST AND, THUS THE MOST CONSERVATIVE, VALUE OF RT_{NDT} THAT WAS MEASURED FOR THE MATERIALS INVOLVED IS 60°.

THEREFORE, $T - RT_{NDT} = 160$

$T = 160 + 60 = 220°F$

BABCOCK & WILCOX

DEPARTMENT NT. V - COMP. ENGRG. DATE 6/78 BY LEW

NON-DUCTILE FAILURE CHECKED DATE BY

ANALYSIS JOB NO. 620-0011-55

REVISION

SHEET 176 OF

BMS 247-1

THEREFORE, THIS SHOWS THAT THE ACTUAL METAL TEMPERATURE NEEDS TO BE GREATER THAN 220°F TO PREVENT NON-DUCTILE FAILURE.

PER PAGE ______, THE ACTUAL METAL TEMPERATURE AT THE WELD LOCATION, INSIDE SURFACE, IS 308°F (NODAL TEMPS @ 24, 50, 76, 102 INTERPOLATED TO INSIDE SURFACE FOR ITER 72 - SEE PAGE 44).

SINCE 308°F > 220°F, NON-DUCTILE FAILURE DUE TO A 1/4T × 1 1/2T DEFECT WILL NOT OCCUR.

BABCOCK & WILCOX		REVISION
DEPARTMENT NIT V-COMP. ENGRG.	DATE 6/78 BY LEW	
NON-DUCTILE FAILURE	CHECKED DATE BY	
ANALYSIS	JOB NO. 620-0011-55	SHEET 177 OF

APPENDIX

Information supplied to Mt. Vernon Component Engineering describing the 'Rapid Cooldown' parameters.

cc: BA Karrasch
RN Tornow
LH Bohn
JR Burris
PA Sherburne
CE Harris
HS Palme
JT Janis
RM Douglass-MT. Ver
RN Bottorf-MT. Vern

BDS 653.5

THE BABCOCK & WILCOX COMPANY
POWER GENERATION GROUP

To	DISTRIBUTION
From	J. M. BURNETT - RCS COMPONENTS
Cust.	SMUD
File No. or Ref.	
Subj.	SMUD COOLDOWN INCIDENT
Date	4/4/78

This letter to cover one customer and one subject only.

DISTRIBUTION

~~C. W. Bruny - MT. Vernon~~
H. W. Behnke - MT. Vernon
A. D. McKim - MT. Vernon
R. R. Schaefer - MT. Vernon

Reference: (1) Memo, B. A. Karrasch to G. M. Olds, "SMUD Cooldown Incident", dated 3/29/78.

Attached for your information and use is a copy of reference memo (1), including attachments. The transient sequence of events and curves contained in the referenced package comprise the official information regarding the subject transient. Based on the preliminary assessments performed on the RV, SG's, RC Piping, and Pressurizer SMUD has been allowed to go back to power operation (restricted to 75% full power). B&W has subsequently committed to a follow-up program of analysis and documentation to support the issuance of a letter from B&W to SMUD authorizing return to 100% full power. To support this Company commitment, those on distribution are requested to formalize and finalize all necessary analytical efforts for the affected components by May 15, 1978 (calculation packages and documentation should be in Lynchburg on this date). Steam generator analytical efforts should be coordinated with P. A. Sherburne. All other component activities should be coordinated with J. M. Burnett (C. E. Harris and H. S. Palme will be assisting J. M. Burnett in evaluation of the RV from a fracture mechanics standpoint).

Manhour charges should continue per the previously authorized charge number (Contract 595-7072, Task 68, WBS Charge AM680B72) and appropriate Time and Materials reporting forms should be transmitted weekly to J. T. Janis, Lynchburg.

Any problems or questions that arise should be addressed to J. M. Burnett or P. A. Sherburne as noted previously. Your cooperation in these activities are very much appreciated.

J M Burnett
J. M. BURNETT

LEW
620-0011-55
6/78
A-2

ef

man hours to 595-7072-68-05

J M. Burnette

THE BABCOCK & WILCOX COMPANY
POWER GENERATION GROUP

To	G. M. Olds, Manager, Nuclear Service	
From	B. A. Karrasch, Manager, Plant Integration	BDS 663.3
Cust.	177 - All	File No. or Ref.
Subj.	SMUD Cooldown Incident	Date March 29, 1978

This letter to cover one customer and one subject only.

On March 20, 1978, SMUD experienced a loss of power to a substantial portion of the non-nuclear instrumentation (see details - Attachment 3). Although the Reactor Protection System (RPS) and Safety Features Actuation System (SFAS) functioned properly, SMUD still experienced the most severe thermal transient on any B&W plant to date. The subsequent investigation pointed out that additional guidance to our operating customers in the area of limiting potential events of this nature is warranted. Accordingly, the Engineering Department recommends that our operating plant customers be informed of this incident, and suggestions be made on how to minimize the plant thermal transient for loss of NNI and other similar events. Attachment 1, a sequence of events, and Attachment 2, a series of descriptive curves, are provided to assist you in preparation of a customer letter.

In addition, the following recommendations should be made to assure proper operator action for events of this nature:

1. Operators should be trained to recognize a loss of power to all or a majority of their NNI (indicators fail to mid-range, automatic or manual transfer to alternate instrument strings brings no response, etc.). The loss of power is emphasized here rather than the failure of any one instrument or control signal. These minor events are adequately covered in our present simulator course.

2. Given that the operator can determine that he has lost power to all or most of the NNI, he should know the location of the power supplies and power supply breakers and have a procedure available to regain power.

3. If the fault cannot be cleared (e.g., the breakers to the power supplies reopen), he should have a list of alternate instrumentation available to him. Some possibilities are:

    a) ESFAS panels

    b) RPS panels

    c) ECI

    d) SRCI

LEW
620-0011-55
6/78
A-3

e) Remote shutdown panels

f) Local gages

g) Plant Computer

Note that each plant will be different in detail, but the list should be developed in advance and the operators thoroughly trained in its usage.

4. The above instrumentation sources should also be keyed to certain critical variables to help the operator select his <u>priorities</u> during the emergency condition. It is recognized that no procedure can cover all the possible combinations of non-nuclear instrumentation failures, however, if the operator knows he has an instrument problem (as opposed to a LOCA or steam line break, for example), he can limit the transient by controlling only a few variables. These are:

    a) Pressurizer level (via HPI or normal makeup pumps)

    b) RCS pressure (via pressurizer heaters, spray, E/M relief valve)

    c) Steam generator level (via feed flow, feedwater valves)

    d) Steam generator pressure (via turbine bypass system)

    The pressurizer level and RCS pressure assure that the Reactor Coolant System is filled and the steam generator level and pressure assure adequate decay heat removal.

In our opinion, the preferred solution is to install safety grade steam generator level instrumentation, start auxiliary feedwater on a low level steam generator signal, and control steam generator level automatically, as is required on our IEOTSG plants. This may not be a practical backfit solution for the operating plants, however, this solution should be suggested as a possible way to assure minimal lost capacity days due to equipment failure. Plant Integration will be happy to assist you in the preparation of the customer letter.

B A Karrasch

BAK:jl

cc: J. C. Deddens
D. H. Roy
R. M. Ball
T. M. Schuler
C. W. Pryor
L. J. Stanek
K. E. Suhrke
J. S. Tulenko
J. H. Taylor
E. W. Swanson
J. J. Kelly
J. D. Phinney
D. F. Hallman
J. A. Castanes
P. A. Sherburne
J. R. Burris
R. W. Moore
R. W. Winks
J. T. Janis
A. W. Brown
B. J. Shepherd
L. R. Cartin
C. E. Harris
H. S. Palme
J. M. Burnette
G. A. Meyer

LEW
620-0011-55
6/78
A-4

ATTACHMENT 1

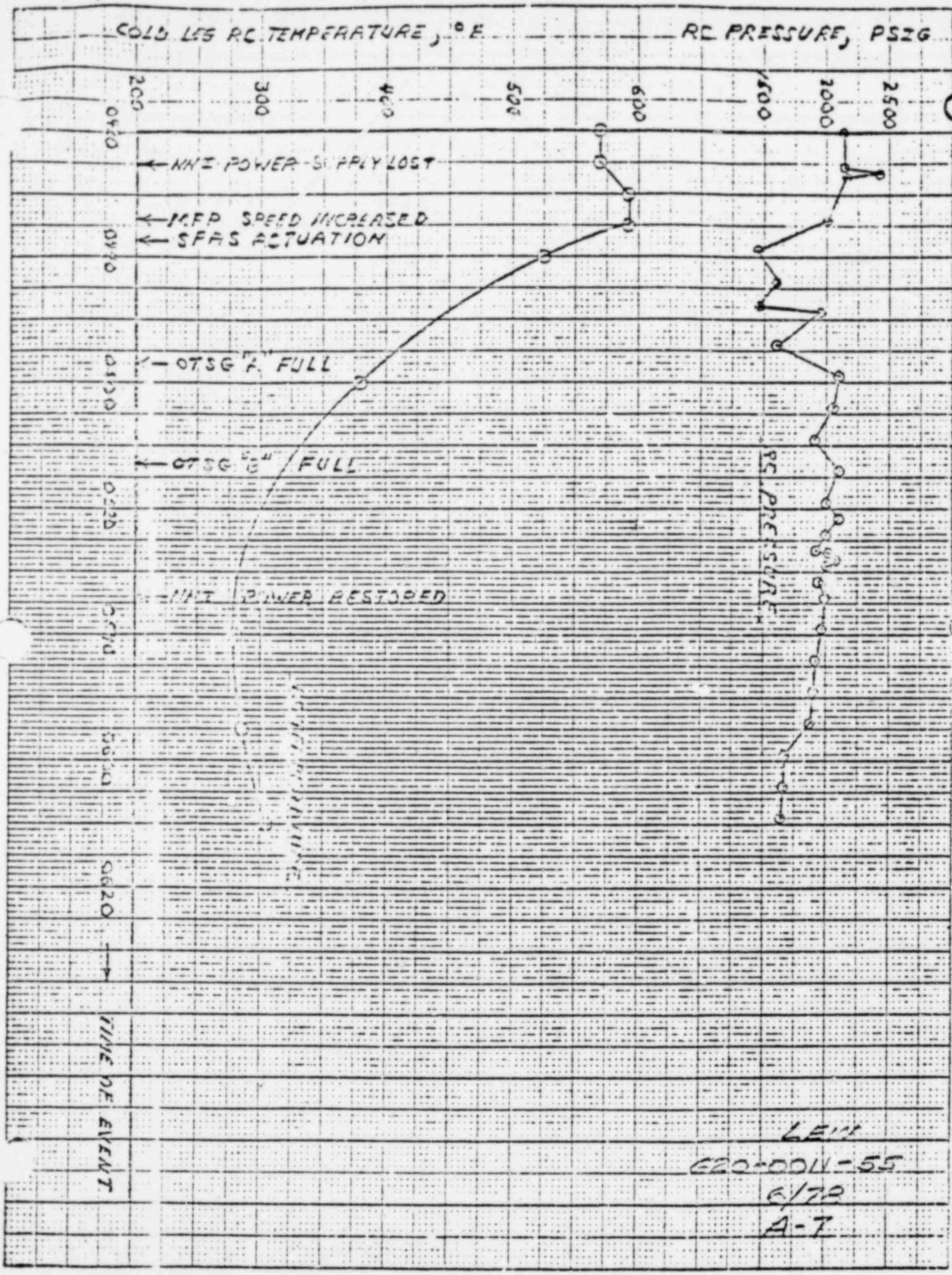
SEQUENCE OF EVENTS - 04:25(AM) to 05:34(AM)

TIME	EVENT
4:25:35	- Lost NNI power supply cabinets 5,6, & 7 (B&W Channel "Y")
	- This caused a loss of T_H signals to the ICS. BTU limits ran back feedwater, resulting in a loss of feedwater (actual Rx power was 72%).
4:25:46	- Reactor trip on high pressure, turbine trip on interlock.
	- Pressurizer code relief setting was known to be low (≈2225 psig). The electromatic relief was isolated due to previous leakage problems. The data indicates primary pressure went ≈2400 psig =>code relief valve lifted.
4:26:17	- Operator starts HPI pump "B" to maintain pzr. level.
4:28:23	- Operator stops HPI pump "B".
4:30	- OTSG "B" goes dry. Data indicates that "A" OTSG probably also went dry.
4:34:25	- RC pressure ≈1900 PSI (low pressure trip set-point.
4:34	- Operator increases speed of a MFP and feeds "A" OTSG. This starts RCS on pressure and temperature decrease.
4:37:16	- SFAS actuation at 1600 psig This starts HPI, LPI and initiates aux. feed. Aux. FW valves are opened to full open position. The system makes no automatic attempt to control steam generator water level.
4:40	- RC pressure at 1475 psig. It starts to recover from this point due to HPI. T_{ave} = 528°F.
4:43:56	- "A" HPI pump secured.
4:46:09	- LPI secured.
4:49:54	- "A" HPI initiated. From this point on, the operator started and stopped HPI pumps as necessary to maintain pressurized level.

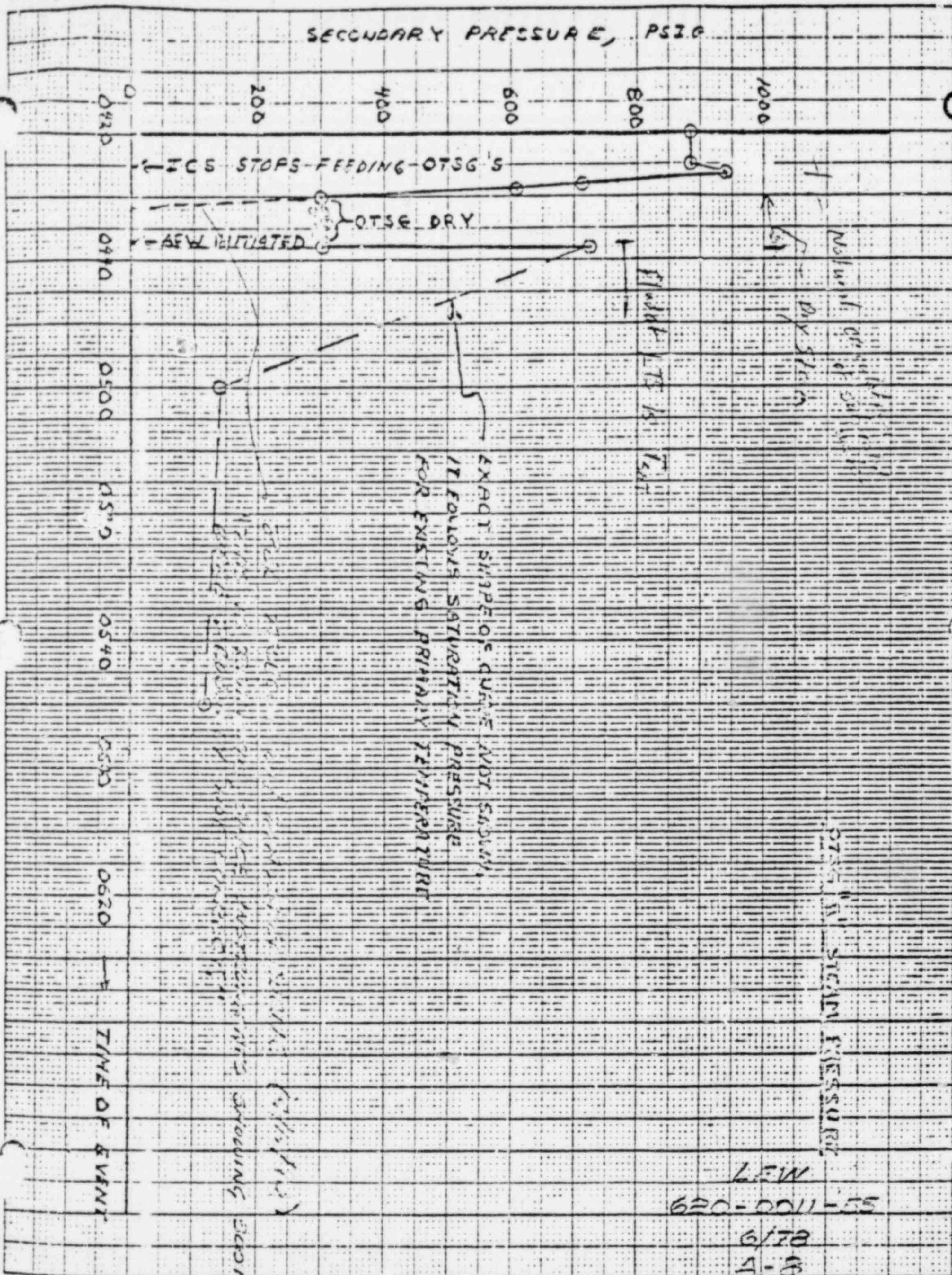
LEW
620-0011-55
6/78
A-5

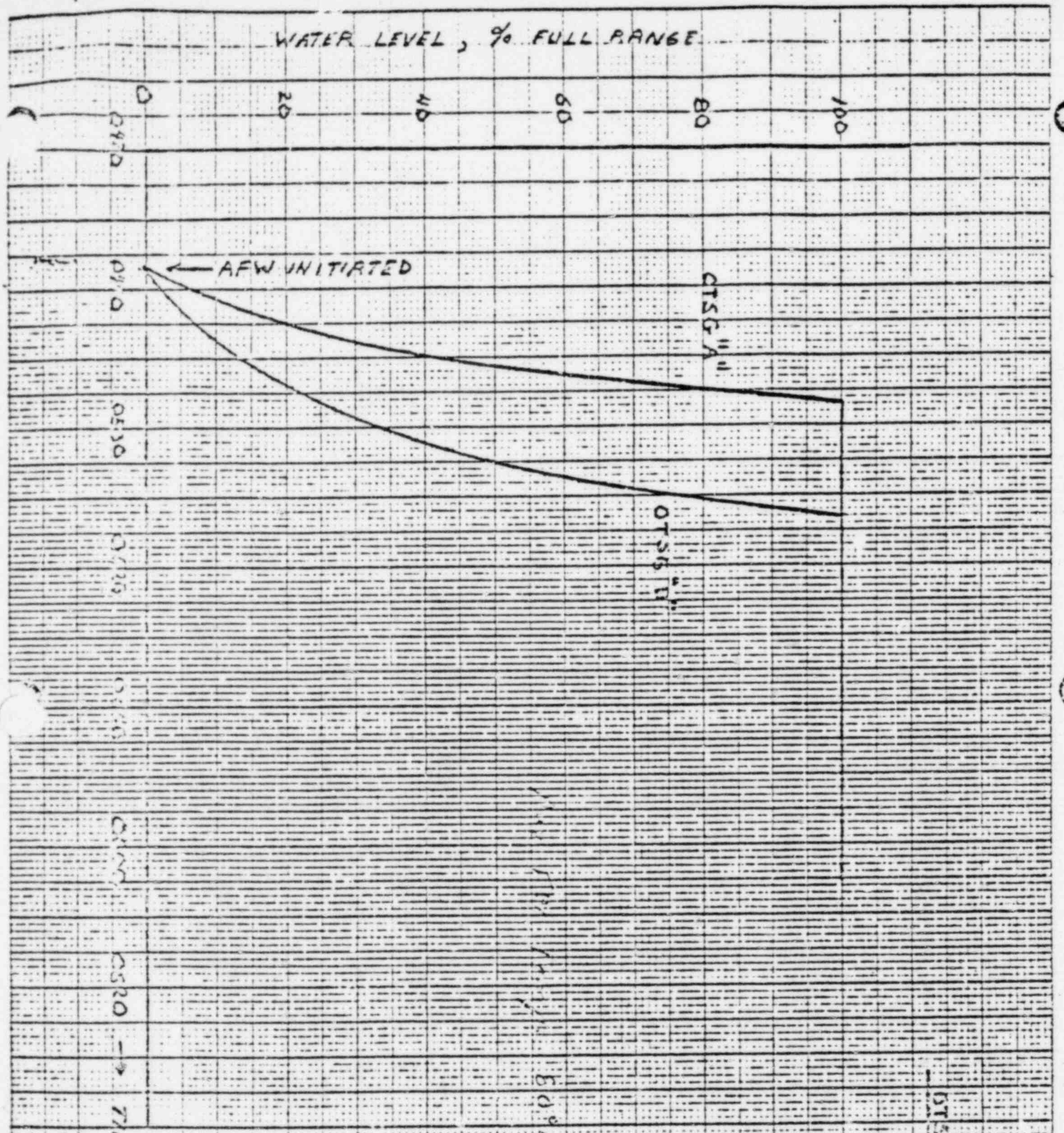
TIME		EVENT
4:51:25	-	Secured RCP-D (T_{ave} ≈435°F) This reduced #RCP's to three
4:47:27	-	OTSG "A" water level - 599.7" Speculate that ≈2 ft of tubes are not flooded (at top) due to steam line arrangement.
5:00:00	-	Hourly computer log printout Steam temp 380°F (OTSG "B") Steam pressure 171 psig (OTSG "B") Assuming $T_{ave} = T_{sat} \Rightarrow T_{ave} = 380°F$
5:13:47	-	Power restored to NNI cabinets 5,6, & 7 T_{ave} = 285°F RCS Pressure ≈2000 psig Both OTSG full level ranges pegged high Operator begins to reduce RC pressure using pzr. spray. Operator stops aux. FW pump.

LEW
620-0011-55
6/78
A-6



ATTACHMENT 2


SECONDARY PRESSURE, PSIG
0
200
400
600
800
1000
0420
0440
0500
0540
0620
ICS STOPS FEEDING OTSG'S
OTSG DRY
AFW INITIATED
EXACT SHAPE OF CURVE NOT SHOWN.
IT FOLLOWS SATURATION PRESSURE
FOR EXISTING PRIMARY TEMPERATURE
TIME OF EVENT
LEW
620-0011-55
6/78


WATER LEVEL, % FULL RANGE
0
20
40
60
80
100
AFW INITIATED
OTSG "A"
OTSG "B"
0520
TIME OF EVENT
OTSG WATER LEVEL
LEW
620-0001-55
6/78

ATTACHMENT III

The operator was in the process of changing a light bulb in a turbine header pressure transfer switch when he dropped the bulb into the switch and shorted the switch to ground. A protective fuse in the circuit had no chance to blow before the power supply monitor circuit sensed the short on the bus and opened the breakers to the "Y" and "Z" power supplies. This resulted in the loss of approximately half the NNI signals ("X" power supply remained energized) and the ability to transfer from "bad" to "good" signals, It should be pointed out that the utility changed the original B&W design in the area of the power supplies. If the original B&W design were installed, the incident would have resulted in the loss of the ability to transfer (select) signals only. No active signal would have lost power.

LEW
620-0011-55
6/78
A-10

TO: J.D BREN

THE BABCOCK & WILCOX COMPANY
POWER GENERATION GROUP

To
C. W. BRUNY, OTSG ENGINEERING, MT. VERNON

From
P. A. SHERBURNE, STEAM GENERATOR UNIT, NPGD

Cust.

File No. or Ref. T3.55/12.5

Subj.
SMUD COOLDOWN INCIDENT

Date
5-11-78

This letter to cover one customer and one subject only.

Reference: B&W Document #32-8053-00, SG Shell Temperature -- SMUD Rapid Cooldown Incident, May 1, 1978

Previous OTSG data transmittals to you regarding the subject transient indicated that maximum tube-to-shell ΔT was 170°F for the "A" steam generator. Recent calculations (Reference) show that OTSG "B" developed 186°F ΔT. The time history of average shell temperature for the "B" steam generator is as follows:

Time	Avg. Shell Temperature	Tube-to-Shell ΔT
hrs	°F	°F
0445	570.0	95
0450	567.8	128
0455	564.2	159
0500	557.3	177
0505	545.8	186
0515	496.8	182
0525	460.8	174
0535	435.2	160
0545	422.3	142

Please define the impact that the latest data will have on your analysis, conclusions, and schedule for completion.

P. A. Sherburne

P. A. SHERBURNE

cf
cc: JM Burnett

LEW
620-0011-55
6/78
A-11 of 11