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October 25, 2012

Docket Nos.: 50-348
50-364

NL-12-2080

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555-0001

Joseph M. Farley Nuclear Plant – Units 1 and 2
Response to Supplemental Information Request Regarding Technical Specifications Condensate Storage Tank Minimum Level
License Amendment Request

Ladies and Gentlemen:

By letter to the U.S. Nuclear Regulatory Commission (NRC) dated August 20, 2012 (Agencywide Documents Access and Management System (ADAMS), Accession No. ML12234A743), Southern Nuclear Operating Company, Inc., (SNC) submitted a license amendment request for TS 3.7.6, "Condensate Storage Tank." The change revises the minimum condensate storage tank level from 150,000 gallons to 164,000 gallons. On September 25, 2012, the NRC provided SNC with a Request for Supplemental Information letter (ML12257A098), containing 4 questions regarding the license amendment request.

Enclosure 1 contains the responses to the NRC's request for supplemental information. Enclosure 2 contains a calculation supporting SNC's response. As discussed with the NRC on October 25, 2012, this letter will be supplemented with Enclosure 3, which will contain Westinghouse Electric Company, LLC proprietary information that also supports SNC's response, in a separate letter.

This letter contains no NRC commitments. If you have any questions, please contact Ken McElroy at (205) 992-7369.

Mr. Mark Ajluni states he is Nuclear Licensing Director of Southern Nuclear Operating Company, is authorized to execute this oath on behalf of Southern Nuclear Operating Company and, to the best of his knowledge and belief, the facts set forth in this letter are true.

Sworn to and subscribed before me this 25 *day of* October, *2012.*

Laura L. Cagle
Notary Public

My commission expires: 11-2-2013

Sincerely,

Mark J. Ajluni

M. J. Ajluni
Nuclear Licensing Director

MJA/CLN/lac

Enclosures: 1. Responses to Request for Supplemental Information

2. SNC Calculation BM-95-0961-001, "Verification of CST Sizing Basis", Version 6

cc: Southern Nuclear Operating Company
Mr. S. E. Kuczynski, Chairman, President & CEO
Mr. D. G. Bost, Executive Vice President & Chief Nuclear Officer
Mr. T. A. Lynch, Vice President – Farley
Mr. B. L. Ivey, Vice President – Regulatory Affairs
Mr. B. J. Adams, Vice President – Fleet Operations
RTYPE: CFA04.054

U. S. Nuclear Regulatory Commission
Mr. V. M. McCree, Regional Administrator
Mr. R. E. Martin, NRR Project Manager – Fleet
Mr. E. L. Crowe, Senior Resident Inspector – Farley

Joseph M. Farley Nuclear Plant – Units 1 and 2
Response to Supplemental Information Request Regarding Technical Specifications Condensate Storage Tank Minimum Level
<u>License Amendment Request</u>

Enclosure 1

Responses to Request for Supplemental Information

Question 1:

Regarding Standard Review Plan (SRP) Branch Technical Position (BTP) Reactor Systems Branch (RSB) 5.1, the LAR provides neither the assumption changes, nor the new BTP RSB 5.1 analysis reflecting the change to assumptions for determination of the revised CST water volume.

Clarify whether the current analysis satisfying BTP RSB 5.1 is changed in support of the LAR. If the current analysis is changed, provide the new analysis for NRC staff review.

Please also clarify whether the Technical Specifications (TSs) for the CST water is based on the BTP RSB 5.1 (natural circulation cooldown analysis) or not. If not, specify the basis (i.e., the plant-specific analysis) supporting the TS and provide information to justify the associated TS basis.

SNC Response:

a) Standard Review Plan (SRP) Branch Technical Position (BTP) Reactor Systems Branch (RSB) 5.1 was referenced in the license amendment request (LAR) specifically for section G, "Auxiliary Feedwater Supply". This section of the BTP RSB 5.1 states that the auxiliary feedwater system shall have a sufficient inventory to allow operation at hot shutdown for at least 4 hours, followed by cooldown to the conditions permitting operation of the residual heat removal system (RHR). This inventory needed for cooldown is to be based on the longest cooldown time needed with either only onsite or only offsite power available with an assumed single failure.

Enclosure 2 shows that the condensate storage tank (CST) has sufficient inventory in the maximum protected water area to hold the reactor at hot standby for 2 hours and cooldown in 4 hours at 350 °F at a cooldown rate of 50 °F/hr, including:

- the total water volume lost from assumed ruptured lines of AFW pump recirculation lines and unisolated flow instrumentation lines;
- useable volume for one reactor coolant pump (RCP) in operation for the duration of the event (6 hours) plus 10 megawatt thermal (MWt) net RCP heat added and decayed over one hour;
- minimum tank level to prevent vortexing.

Relative to the requirements of BTP RSB 5.1, Section G, the revised calculation does not represent a change in satisfying the requirements of this section. The only change to assumptions made for determination of the revised CST water volume is the addition of an assumption that considers the potential for vortex formation. Thus, a minimum submergence level is added to the CST required water volume to prevent formation of a vortex.

The event described above is the most limiting, requiring 154,054 gallons. Other events, including those with either only onsite or only offsite power available with an assumed single failure, require less inventory and are discussed in response to question 2.

b) The TS Bases – Operability (B.3.7.6) (Mode 3 for 9 hours) assumes natural circulation, since this event is concurrent with a LOSP where RCPs have lost power; thus, natural circulation is in process. Furthermore, per the documentation of an engineering analysis of all events that assume a loss of off-site power (LOSP) as defined by FSAR Chapter 15 and the TS Bases requirements, natural circulation is considered, since power is lost to the RCP during a LOSP event. In these events, no heat addition to the RCS is included since the pumps are not operating; however, 10MWt residual RCP heat is added due to the power operation prior to the event with LOSP.

Question 2:

The licensee stated in the LAR that the revised calculation for the CST minimum volume is based upon additional assumptions regarding heat loads as referenced from the Component Design Basis Inspection report. The licensee also stated that plant events involving the usage of the CST were reanalyzed with the revised calculation to identify the most limiting event to arrive at the new CST minimum volume amount.

Provide additional information on how the new heat load assumptions were factored into the revised calculation. Also provide additional information on all of the events analyzed with the revised calculation for the CST to verify how the licensee identified the most limiting event involving the CST.

SNC Response:

a) (1) Heat Load Assumptions:

Decay heat load was based on assuming 102% power; i.e., 102% of 2775 MWt (100% power). Thus, the CST volume to remove decay heat was based on 2831 MWt. Prior to the CDBI, the previous version of design basis calculation for the CST volume verification considered decay heat load based on 100% power.

Sensible heat load assumption was based on the Tavg (hot) of 577 °F plus 6 °F (583 °F) for measurement uncertainty for plant events where the unit is being shutdown. Prior to the CDBI, the previous version of design basis calculation for the CST volume verification determined sensible heat at Tavg (no load) of 547 °F conditions. For plant events where the unit is being held at hot standby, no sensible heat load is added to the CST volume required since the unit is not in transition to a shutdown mode but is held in hot standby with the intention to return the unit to power.

Reactor Coolant Pump (RCP) heat load assumptions were based on several factors. First, if a loss of offsite power (LOSP) was the event or concurrent with another event, no RCP heat was added during the hot standby or cooldown of the unit. In these instances, only 10 MWt net heat input added to the RCS was included due to power operation prior to the event. Secondly, if an LOSP was not the event or not concurrent with the event and the unit is being shutdown, RCP heat for operation of the pump(s) during the cooldown and the net heat added during power operation prior to the event were considered in determining the CST volume.

The following are the specific assumptions relative to RCP heat load included for the events analyzed:

- Due to power operation prior to an event, 10 MWt net heat input is added to the Reactor Coolant System (RCS) for all events analyzed with exception to Loss of Normal Feedwater (LONF) event, which conservatively adds 15 MWt net heat input to the RCS. This net heat is added to the CST volume requirements due to operation of the RCPs at power prior to the event.

- Technical Specification (TS) Bases – Operability (9 hrs. at hot standby), Main Feedwater Line Break (MFWLB), Main Steam Line Break (MSLB) with LOSP, Small Break Loss of Coolant Accident (SBLOCA), and LOSP events were analyzed with no RCP heat added during hot standby or cooldown. For each of these events, LOSP is assumed as the event or concurrent with the event.

- TS Bases Design (Normal Cooldown 2 hrs. hot standby with 4 hrs. cooldown) event assumed 1 RCP pump will be operating during the 6 hour duration of the event.

- Depressurization of Main Steam event assumes three RCPs operate for 10 minutes to reach RCS equilibrium, and then, one RCP operates for the remainder of 9 hours with the reactor in hot standby. This assumption is supported by Chapter 15 of the FSAR and WCAP 15097, "FNP Units 1 and 2 Replacements Steam Generator Program NSSS Engineering Report Book 1, March 2001".

- Main Steam Line Break without LOSP event assumes three RCPs operate for the duration of the event which is determined by a conservative cooldown rate of 50°F/hr from Tavg (no-load) to 350°F.

- Loss of Normal Feedwater (LNFW) event assumes three RCPs operate for 10 minutes to reach RCS equilibrium then one RCP operates for the remainder of 9 hours with the reactor in hot standby. These assumptions are supported by Chapter 15 of the FSAR.

a) (2) Vortex Assumptions:

During the Component Design Bases Inspection (71111.21), the lack of a vortex prevention calculation for the CST was identified as an unresolved issue. Subsequently, a Green non-cited violation was issued in the NRC Quarterly Report "Joseph M. Farley Nuclear Plant - NRC Integrated Inspection Report 05000348/2012003 and 05000364/2012003", dated July 20, 2012. In response to this violation, a minimum submergence level to prevent vortex formation has been added to the revised calculation (Enclosure 2). Vortexing was considered for events where a breach to the tank's unprotected walls or connecting lines could occur and allow air to enter the tank beneath the tank's diaphragm. It has been assumed that this breach is due to a tornado missile or seismic event. The events that make this assumption are the Normal Cooldown event and the LOSP events with a tornado or seismic event concurrent. Assuming a failure of the CST that would allow air entrainment into the tank below the diaphragm during a Normal Cooldown event is a conservative assumption that adds margin to the minimum required volume of the CST.

All events analyzed include the unusable volume below the AFW pump's suction nozzles of the CST. This unusable volume is considered in the minimum submergence level required to prevent vortex formation for the events identified above.

a) (3) Inventory Loss Assumptions:

The CST inventory loss due to the rupture of the AFW pump's minimum flow recirculation lines and the tank's instrumentation line has been assumed for those events that postulate a tornado event concurrent. As described above for the minimum submergence level assumption, these events are LOSP and Normal Cooldown (TS Design Bases).

The CST inventory loss due to main steam (MSLB) and feedwater line break events (MFWLB) is accounted for in the determination of the CST volume. That is, the volume of auxiliary feedwater lost through these line breaks is not available to provide shutdown cooling of the RCS. Assumptions are made and documented for the time required for the isolation of the AFW through these breaks in order to determine the volume of the inventory losses.

b) Determination of the most limiting event

The Technical Specification (TS) Bases, B 3.7.6, in the Applicable Safety Analysis, states that the CST provides cooling water to remove decay heat and to cool down the unit following all events in the accident analysis as discussed in the FSAR, Chapters 6 and 15. Upon review of these

FSAR chapters, as well as the TS Bases, the events that require cooling the RCS by the AFW were identified and the operability and design requirements of the CST per the LCO section of the CST TS Bases were defined. These events and requirements include:

- LOSP w/ Seismic Event
- LOSP
- MSLB w/o LOSP
- LNFW w/o LSOP
- Depressurization Main Steam
- LOSP w/ Tornado Event
- SBLOCA
- MSLB w/ LOSP
- MFWLB w/LOSP
- TS Bases - Design (Normal Cooldown)
- TS Bases - Operability

The TS Bases - Operability requirement of the CST is defined as having sufficient water available to maintain the RCS in MODE 3 for 9 hours with steam discharge to the atmosphere concurrent with a loss of offsite power. In addition, the TS Bases – Design, labeled "Normal Cooldown", defines the design bases requirement of the CST as holding the unit in Mode 3 for 2 hours, followed by a 4 hour cooldown to RHR entry conditions of 350°F at a rate of 50°F/hr.

The previous version of the design basis calculation identified the CST sizing components that made up the required volume. These sizing components consisted of decay heat, sensible heat, and RCP heat removal, as well as inventory loss due to AFW recirculation and instrumentation line ruptures. Pressurizer heater heat input to the RCS as required by the FSAR accident analysis for Loss of Normal Feedwater has been included in this version of the calculation. As discussed in the CDBI and documented in the CDBI report, a volume for vortex protection has been added to the CST minimum required volume for events that consider a seismic event or tornado event concurrent as well as CST inventory volume losses due to main steam and feedwater line break events.

For each event identified including the TS Bases - Operability and TS Bases - Design requirements, the CST minimum required volume to remove the specific heat load from the RCS was determined upon application of the assumptions as described above in response to question number 2(a). The required volumes of CST water to remove the different RCS heat components (decay, sensible, and RCP) were determined using a calometeric method whereby the enthalpy differences between the maximum allowable water temperature in the CST and the saturated steam pressure of the steam generator secondary side were used.

Portions of the AFW pump's minimum flow recirculation line and the four instrumentation lines attached to the AFW pump suction pipes are located outdoors and exposed to a potential tornado missile. Thus, the inventory losses due to the rupture of these lines have been considered in determining the CST required minimum flow for events whereby a tornado is assumed. These events include Normal Cooldown, LOSP with Tornado, and LOSP with Seismic event.

It is assumed that the recirculation lines from all three pumps would be isolated within 30 minutes. The recirculation flow from each pump is conservatively considered greater than the calculated value to accommodate for the slight decrease in frictional loss due to a line break. The maximum volume of water lost during the 30 minutes span before isolation is the summation of all three pumps' minimum flow assumed. No inventory loss is considered from the CST through the AFW pump's recirculation connection to the tank since this connection is above the 164,000 gallon protected volume of the tank.

The break point of the four instrumentation lines is assumed to occur at the lowest location above the ground level where the instrumentation lines are exposed to missile impact. The inventory loss through the breaks is based on the flow through a discharge nozzle of a size equivalent to the ID of tubing at a pressure equivalent to the middle point height between the protected volume (164,000 gallons) level to the assumed break point of the tubing ignoring line losses. It is considered that these four instrumentation lines will not be isolated during the 6-hour unit cooldown or the 9-hour unit hot standby period.

Thus, the total inventory losses due to the ruptured instrumentation lines and the AFW pump's minimum flow recirculation lines were accounted for in determining the CST required minimum volume for events that occur concurrent with a potential tornado missile.

Additional CST inventory losses due to MSLB and MFWLB events were also considered in determining the minimum required volume of the CST. The magnitude of these losses was determined from the design bases calculations of record, "Verification of AFW Flow Bases". The Units 1 and 2 calculations identify the required AFW flow rates for various normal and accident events which are supported by the AFW system. These flow models of the system for these accidents determined the flow rates through the main steam and main feedwater line breaks to the faulted steam generator. It has been assumed that the time required for isolation of the AFW flow through the MSLB break is 15 minutes and 30 minutes for the MFWLB. Given this information, time of isolation and magnitude of AFW flow through these breaks, the CST inventory losses were determined for each event and accounted for in the determination of the minimum required volume of the CST. No credit for AFW heat removal was applied for the MSLB event, even though some RCS heat removal does occur since the MSLB location is downstream of the faulted steam generator.

With the volume of CST water determined to remove each heat load component of the RCS, the CST inventory losses, and the minimum submergence level required to prevent vortex formation, the most limiting event could be determined. Summing the water volumes required for each sizing component revealed that the TS Bases - Design (Normal Cooldown) was the most limiting event. It is noted that this event includes several conservatisms which account for its greater volume requirement, such as the inventory losses due to the rupture of the AFW pump's minimum flow recirculation lines and the four instrumentation lines, as well as the vortex formation prevention volume. These added volumes are considered conservative since the Normal Cooldown event does not require the assumption of a tornado event concurrent with this event. The minimum required volume of 154,054 gallons for this event was used as the bases in establishing the greater than or equal to 164,000 gallons TS minimum level for the CST.

Question 3:

The LAR states that additional consideration regarding vortexing was applied during the revised calculation of the CST minimum volume. However, the LAR did not describe specific considerations that factored into changes made to the referenced revised calculations.

Provide additional information to describe how the licensee factored in the vortexing effects as part of the revised calculation for the CST volume.

SNC Response:

During the CDBI inspection, the NRC team identified an unresolved item (URI 05000348, 364/2011010-04) regarding the evaluation of the CST minimum required submergence for the AFW pumps, given the potential for vortex formation in the CST. During the inspection, it was observed that the design calculation for the CST sizing did not evaluate the effects of tornado missile damage to the un-protected portion of the CST which could create an air introduction path under the CST bladder which would allow a vortex formation. Subsequently, a Green non-cited violation was issued in the NRC Quarterly Report "Joseph M. Farley Nuclear Plant - NRC Integrated Inspection Report 05000348/2012003; and 05000364/2012003", dated July 20, 2012.

In response to this URI and Green non-cited violation, compensatory measures have been taken to evaluate the minimum required submergence for the AFW pumps assuming the potential for vortex formation in the CST. This evaluation has been performed and issued as a separate and unique design calculation that determines the minimum submergence level required for the specific physical configuration of the AFW pump's suction piping (see Enclosure 3 which will be submitted in a separate letter as a supplement to this letter). The results of this calculation have been used as design input into determining the minimum required volume of the CST.

The CST has two 8" AFW suction pipes – one for the TDAFW pump and one for both MDAFW pumps. Both suction pipes open at 4" from the tank's bottom, facing down at a 45 degree angle. The suction piping centers are approximately 1'-3" apart. The CST has an internal bladder that prevents introduction of air under normal operating conditions.

The primary technical reference utilized in determination of the minimum submergence level is Calculation–Note Number FAI/09-19, Rev. 0, titled "Vortex Evaluation for Vogtle and Farley RWSTs and Hatch CSTs", dated January 2009, by Fauske and Associates, Inc. (Attachment 3 to Enclosure 3). Note Enclosure 3 contains Westinghouse Electric Company LLC proprietary information and is not included with this letter. Enclosure 3 will be submitted in a separate letter as a supplement to this letter.

This calculation-note was issued to Southern Nuclear by Westinghouse Nuclear Services per letter GP-18458 dated 1/16/2009 as supporting documentation to the GL 2008-01 response. This calculation-note was reviewed and evaluated for applicability to the Farley CST in determining the minimum submergence level required to prevent vortex formation. This document states in the summary that data taken for tank configurations at D.C.Cook, McGuire, Catawba, Oconee and Cooper nuclear plants all relate to the specific configurations used in the Southern Nuclear plants. In addition, it states that specific measurements all provide justification for the manner in which air intrusion should be assessed for the Vogtle, Farley, and Hatch CSTs. The results obtained from data taken produced results that are consistent with radial inflow conditions being the mechanism whereby significant gas intrusion would be drawn into the specific suction configurations. The downward facing suction configuration that is installed in Farley's CSTs acts to considerably suppress the potential for air intrusion. Evaluations of this radial inflow to a downward-facing elbow resulted in a bounding correlation for misbehavior that is given by $S/D = 0.5(N_{FR})^2$ where the submergence S is the same as that defined in Figure 7, Catawba Fueling Water Storage Tank Vortex Study Tank and Suction Nozzle Setup, 45 degree downward facing configuration. Since the Farley CST AFW pump's nozzle configuration is also a 45 degree downward facing configuration, this correlation can be used to determine the submergence required to suppress air intrusion and vortex formation.

However, upon development of the calculation for determining the minimum submergence (Enclosure 3) for the Farley AFW pump's suction nozzles, the equation also presented in the calculation-note FAI/09-19 based on the Harleman correlation was utilized (note Enclosure 3 contains Westinghouse Electric Company LLC proprietary information and is not included with this letter. Enclosure 3 will be submitted in a separate letter as a supplement to this letter). This correlation defines the submergence level required above the horizontal entrance to a vertically downward suction as shown in Figure 5(a) of the FAI/09-19 Calculation–Note FAI/09-19. This correlation is given as $S_H/D = 0.75[N_{Fr}]^{0.4}$ on page 13 of 25. Even though the Farley suction nozzle is a 45 degree downward facing nozzle configuration, this Harleman correlation was used to provide a conservative submergence level. Using this vertically downward suction correlation increased the submergence level by a factor of two over the submergence for a 45 degree angle pipe or elbow nozzle facing downward. Thus, this greater submergence level was used in determining the volume component required in the CST sizing calculation for vortex prevention.

Question 4:

The LAR is incomplete and the staff cannot initiate a technical review until, at a minimum, the following is provided:

- Calculation of post-trip water requirements.
- Information that supports an independent evaluation of the level necessary to prevent vortexing.
- Provide the licensee's determination of the level that prevents vortexing.
- Applicable updated Final Safety Analysis Report sections.

SNC Response:

a) Calculation of post-trip water requirements.

The calculation SM-95-0961-001, Version 6, "Verification of CST Sizing Basis" (Enclosure 2 to this submittal), consists of the detail calculations, assumptions, and design inputs that form the bases for the determination of the post-trip water requirements of the CST. A detailed results and conclusions presented on sheets 21 and 22 of this calculation summarizes the minimum CST volume requirements for the TS Bases - Operability and TS Bases - Design (Normal Cooldown) requirements, including the volume requirement for the LONF without LOSP event which results in the worst case CST volume requirement of the FSAR Chapter 15 accidents.

b) Information that supports an independent evaluation of the level necessary to prevent vortexing.

The information necessary to support this request can be found in calculation SM-SNC335993-001 Version 2.0, titled "CST AFW Pump Suction – Submergence Analysis". This calculation will be included in Enclosure 3, which will be submitted in a separate letter as a supplement to this letter. The purpose of this calcuation states "for the withdrawal of water from the CST, determine the minimum submergence water level in the tank to prevent vortexing at the AFW suction inlet when the flow rate is

700 gpm. This level (water volume) has been incorporated as input into the "Verification of CST Sizing Basis" calculation, BM-95-0961-001 Version 6. Attached to calculation SM-SNC335993-001 Version 2.0 (Enclosure 3, which will be submitted in a separate letter as a supplement to this letter) is the Fauske & Associates, Inc. Calculation–Note FAI/09-19 referenced in the response to question 3 above. As stated, this calculation–note provides the bases for the method used in determination of the submergence level required to prevent vortex formation and air intrusion into the AFW pump's suction piping.

The summary of conclusions states the minimum submergence level required in the CST based on the operation of two (2) MDAFW pumps or the TDAFW pumps shall be 9.78 inches from the bottom of the tank which includes 4 inches of unusable volume below the suction nozzles. Also, the minimum submergence level required in the CST based on the operation of one (1) MDAFW pump shall be 8.36 inches from the bottom of the tank.

c) Provide the licensee's determination of the level that prevents vortexing.

The equation based on the Harleman correlation presented on page 13 of 25 of FAI/09-19, Calculation-Note defines the submergence as the water height above the horizontal entrance to the vertically downward suction location as shown in Figure 5(a) of this calculation–note. This correlation is given as $S_H/D = 0.75[N_{Fr}]^{0.4}$. Even though the Farley suction nozzle is a 45 degree downward facing nozzle configuration that results in a lesser submergence level, as shown in Figure 7, the Harleman correlation was used to provide a conservative submergence level. Using this vertically downward suction correlation increased the submergence level by a factor of two over the submergence for a 45 degree angle pipe or elbow nozzle facing downward. Thus, this greater submergence level was used in determining the volume component required in the CST sizing calculation for vortex prevention. The submergence level, based on the vertically downward suction configuration, the piping size, and the AFW pumps flow rates, was determined to be 5.78 inches. Since the AFW pump's suction pipes open at 4 inches from the tank's bottom, the submergence level used to determine the CST's volume component to prevent air intrusion and vortex formation is 9.78 inches (see Enclosure 3, which will be submitted in a separate letter as a supplement to this letter).

d) Applicable updated Final Safety Analysis Report sections.

The following sections of the FSAR will be updated, as appropriate, following approval of this license amendment request (next page).

- FSAR Section 6.5.1, Rev. 24, June 2012 – AFW Design Bases
- FSAR Section 9.2.6, Rev. 24, June 2012, – Condensate Storage Facilities
- FSAR Section 15.2.8, Rev. 24, June 2012 – Loss of Normal Feedwater
- FSAR Section 15.2.9, Rev. 24, June 2012 – Loss of All AC Power to the Station Auxiliaries
- FSAR Section 15.2.13 , Rev. 24, June 2012 – Accidental Depressurization of the Main Steam System
- FSAR Section 15.3.1, Rev. 24 June 2012, – Loss of Reactor Coolant From Small Ruptured Pipes or From Cracks in Large Pipes Which Actuate Emergency Core Cooling System
- FSAR Section 15.4.2.1, Rev. 24, June 2012 – Rupture of Main Steam Line
- FSAR Section 15.4.2.2, Rev. 24, June 2012, – Main Rupture of a Main Feedwater Line Pipe

Joseph M. Farley Nuclear Plant – Units 1 and 2
Response to Supplemental Information Request Regarding Technical Specifications Condensate Storage Tank Minimum Level
<u>License Amendment Request</u>

Enclosure 2

SNC Calculation BM-95-0961-001,
"Verification of CST Sizing Basis", Version 6

SOUTHERN COMPANY
Energy to Serve Your World®

Southern Nuclear Design Calculation

Calculation Number:
BM-95-0961-001

Plant: Farley Units 1 and 2	Unit: ☐ 1 ☐ 2 ☒ 1 & 2	Discipline: Mechanical
Title: Verification of CST Sizing Basis		Subject: CST/AFW
Purpose / Objective: Verification of CST Sizing Basis		
System or Equipment Tag Numbers: Q1P11T001, Q2P11T001		

Contents

Nuclear Quality Level

☒ Safety-Related ☐ Safety Significant ☐ Non- Safety -Significant

Version Record

Version No.	Description	Originator Printed Name Initial / Date	Reviewer Printed Name Initial / Date	Approval 1 Printed Name Initial / Date	Approval 2 Printed Name Initial / Date
5	Status: AP Revised to modify design basis for the CST per TEs. (see Sht. 1 for TEs).	W.J.Jennings; WJJ/ 7-5-2012	Andy Patko; AJP/ 7-5-2012	C.M. Sellers; CMS/7-5-2012	C.M. Sellers; CMS/7-5-2012
6	Status: AP Revised to add LONF event and modify MFWLB event.	W.J.Jennings [signature] 10-10-2012	Andy Patko [signature] 10/10/12	C.M.Sellers CMS 10/10/12	C.M.Sellers CMS 10/10/12

Notes:

Plant: Farley Nuclear Plant Units 1 & 2	Calculation Number: BM-95-0961-001	Sheet: 1 of 23

CALCULATION COVER SHEET

PROJECT	JOB NO.	CALC NO.	SHEET
Farley Units 1 and 2	07597	41.06	1
SUBJECT: Verification of CST Sizing Basis		DISCIPLINE: Mechanical	

CALCULATION STATUS DESIGNATION	PRELIMINARY	CONFIRMED	SUPERSEDED	VOIDED
	☐	☒	☐	☐

COMPUTER PROGRAM/TYPE	SCP YES	SCP NO	MAINFRAME	PC	PROGRAM NO.	VERSION/RELEASE NO.
	☐	☐	☐	☒	MAP-121	V01

Calculation prepared in support of REA 95-0961. This REA was prepared to resolve condensate storage tank issues identified by Assessment Observation AFW-MECH-02. Since power up-rate is currently being evaluated for FNP, power up-rate is considered in this evaluation.

NOTE:
Revision 2 of this calculation does not affect the referenced material in the Auxiliary Feedwater System Functional System Description (A-181010). A-181010 has been reviewed for this determination.

Revision 3 fixes a typographical error on Sheet No. 7.

Revision 4 of this calculation was performed per REA 99-1965, and affects FSAR Sections 6.5 and 9.2 and the Auxiliary Feedwater Functional System Description (A-181010). Changes to these documents have been initiated.

Revision 5 of this calculation was performed to modify the design basis for the CST in resolution of TE 320363, TE 286016, TE 302547, TE 289230 and TE289260.

Revision 6 of this calculation was performed to modify the loss of CST inventory and results for the MFWLB event, add the calculations and results for the LONF event and provide reference to RER SNC419117 Sequence 2 response .

NO.	REASON FOR REVISION	TOTAL NO. OF SHEETS	LAST SHEET NO.	BY	CHECKED	APPROVED/ ACCEPTED	DATE
4	Revised per REA 99-1965	33	13	UYP	[illegible]	DWM	3/25/99
3	Revised text on Sheet 7	31	11	MGG	DWM	PES	7/23/98
2	Change to SG level setpoints	31	11	MGG	MEA	PES	6/12/98
1	Change to CST Design Basis Temperature (SCS Calc SM-95-0721-005)	31	11	BKS	DWM	RCG	6/6/96
0	Initial Issue	31	11	DWM	SSR	RCG	3/12/96

RECORD OF REVISIONS

CALCULATION SHEET

PROJECT: Farley

JOB NUMBER: 07597

SUBJECT Verification of CST Sizing Basis

CALC NO. 41.06

SHEET NO. 2

BY D. W. Murphy DATE 03/06/96 SHEET REV. 4 4 WWP 3/24/99

TABLE OF CONTENTS

See Calculation Cover Sheet for Table of Contents

I. INTRODUCTION / PURPOSE

The purpose of this calculation is to verify the sizing basis of the Condensate Storage Tank (CST). This calculation is therefore composed of the following determinations:

A. Determine the maximum protected volume of the CST.

B. Verify adequate volume is available in the missile protected portion of the CST for "Normal Cooldown"; that is, to hold the reactor at hot standyby for 2 hours and cooldown in 4 hours to 350 °F at 50 °F/hr. where RHR may be utilized for cooling. Up-rate power conditions of 2785 MWth (2775 MWth core power plus 10 MWth from the RCPs) will be considered in this evaluation. Also, verify adequate reserve margin is available considering a missile rupture of the recirculation line from the AFW pumps back to the CST and the four instrumentation lines for the two suction lines of the Auxiliary Feedwater Pumps. Since the portions of these lines are located outdoor and are exposed to a potential tornado missile, the impact to the CST and AFW systems due to a potential rupture of these lines will be evaluated. Also, verify adequate reserve margin is available to provide a minimum submergence water height above AFW pump nozzles to prevent vortex formation.

C. Verify adequate volume is available in the missile protected portion of the CST for a" Main Feedwater Line Break with Loss of Off-Site Power" event; that is, to hold the reactor at hot standyby for 2 hours and cooldown in 4 hours to 350 °F at 50 °F/hr. where RHR may be utilized for cooling. Up-rate power conditions of 2785 MWth (2775 MWth core power plus 10 MWth from the RCPs) will be considered in this evaluation. Also, verify adequate reserve margin is available considering the loss of CST inventory due to the main feedwater line break. No other line failures, such as, AFW pumps recirculation or CST instrument lines, are considered to fail due to a seismic event or tornado generated missile. Also, no reserve margin is required to provide a minimum submergence water height above AFW pump nozzles to prevent vortex formation since no lines attached to the tank are assumed to fail allowing air to enter the tank.

D. Verify CST capacity based on the Technical Specification Bases (OPERABILITY) that sufficient water is available to maintain the RCS at hot standby conditions for 9 hours with steam discharge to the atmosphere concurrent with a total loss of off-site power. Up-rate power conditions will be also considered for this case (Reference 4).

E. Verify adequate volume is available in the missile protected portion of the CST for a "Loss of Normal Feedwater" (LONF) event w/o Loss of Off-Site Power; that is, verify sufficient water is available to maintain the RCS at hot standby conditions for 9 hours with steam discharge to the atmosphere. Up-rate power conditions of 2775 MWth core power will be considered in this evaluation. The WCAP 15097 (Ref. 22) assumes a conservatively large RCP net heat input of 15MWt. This initial net heat input of 15MWt is assumed to decay over 1 hour. Per this WCAP, all three(3) RCPs operate at the initiation of the event for 10 mins and one(1) RCP operates for the duration of the event; i.e. 9 hrs. in hot standby. No line failures, such as, AFW pumps recirculation or CST instrument lines, are considered to fail due to a seismic event or tornado generated missile. Also, no reserve margin is required to provide a minimum submergence water height above AFW pump nozzles to prevent vortex formation since no lines attached to the tank are assumed to fail allowing air to enter the tank. Per WCAP 15097, during a Loss of Normal Feedwater (LONF) event, the pressurizer proportional and backup heaters are assumed operable. The total capacity of the pressurizer heaters is 1.4 MWt. The heaters output represents an addition to the RCS energy which must be removed by the AFW system.

II. METHODOLOGY

Decay heat calculation code MAP-121, Version V01 was used to determine the decay heat of the core. This model calculates decay heat based on NRC Branch Technical Position ASB 9-2. FSAR section 9A.1 and figure 9A-2 discusses the conservatism of basing the decay heat on Branch Technical Position ASB 9-2 as opposed to the original basis provided by Westinghouse specification BOP-FR-8, Revision 1 and as presented in FSAR figure 9A-1.

The results of this decay heat model as shown in Appendix "A" is based on operating power of 2785 MWt (2775 MWt core power plus 10 MWt from RCPs). The model decays the total heat in Btu/hr equivalent to 2785 MWt, including the RCP heat. This version of the calculation separates the decay heat due to fission products from RCP heat and applies both to the CST volume sizing individually. That is, 2775 MWt due to fission product heat is decayed according to the model; however, the 10 MWt due to RCP heat is decayed over a one(1) hour period and both applied to the required CST volume separately.

This calculation determines the CST volume required for four(4) different plant events: Normal Cooldown (2 hrs at hot standby and 4 hrs to 350°F at 50°F/hr where RHR is utilized for cooling), Main Feedwater Line Break w LOSP (2 hrs at hot standby and 4 hrs to 350°F at 50°F/hr where RHR is utilized for cooling), Hot Standby for 9 hrs. w/ LOSP per T.S. Bases B.3.7.6 and Loss of Normal Feedwater w/o LOSP. Several different heat loads, volume loses due to tornado missiles, seismic events and piping breaks, and a minimum submergence level to prevent vortex formation have been determined for each of the plant events, as to determine the CST volume required to cooldown the RCS for each plant event.

III. INPUT / ASSUMPTIONS

1. Up-rate power conditions of 2785 MWt (2775 MWt core power plus 10 MWt from RCPs).
2. "DELETED"
3. CST temperature 110 °F (Reference 13)
4. Reactor trip occurs from 102 percent power. An initinite reactor operating time is assumed.
5. The RCS is maintained at hot standby for 2 hours and cooldown to 350°F is accomplished in 4 hours. Hot standby is defined as reactivity less than 0.99 and temperature greater than or equal to 350 °F.
6. Release of decay heat is based on NRC Branch Technical Position ASB 9-2.

7. Specific volume of water (v_f) at 110°F is 0.016165 ft^3/lb. (Reference 6)

8. To envelop all possible scenarios of decay heat removal, the worst case steam generator back pressure (highest) from Reference 1 will be used to determine the final enthalpy of steam released from the steam generators.

9. During cooldown the steam generator pressure decreases from the hot standby condition,1155 psia to 135 psia (saturation pressure at 350 °F). The enthalpy varies 1204 Btu/lb to an enthalpy of 1187 Btu/lb. The lower enthalpy, 1187 Btu/lb is conservatively used to determine the water volume required (See Attachment "A")

10. "Deleted"

11. Based on the as-built condition of the CST, the missile protected portion of the tank is approximately 16'-5" of the tank's overall height (References 12, 23). This missile protected portion contains a volume of 204,706, (Volume = (197"/12") x π(46')^2/4 x 7.48 = 204,076 gallons).

    This volume of 204,076 gallons does not however consider the condensate makeup and return line, 24" HBD-252, connection to the CST. This line connects to the CST in the missile protected portion of the tank, and is Seismic Category II, not protected from a tornado missile. This line therefore establishes the maximum protected volume of the CST since a failure of this line is assumed based on it's design. See Sheets 5 for determination of the maximum protected volume of the CST.

12. The rupture of the pump recirculation line is assumed to occur at the location near the CST connection where the portion of the line is unprotected by the missile barrier (References 11 and 18).

13. The four 3/8" instrumentation lines for the Auxiliary Feedback Pump suction lines are assumed to rupture at the same elevation as of the pump suction nozzle at the CST (el. 156-9") for conservative purpose. This elevation is the lowest point above the ground level for the portion of the instrumentation lines that are unprotected from the missile impact.

14. RCP heat added is equivalent to 5 MWt per pump; however, the pump net heat added to RCS is 10 MWt when the unit is operating at 100% power (Reference 22). No RCPs are in operation during a LOSP event.

15. Isolation of the faulted S/G will be accomplished by FNP Operations within 30 minutes due to a main feedwater line break. (See Attachment "B")

IV. CALCULATIONS

A. Maximum Protected Volume of the CST

Determine the maximum protected volume of the CST. This volume is based on the elevation of the condensate makeup and return line, 24" HBD-252. Since this line connects to the CST in the missile protected portion of the tank, is seismic category II, not protected from a tornado missile and the only non missile protected Seismic Category II line in the missile protected portion of the tank this line establishes maximum protected volume of the tank. Thus, the maximum protected volume of the CST is determined by the elevation of the invert of the condensate makeup and return line since failure of this line is assumed based on it's design.

From vendor documents U-161693 and U-213481 (Reference 11), the 24 inch dia, condensate and makeup return nozzle is 14'-2 ¾" from the bottom of tank. The piping 24" HBD piping and tank nozzle is Sch. 40 with a wall thickness of 0.375 inches. Therefore, the invert of the pipe is:

- Cond. Makeup Invert = 14.229 – (ID/2), where the ID of the piping is 23.250 in.

  = 14.229 ft – ((23.250 in/2) x 1 ft/12 in)

  = 13.260 ft

Now, Tank bottom area: $\pi r^2 = \pi\ (23\ \text{ft.})^2 = 1662\ \text{ft}^2$ (Reference 11)

Based on 24" HBD-252 piping invert of 13.260 ft, the maximum protected volume of the CST is:

W (maximum protected volume of the CST) = Tank Area x height

$$= \frac{1662\ \text{ft}^2 \times 13.260\ \text{ft}}{0.1337\ \text{ft}^3/\text{gal.}}$$

W (maximum protected volume of the CST) = 164,832 gallons

B. Normal Cooldown

Determine required CST volume based on holding the reactor at hot standby for 2 hours and cooldown in 4 hours to 350°F at 50°F/hr where RHR may be utilized for cooling.

Decay Heat

- Adjust decay load from Appendix "A" which represents 2775 MWt (100% power) plus 10 MWt pump heat to values that represents only decay heat due to fisson products decay heat.

  The portion of decay heat results that is due to pump heat is: 10 MWt / 2785 MWt = 0.00359

  The decay heat from App. "A" at 2 hrs after shutdown is 0.35713×10^9 Btu.

Therefore, the decay heat at 2 hrs. after shutdown from fisson products alone is:

$0.35713 \times 10^9 - 0.00359(0.35713 \times 10^9) = 0.35584 \times 10^9$ Btu

Since it is conservatively assumed that the reactor trips at 102% of rated reactor thermal power for this event, the fission product decay heat at 2 hrs after shutdown becomes:

0.35584×10^9 Btu x 1.02 = $\underline{0.3630 \times 10^9 \text{ Btu}}$

The decay heat from App. "A" at 6 hrs after shutdown is 0.7878×10^9 Btu.

Therefore, the decay heat at 6 hrs. from fisson product heat alone is:

$0.7878 \times 10^9 - 0.00359(0.7878 \times 10^9) = 0.7849 \times 10^9$ Btu

Since it is conservatively assumed that the reactor trips at 102% of rated reactor thermal power for this event, the fission product decay heat at 6 hrs after shutdown becomes:

0.7849×10^9 Btu x 1.02 = $\underline{0.8006 \times 10^9 \text{ Btu}}$

Volume of water required for heat removal is determined by:

$W = (Q / \Delta h) \times v_f\,(110°F) \times (gal/ft^3)$ (Reference 2)

Where,

$\Delta h = h_g(1155\ psia) - h_f\,(110°F)$ (Reference 1)

$\Delta h = 1187 - 78 = 1109$ Btu/lb (Reference 5)

Calculating the required volume of condensate water for the 2 hour holding period results in:

W(2 hrs) = $[0.3630 \times 10^9 \text{ Btu} / 1109 \text{ Btu/lb}]\ (0.016165\ ft^3/lb)\ (1gal / 0.1337\ ft^3)$

<u>W(2 hrs) = 39575 gallons</u>

Calculating the required volume of condensate water for the 4 hour holding period results in:

W(4 hrs) = $[(0.8006 \times 10^9 \text{ Btu} - 0.3630 \times 10^9 \text{ Btu}) / 1109 \text{ Btu/lb}]\ (0.016165\ ft^3/lb)\ (1gal / 0.1337\ ft^3)$

<u>W(4 hrs) = 47,708 gallons</u>

Sensible Heat

- Determine required CST volume for removal of Sensible Heat in the RCS at Tavg (hot) of 577.2°F. An uncertainty of 6°F on the initial reactor average coolant temperature is conservatively assumed. Thus, sensible heat calculation is based on a RCS temperature of 577.2 °F + 6°F = 583.2 °F for the thermal capacity of the system metal and the reactor coolant fluid enthalpy change from 583.2 °F to 350°F. The equation used to calculate the sensible heat load is based upon the conservation of mass and energy:

$dU = m \times c_p \times \Delta T + \Delta h \times M$ where;
dU = sensible heat load from RCS temperature of 583.2 °F to 350°F, Btu

m = mass of RCS metal, lbm
$\approx 5.0 \times 10^6$ lbs (from Reference 2)

ΔT = 583.2°F - 350°F

c_p = specific heat of metal, 0.11 Btu/°F-lbm (from Reference 4)

Δh = enthalpy change of reactor coolant, Btu/lb
@ 583.2 °F; h_{f1} = 593.02 Btu/lb; v_{f1} = 0.022918 ft^3/lb
@ 350°F; h_{f2} = 321.80 Btu/lb; v_{f2} = 0.01799 ft^3/lb

M = total reactor coolant mass, lb
= V / v_f, where

V = total reactor coolant volume, ft^3
= 9,723 ft^3

v_f = specific volume of reactor coolant, where $v_{f1} = v_{f2}$ for conservatism.
= 0.018 ft^3/lb;

M = 9,723 ft^3/0.018 ft^3/lb = 540,167 lbs

Thus,

$dU = m \times c_p \times \Delta T + \Delta h \times M$

= 5.0×10^6 lbs. x 0.11 Btu/°F-lbm x (583.2°F - 350°F) + (593.02 Btu/lb - 321.80 Btu/lb) x 540,167 lbs.

<u>dU = 2.7476×10^8 Btus</u>

<u>Volume of CST required for Sensible Heat Load</u>

$$W \text{ (sensible ht.)} = \frac{2.7476 \times 10^8 \text{ Btu} \times 0.016165 \text{ ft}^3/\text{lbm}}{1109 \text{ Btu/lbm} \times 0.1337 \text{ ft}^3/\text{gal.}}$$

<u>W (sensible ht.) = 29,955 gallons required for sensible heat load</u>

RCP Heat

- Determine required CST volume for removal of the heat added to the RCS by the reactor coolant pumps.

For this event, normal cooldown, the heat added to the RCS is based on 1 RCP in operation for the duration of the event, 6 hrs. plus 10MWt net RCP heat added and assumed to decay over one(1) hr. after shutdown.

Per Reference 22, the heat added to RCS per pump is assumed at 5 MWt and the net heat input added for all three(3) RCPs is 10 MWt.

For 5 MWt (1 RCP), the CST volume required per hour is:

5 MWt = 5 x 10^6 watts and 1 Btu/hr = 0.293 watts, therefore,

5 MWt = 5 x 10^6 watts x (1 Btu/hr / 0.293 watts) = 1.7065 x 10^7 Btu/hr.

$$W/hr\ (1\ RCP) = \frac{1.7065 \times 10^7\ Btu/hr \times 0.016165\ ft^3/lb}{1109\ Btu/lb \times 0.1337\ ft^3/gal};$$

where 1109 Btu/lb is the enthalpy heat sink of the AFW, from 110°F to 1155 psia, maximum backpressure of the S/G secondary side,

W/hr (1 RCP) = 1860 gals/hr.

For 10 MWt the CST volume required per hour is:

10 MWt = 3.4129 x 10^7 Btu/hr

$$W/hr\ (10\ MWt\ net\ heat\ added) = \frac{3.4129 \times 10^7\ Btu/hr \times 0.016165\ ft^3/lb}{1109\ Btu/lb \times 0.1337\ ft^3/gal.};$$

W/hr (10 MWt net heat added) = 3721 gal/hr.

Therefore, for this normal cooldown event, the CST volume required for removal of RCP heat is;

W (RCP heat) = (6 hr. x 1860 gal/hr) + (1hr x 3721 gal/hr)

W (RCP heat) = 14881 gallons

Thus far, the volume required by the CST for normal cooldown is 132,119 gallons, now consider vortex prevention, AFW pumping capacity and CST potential inventory losses for conservatism.

Vortex Prevention

- Determine the CST volume required based on the minimum submergence water level required in the CST to prevent vortexing at the AFW pump's suction inlet. Per Reference 24, the minimum submergence level required in the CST based on the operation of two(2) MDAFW pumps or the TDAFW pumps shall be greater than or equal 9.78 inches from the bottom of the tank.

From the internal dimensions of the tank per Reference 23, the volume required is:

$$\text{Volume Req'd (gallons)} = \text{Tank Area } (ft^2) \times \text{Min. Submergence (ft.)} \times \frac{7.48 \text{ gallons}}{ft.^3}$$

Tank Area $(ft.^2) = \pi \text{ radius}^2$, where the radius is equal to 23 ft.

Tank Area $(ft.^2) = \pi\,(23)^2 = 1661.9\ ft.^2$, use 1662 ft^2

Min. Submergence(ft.) = 9.78 inches x (1ft./12inches) = 0.815 ft.

Thus,

Volume Req'd (gallons) for Vortex Prevention= $\mathbf{1662\ ft^2 \times 0.815\ ft. \times \frac{7.48\ gallons}{ft.^3} = \underline{10{,}132\ gallons}}$

Pumping Capacity and Inventory Loss

During normal plant cooldown, operating of one MDAFW pump will permit a maximum initial cooldown rate of 100°F/Hr. Each of the MDAFW pump is sized to supply the steam generators with 100 percent of the required feedwater flow for a normal safe cooldown of the reactor coolant system (References 1and 4). Therefore, one MDAFW pump is sufficient for a normal cooling operation with a cooldown rate of 50 °F/Hr assumed for this calculation. For conservative approach for this calculation, however, it is modeled for all three AFW pumps (the TDAFW and two MDAFW pumps, each at the design flow rate of 700 and 350 gpm, respectively) to operate for the first 30 minutes before the TDAFW and one MDAFW pumps are secured.

For normal plant cooldown, the AFWS is placed under manual control to supply feedwater to steam generators for removal of decay and sensible heat from the reactor system. The TDAFW pump is designed to be manually or automatically initiated to its rated capacity and head within 1 minute from starting at rest for at least 2 hours independent of any ac power (Reference 1). Operator action to secure the TDAFW and one MDAFW pump within 30 minutes will be adequate for this calculation purpose.

It is necessary to check that this operational mode will deliver sufficient water during the given period (6 hours) to meet the required volume of 132,119 gallons calculated above. The amount of water the pumps can deliver during the 6-hour period will be:

(700 gpm + 2 x 350 gpm) x 0.5 + 350 gpm x 5.5 hours = 157,500 gallons.

Therefore, the pumps will cover the required water volume during the 6-hour period.

The volume of water lost out from a break in the pump recirculation line will be calculated with an assumption that the ruptured minimum flow recirculation will be isolated within 30 minutes. Three recirculation lines of the pumps form one 6-inch line to the CST. It is assumed that, even though this single 6-inch return line would rupture at a location near the CST, all the three pump recirculation lines would be isolated. The MDAFW pumps will be operated with the minimum flow lines isolated during the remaining time of 5.5-hour period and this will not affect the pump performance for this operation mode.

Since the valves for the recirculation lines can be closed manually inside the plant, 30-minute span for the action is considered sufficient (Reference 4, Section B.3.7.6).

From References 9 and 10, the maximum recirculation flow for the TDAFW pumps is 100 gpm, and 50 gpm for each MDAFW pump. These recirculation flow values are slightly higher than calculated to conservatively accommodate the slight decrease in frictional loss due to a line break.

Thus, the maximum volume of water that will be lost during the 30-minute span from the recirculation line failure while all three AFW pumps are in operation is:

(100 + 50 + 50)gpm x 0.5 hour = 6,000 gallons.

Since the nozzle of the AFW pump recirculation line is located at 19 feet above the CST base, which is well above the height (13.25 feet, see below calculation) of the protected 164,832 gallon volume, or even above the protected height of the tank (16') (Reference 11), a possibility of water coming out from the CST through the ruptured recirculation line is not considered.

From References 14, 15, 16, 17 and 18, the four flow instrumentation lines branch out from the two AFW pump suction lines at El. 150 ft. location. Since the locations of the branch-out are in the pipe trench, for a conservative calculation purpose, the break point of the instrumentation lines is assumed to happen at the lowest location above the ground level (El.156'-9") where the instrumentation lines are exposed to missile impact. This is the same elevation as of the pump suction nozzle at the CST.

The instrument tubing is 3/8" size with 0.065 minimum wall with ID 0.245" (Reference 17). In order to calculate the flow rate at the rupture point, assume all the pressure losses in the 8" pump suction pipe and the instrument tubing are ignored. This will give a conservative result for the flow rate. Since the lower 164,832 gallon volume of the tank shall be reserved for handling decay heat and cooldown, the height of this water volume in the tank is:

Tank bottom area: $\pi r^2 = \pi (23ft)^2 = 1662 ft^2$ (Reference 11)

Height of volume (164,832 gallons) = (164832 gals / 7.48gals/ft^3) / 1662 ft^2 = 13.25 ft. (equivalent to a pressure of 5.73 psi). From Reference 6, page 2-9, the water flow from the break point is calculated by extrapolation. The break size of the tubing (0.245" ID) is approximately equivalent to 1/4". The discharges of 1/4" nozzle at 10 and 15 psi are 5.91 and 7.24 gpm, respectively (Reference 6).

Taking a middle point of the CSTwater level for the fluid pressure at the instrument line break point, or 2.9 psi, and ignoring all the line losses and the effect of the AFW pump suction pressures for conservatism, then the flow at the break points is calculated as:

$$5.91 \text{ gpm} - \{[(7.24 - 5.91)/(15-10)] \times (10-2.9)\} = 5.91 - 1.88 = 4.03 \text{ gpm per line}$$

Total outflow for four instrumentation lines : 4.03 x 4 lines = 16.1 gpm

If we consider that these instrumentation tubing will not be isolated during the 6-hour cooldown period, than the total volume lost from the ruptured instrument lines for 6 hours is 16.1 x 6 x 60 = 5803 gallons.

The total volume inventory lost from all the ruptured lines is, assuming all the line ruptures were occurred at time = 0 sec. of the cooldown mode: 6,000 + 5,803 = 11,803 gallons

In addition to the conservative scenario assumed in this calculation, this result is even more conservative for the following aspects.

First, operating all three pumps at the beginning of the normal plant cooldown is a highly conservative scenario. Only one or two pumps would be used for this purpose, which would make the water lost from the ruptured line much less than the calculated value. The water volume lost from the one 6-inch recirculation line was calculated by combining all the designed recirculation flows (200 gpm) from each AFW pumps.

Secondly, the volume of water required for decay and sensible heat removal has been calculated based on the enthalpy of water at 1155 psia. The rate of decay and sensible heat removal at lower pressures will be significantly higher (enthalpy increase from 1187 Btu/lb at 1155 psia to 1204 Btu/lb at 135 psia) and the calculation does not take any credit for the increase in enthalpy at lower pressures and, thus, higher heat removal capacity (References: Attachment A and Assumption 9).

Total CST Volume Required for Normal Cooldown is:

39575(decay ht. 2 hrs) + 47,708(decay ht. 4 hrs) + 29,955(sensible ht.) + 14881(RCP heat) + 10,132(vortex prevention) + 11,803(inventory loss) = **154,054 gallons**

This amount which consrvatively assumes a minimum submergence volume to prevent a vortex and the volume lost due to the failure of the AFW reciculation line and the instrumentation lines is still within the 164,832 gallons of the CST protected water volume.

C. CST Sizing - Main Feedwater Line Break with LOSP

Determine required CST volume based on holding the reactor at hot standby for 2 hours and cooldown in 4 hours to 350°F at 50°F/hr where RHR may be utilized for cooling.

Assumption: With off-site power unavailable, the RCPS will not be in operation through the duration of this event thus heat removal of RCS will be from natural circulation where the cooldown rate will be at 50 °F/hr. Thus, the duration of the event is set at 6 hours; 2 hours at hot standby and 4 hours to cooldown to 350°F. Also, it is asssumed that FNP Operations will isolate AFW to the faulted steam generator within 30 minutes.

Decay Heat

- Adjust decay load from Appendix "A" which represents 2775 MWt (100% power) plus 10 MWt pump heat to values that represents only decay heat due to fisson products decay heat.

The portion of decay heat results that is due to pump heat is: 10 MWt / 2785 MWt = 0.00359

The decay heat from App. "A" at 2 hrs after shutdown is 0.35713×10^9 Btu.

Therefore, the decay heat at 2 hrs. after shutdown from fisson products alone is:

$$0.35713 \times 10^9 - 0.00359(0.35713 \times 10^9) = 0.35584 \times 10^9 \text{ Btu}$$

Since it is conservatively assumed that the reactor trips at 102% of rated reactor thermal power for this event, the fission product decay heat at **2 hrs.** after shutdown becomes:

$$0.35584 \times 10^9 \text{ Btu} \times 1.02 = \underline{0.3630 \times 10^9 \text{ Btu}}$$

The decay heat from App. "A" at 6 hrs after shutdown is 0.7878×10^9 Btu.

Therefore, the decay heat at **6 hrs.** from fisson product heat alone is:

$$0.7878 \times 10^9 - 0.00359(0.7878 \times 10^9) = 0.7849 \times 10^9 \text{ Btu}$$

Since it is conservatively assumed that the reactor trips at 102% of rated reactor thermal power for this event, the fission product decay heat at **6 hrs** after shutdown becomes:

$$0.7849 \times 10^9 \text{ Btu} \times 1.02 = \underline{0.8006 \times 10^9 \text{ Btu}}$$

Volume of water required for heat removal is determined by:

$W = (Q / \Delta h) \times v_f\,(110°F) \times (gal/ft^3)$ (Reference 2)

Where,

$\Delta h = h_g(1155\ psia) - h_f\,(110°F)$ (Reference 1)

$\Delta h = 1187 - 78 = 1109$ Btu/lb (Reference 5)

Calculating the required volume of condensate water for the 2 hour holding period results in:

$W(2\ hrs) = [0.3630 \times 10^9\ Btu / 1109\ Btu/lb]\ (0.016165\ ft^3/lb)\ (1gal / 0.1337\ ft^3)$

W(2 hrs) = 39575 gallons

Calculating the required volume of condensate water for the 4 hour holding period (6 hrs. – 2 hrs.) results in:

W(4 hrs) =[(0.8006 x 10^9 Btu - 0.3630 x 10^9 Btu) / 1109 Btu/lb] (0.016165 ft^3/lb) (1gal / 0.1337 ft^3)

W(4 hrs) = 47,708 gallons

Sensible Heat

- Determine required CST volume for removal of Sensible Heat in the RCS at Tavg (hot) of 577.2°F. An uncertainty of 6°F on the initial reactor average coolant temperature is conservatively assumed. Thus, sensible heat calculation is based on a RCS temperature of 577.2 °F + 6°F = 583.2 °F for the thermal capacity of the system metal and the reactor coolant fluid enthalpy change from 583.2 °F to 350°F. The equation used to calculate the sensible heat load is based upon the conservation of mass and energy:

$dU = m \times c_p \times \Delta T + \Delta h \times M$ where;
dU = sensible heat load from RCS temperature of 583.2 °F to 350°F, Btu

m = mass of RCS metal, lbm
≈ 5.0 x 10^6 lbs (from Reference 2)

ΔT = 583.2°F - 350°F

c_p = specific heat of metal, 0.11 Btu/°F-lbm (from Reference 4)

Δh = enthalpy change of reactor coolant, Btu/lb
@ 583.2 °F; h_{f1} = 593.02 Btu/lb; v_{f1} = 0.022918 ft^3/lb
@ 350°F; h_{f2} = 321.80 Btu/lb; v_{f2} = 0.01799 ft^3/lb

M = total reactor coolant mass, lb
= V / v_f, where

V = total reactor coolant volume, ft^3
= 9,723 ft^3

v_f = specific volume of reactor coolant, where $v_{f1} = v_{f2}$ for conservatism.
= 0.018 ft^3/lb;

M = 9,723 ft^3/0.018 ft^3/lb = 540,167 lbs

Thus,

$dU = m \times c_p \times \Delta T + \Delta h \times M$

= 5.0 x 10^6 lbs. x 0.11 Btu/°F-lbm x (583.2°F - 350°F) + (593.02 Btu/lb - 321.80 Btu/lb) x 540,167 lbs.

<u>dU = 2.7476 x 10^8 Btus</u>

<u>Volume of CST required for Sensible Heat Load</u>

$$W \text{ (sensible ht.)} = \frac{2.7476 \times 10^8 \text{ Btu} \times 0.016165 \text{ ft}^3/\text{lbm}}{1109 \text{ Btu/lbm} \times 0.1337 \text{ ft}^3/\text{gal.}}$$

W (sensible ht.) = 29,955 gallons required for sensible heat load

RCP Heat with LOSP

Determine CST volume required for removal of the RCP heat added to the RCS.

This RCP heat is based on net heat input of 10 MWt from the full power operation of the unit prior to the event per WCAP-15097. The FSAR Section 15.4.2.1 does not assume a conservatively large RCP heat of 15MWt. The initial net heat input of 10MWt is assumed to decay over 1 hour and no operation of the RCPs is condsidered since LOSP is assummed.

Determine number of gallons per hour required remove **10MWt** pump heat is:

$W \text{ (gal/hr.)} = (3.41297 \times 10^7 \text{ Btu/hr} / 1109 \text{ Btu/lb}) \times 0.16165 \text{ ft}^3/\text{lbm} \times \text{gal}/.1337\text{ft}^3$

W = 3721 gal/hr to remove 10MWt pump heat

For the initial net RCP heat input of 10MWt that is assumed to decay over 1 hour from the start of the event the CST volume required is: 3721 gallons.

Therefore, the total CST volume required to remove the initial heat: 3721 gallons

Unusable Volume

- Unusable Volume in CST is equivalent to the 4 inches (0.33 ft) of CST volume below the pumps' suction nozzles since no vortex prevention is required while bringing the unit to hot shutdown, RCS at 350°F. That is, no attached lines to the CST are assumed to fail allowing air to enter the tank below the diaphragm during this event due to the single failure criteria.

Unusable Volume (gallons) = Tank Area (ft^2) x 0.33 ft. x 7.48 gallons/ft.^3

Tank Area (ft.^2) = π radius^2 , where the radius is equal to 23 ft.

Tank Area (ft.^2) = $\pi (23)^2$ = 1661.9 ft.^2 , use 1662 ft^2

Thus,

Unusable Volume (gallons) = 1662 ft^2 x 0.33 ft. x 7.48 gal/ft^3 = 4102 gal

Loss of Inventory

Determine CST inventory loss from a MFWLB based on new Proto-Flo runs with as-built AFW orifice size.

Per Calculation 40.02, the inventory loss of CST volume due a MFWLB assuming the break is isolated in 30 mins is **14,898 gallons**.

However, a 10% margin is added to this value for uncertainity until this value is documented and verified in a new version of the calculation 40.02. Thus, the new version of calc. 40.02 will be an input this this calculation.

Including the 10% margin: 14,898 + 1490 = **16,388 gallons**

Results

The total volume of the CST required to bring the RCS to 350°F for a MFWLB w/LOSP is:

39575 gals + 47708 gals + 29955 gals + 3721 gals + 4102 gals + 16,388 gals = **141,449 gallons**

This amount is within the 164,832 gallons of the CST protected water volume.

D. Technical Specification Bases

Verify the CST protected water volume capacity based on the Technical Specification Basis B.3.7.6 that states, "The OPERABILITY of the CST is based on having sufficient water available to maintain the RCS in MODE 3 for 9 hours with steam discharge to the atmosphere concurrent with a total loss of offsite power.

Decay Heat

- Adjust decay load from Appendix "A" which represents 2775 MWt (100% power) plus 10 MWt pump heat to values that represents only decay heat due to fisson products decay heat.

  The decay heat from App. "A" at 9 hrs after shutdown is 0.1055×10^{10} Btu which includes 10 MWt pump heat.

  The portion of decay heat results that is due to pump heat is: 10 MWt / 2785 MWt = 0.00359

  Therefore, the decay heat at 9 hrs. after shutdown from fisson products (minus pump heat) is:

$$0.1055 \times 10^{10} - 0.00359(0.1055 \times 10^{10}) = 0.10512 \times 10^{10} \text{ Btu}$$

Since it is conservatively assumed that the reactor trips at 102% of rated reactor thermal power (2775 MWt) for this event, the fission product decay heat at 9 hrs after shutdown becomes:

0.10512×10^{10} Btus x 1.02 = $\underline{0.10722 \times 10^{10} \text{ Btu}}$

Therefore, the CST Volume Required for Decay Heat is:

$$W(9hrs.) = \frac{0.10722 \times 10^{10} \text{Btu}}{1109 \text{ Btu/lbm}} (0.016165 ft^3/lbm)(gal/0.1337\ ft^3)$$

<u>W(9hrs.) = 116,893 gallons</u>

<u>RCP Net Heat</u>

- Per FSAR 9.2.6.3, event is concurent with LOSP, i.e., no RCPs are in operation; however, the net heat input of 10 MWt due to the RCPs at beginning of the event exists in the RCS and it is assumed this heat decays over a one(1) hour period. No RCP heat is added during 9 hr event since a LOSP is assumed with this event.

10 MWt = 3.41297×10^7 Btu/hr (based on 0.293 watts = 1 Btu/hr)

Therefore, CST volume required due to 10 MWt RCP net heat input at beginning of the event and assumed to decay in 1 hour is:

$$W(10MWt\ decayed\ over\ 1\ hr.) = \frac{3.41297 \times 10^7 \text{Btu/hr}}{1109 \text{ Btu/lbm}} (0.016165 ft^3/lbm)(gal/0.1337\ ft^3) \times 1\ hr.$$

<u>W (10 MWt decayed over 1 hr.) = 3721 gallons</u>

<u>Unusable Volume</u>

- Unsable Volume in CST is equivlent to the 4 inches (0.33 ft) of CST volume below the pumps' suction nozzles since no vortex prevention is required while maintaining the RCS in MODE 3 for 9 hours (Reference 23). That is, no attached lines to the CST is assumed to fail allowing air to enter the tank below the diaphragm.

$$\text{Unusable Volume (gallons)} = \text{Tank Area } (ft^2) \times 0.33\ ft. \times \frac{7.48 \text{ gallons}}{ft.^3}$$

Tank Area ($ft.^2$) = π radius^2 , where the radius is equal to 23 ft.

Tank Area ($ft.^2$) = $\pi (23)^2 = 1661.9\ ft.^2$, use 1662 ft^2

Thus,

Unusable Volume (gallons) = 1662 ft^2 x 0.33 ft. x $\frac{7.48 \text{ gallons}}{\text{ft.}^3}$ = 4102 gallons

Total CST Volume Required for Technical Specification Bases B.3.7.6 is:

116,893 gallons + 3721 gallons + 4102 gallons = 124,716 gallons

Note : This is the volume of water required for decay heat removal for 9 hours after reactor shutdown does not include the water for sensible heat removal since the RCS temperature will be maintained at the hot standby condition throughout this duration. A line break that would result in CST inventory loss by a tornado missile or a seismic event is not part of the scenario for this mode of 9-hour hot standby condition with a loss of off-site power.

This amount is within the 164,832 gallons of the CST protected water volume.

E. Loss of Normal Feedwater w/o LOSP

Decay Heat

- Adjust decay load from Appendix "A" which represents 2775 MWt (100% power) plus 10 MWt pump heat to values that represents only decay heat due to fisson products decay heat.

  The decay heat from App. "A" at 9 hrs after shutdown is 0.1055 x 10^{10} Btu which includes 10 MWt pump heat.

  The portion of decay heat results that is due to pump heat is: 10 MWt / 2785 MWt = 0.00359

  Therefore, the decay heat at 9 hrs. after shutdown from fisson products (minus pump heat) is:

  $0.1055 \times 10^{10} - 0.00359(0.1055 \times 10^{10}) = 0.10512 \times 10^{10}$ Btu

  Since it is conservatively assumed that the reactor trips at 102% of rated reactor thermal power (2775 MWt) for this event, the fission product decay heat at 9 hrs after shutdown becomes:

  0.10512×10^{10} Btus x 1.02 = $\underline{0.10722 \times 10^{10}}$ Btu

  Therefore, the CST Volume Required for Decay Heat is:

  $$W(9hrs.) = \frac{0.10722 \times 10^{10} \text{Btu}}{1109 \text{ Btu/lbm}} (0.016165 \text{ft}^3/\text{lbm})(\text{gal}/0.1337 \text{ ft}^3)$$

  W(9hrs.) = 116,893 gallons

Sensible Heat

No sensible heat is included since the unit stays at hot standby conditions through-out duration of event.

RCP Heat w/o LOSP

Determine CST volume required for removal of the RCP heat added to the RCS.

This RCP heat is based on net heat input of 15 MWt per WCAP-15097 and operation of all RCPs from Tavg(full power) to 350°F at a cooldown rate of 50°F/hr. The WCAP assumes a conservatively large RCP heat input of 15MWt. This initial net heat input of 15 MWt is assumed to decay over 1 hour. Per this WCAP, all three(3) RCPs operate at the initiation of the event for 10 mins and one(1) RCP operates for the duration of the event; i.e. 9 hrs. in hot standby.

15 MWt pump heat input = 5.119×10^7 Btu/hr.

Determine number of gallons per hour required to remove **15MWt** pump heat is:

W (gal/hr.) = (5.119×10^7 Btu/hr / 1109 Btu/lb) x 0.016165 ft^3/lbm x gal/ 0.1337ft^3

W = 5580 gal/hr to remove 15MWt pump heat. Thus, assumming 1 hr to decay 15 MWt, the net heat input yields:

5581 gallons

Per FSAR 15.2.8.2.1.A, three RCPs operate for **10 mins** at start of event:

5581 gals/hr. x 1 hr./ 60mins x 10 min. = **930 gallons.**

Thus, for the remaining duration of the event which is; 9 hrs – 10 mins, the CST volume required to remove heat input of one (1) RCPs operating is:

1 RCP heat input = 5 MWt = 1.7065×10^7 Btu/hr.

W (gal/hr) = (1.7065×10^7 Btu/hr / 1109 Btu/lb) x 0.016165 ft^3/lbm x gal./ 0.1337 ft^3

W (gal/hr) = 1860 gal/hr

Now, timing remaining = 9 hrs. – (10min x 1 hr/60 min) = 8.83 hr.

Therefore, volume required for timing remaining during event is:

Volume = 1860 gal/hr x 8.83 hr. = **16,430 gallons**

Total CST volume required for RCP heat added during LNFW event is:

5581 + 930 + 16,430 = 22941 gallons

Pressurizer Heaters Input to RCS

Per FSAR Section 15.2.8, during a Loss of Normal Feedwater (LONF) event, the pressurizer proportional and backup heaters are assumed operable. The total capacity of the pressurizer heaters is 1.4 MWt. The heaters output represents an addition to the RCS energy which must be removed by the AFW system. Therefore, determine CST volume required for removal of this energy during the event duration of 9 hours in Mode 3, steaming to atmosphere.

- Loss of Normal Feedwater

Pressurizer Heater capacity in Btu/hr.

1.4 MWt = 4.7781×10^6 Btu/hr (based on 0.293 watts = 1 Btu/hr)

$$W/hr\ (Pzr\ Htrs.) = \frac{4.7781 \times 10^6\ Btu/hr \times 0.016165\ ft^3/lb\ ;}{1109\ Btu/lb \times 0.1337\ ft^3/gal}$$

where 1109 Btu/lb is the enthalpy heat sink of the AFW, from 110°F to 1155 psia, maximum backpressure of the SG secondary side,

W/hr (Pzr Htrs.) = 521 gals/hr.

Therefore, for this LONF event, the CST volume required for removal of Pressurizer Heater energy input to the RCS:

W (Pzr Htrs.) = (9 hr. x 521gal/hr)

W (Pzr Htrs.) = 4689 gallons

Unusable Volume

- Unusable Volume in CST is equivlent to the 4 inches (0.33 ft) of CST volume below the pumps' suction nozzles since no vortex prevention is required while bring the unit to hot shutdown, RCS at 350°F. That is, no attached lines to the CST that are assumed to fail allowing air to enter the tank below the diaphragm during this event due to the single failure criteria.

Unusable Volume (gallons) = Tank Area (ft^2) x 0.33 ft. x 7.48 gallons/$ft.^3$

Tank Area ($ft.^2$) = π $radius^2$, where the radius is equal to 23 ft.

Tank Area ($ft.^2$) = π $(23)^2$ = 1661.9 $ft.^2$, use 1662 ft^2

Thus,

Unusable Volume (gallons) = 1662 ft^2 x 0.33 ft. x 7.48 gal/ft^3 = 4102 gal

Loss of Inventory

No loss of inventory is assumed for this event

Results

The total volume of the CST required to bring the RCS to 350°F for LNFW w/o LOSP is:

116,893 + 22941 + 4689 + 4102 = 148625 gallons

This amount is within the 164,832 gallons of the CST protected water volume.

V. RESULTS / CONCLUSIONS

The quanitity of water required in the protected portion of the CST to cooldown the reactor within 6 hours to a point at which the plant can be transitioned to RHR system cooling is **132,119** gallons which consists of decay, sensible and RCP heat during a Normal Cooldown event.

However, in this analysis for the Normal Cooldown event, several conservative assumptions were made in addition to the decay, sensible and RCP heat loads considered in determing the CST minimum volume required for the Normal Cooldown event. These conservative assumptions included volume losses due to missile rupture of unprotected portion of the pump's recirculation lines and the tank's instrumentation lines, and a reserved minimum submergence height in the CST to prevent a vortex formation. These assumptions are conservative since a tornado event, the failure mechanism, is not required to be assumed concurrent with a Normal Cooldown event. Thus, the conservative amount of water needed for this event is **154,054 gallons**.

This analysis also shows based on the CST volume determined for the Main Feedwater Line Break with Loss-of-Offsite Power event, adequate margin is available to accommodate a loss of CST inventory due to the MFWLB in addition to cooldown the RCS within 6 hours to a point at which the plant can be transitioned to RHR system cooling. The amount of water needed for this MFWLB event is **141,449 gallons**.

The quantity of water to maintain the RCS at hot standby conditions for 9 hours with steam discharge to the atmosphere concurrent with a total loss-of-offsite power, as required for the Technical Specification Bases for Operability, is calculated to be **124,716 gallons**.

This analysis also shows that an adequate volume of water is available in the missile protected portion of the CST to maintain the RCS at hot standby conditions for 9 hours with steam discharging to the atmosphere for the Loss of Normal Feedwater without Loss-of-Offsite Power event. The amount of water needed for this LONF event is **148,625 gallons**.

All of these required water volumes are within the maximum protected water amount of **164,832 gallons** for the CST and the Normal Cooldown has been determined to be the most limiting event for the sizing of the CST volume.

Therefore, the CST capacity is adequate to remove the reactor decay heat from 102% RTP, RCS sensible heat, and RCP heat for various conditions described above which include the water loss from rupture of the unprotected lines due to potential missile impact or a seismic event, inventory loss due to a main steam line break and AFW pump suction vortex prevention.

VI. REFERENCES

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7. "Deleted"
8. "Deleted"
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11. U-161693, Version 2.0, and U-213481, Version 3.0 - CST General Plan
12. "Deleted"
13. SCS Calculation SM-95-0721-005, Revision 1 – Design Basis Temperature Site/Condensate Storage Tank/Refueling Water Storage Tank.
14. Pump Suction Piping Isometric Drawings D-514547, Rev.0 and D-514548, Rev. 0.
15. MDAFW Pump Suction Piping, D-518847, Sheets 2, Rev.0
16. TDAFW Pump Suction Piping, D-518847, Sheet 1, Rev. 0
17. AFW Suction Line Flow Instrument Drawings, A-175856, Rev. 2 and A-205856, Rev. 3
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23. U-161703B, Ver. 0.3; U-161694C, Ver. 0.4; U-213481 Ver.1.0 - CST Internal Dimensions
24. SM-SNC335993-001, Version 2.0 – CST AFW Pump Suction – Submergence Analysis
25. RER SNC419117, Seq. 2 – "CST AI for Enhanced ACD for NRC CDBI NCVs 2011010-01 & 02."

APPENDIX A

Decay heat model was based on an operating power of 2785 MWth and computer code MAP-121, Version V01.

APPENDIX A, CALC. 4. , Rev. 4
19 PAGES DWM
D.W. MURPHY 12/12/95 4 3/8/99

TIME (SEC)	FP (BTU/HR)	U-239 (BTU/HR)	NP-239 (BTU/HR)	U239+NP239 (BTU/HR)	TOTAL (BTU/HR)	INTEGRAL (BTU)

MAP-121 DECAY HEAT CALCULATION CODE, VERSION V01:

***** NRC DECAY HEAT MODEL (ASB-92, REV. 2, 1981) *****

NRC VERSION CALCULATES RESIDUAL DECAY HEAT BY EQUATIONS PRESENTED IN NRC BRANCH TECHNICAL POSITION ASB 9-2. REV.2 JULY 1981. CODE CALCULATES DECAY HEAT RESULTING FROM FISSION PRODUCT DECAY, FP,AND THE DECAY OF U-239 AND NP-239. THE TOTAL DECAY RATE, INCLUDING THE APPROPRIATE UNCERTAINTY FACTORS IS LABELED TOTAL. THE TOTAL HEAT RELEASED IS LABELED INTEGRAL. RESULTS ARE ACCURATE ONLY UP TO 1.0E07 SEC.

FARLEY UNITS 1 & 2

OPERATING POWER = .95070E+10 BTU/HR (2785 MWt)

OUTPUT FILENAME = C:DCPDK.PRN

REACTOR OPERATING TIME = INFINITY

MAXIMUM TIME = .10000E+08 SEC.

PRINTOUT OPTION = 1

TIME (SEC)	FP (BTU/HR)	U-239 (BTU/HR)	NP-239 (BTU/HR)	U239+NP239 (BTU/HR)	TOTAL (BTU/HR)	INTEGRAL (BTU)
.00000E+00	.79850E+09	.15173E+08	.14441E+08	.29614E+08	.95070E+10	.00000E+00
.10000E+00	.78635E+09	.15172E+08	.14441E+08	.29614E+08	.81596E+09	.14337E+06
.20000E+00	.77540E+09	.15172E+08	.14441E+08	.29613E+08	.80502E+09	.16589E+06
.30000E+00	.76550E+09	.15171E+08	.14441E+08	.29612E+08	.79511E+09	.18811E+06
.40000E+00	.75649E+09	.15170E+08	.14441E+08	.29611E+08	.78610E+09	.21007E+06
.50000E+00	.74827E+09	.15169E+08	.14441E+08	.29611E+08	.77788E+09	.23180E+06
.60000E+00	.74074E+09	.15169E+08	.14441E+08	.29610E+08	.77035E+09	.25330E+06
.70000E+00	.73381E+09	.15168E+08	.14441E+08	.29609E+08	.76342E+09	.27460E+06
.80000E+00	.72740E+09	.15167E+08	.14441E+08	.29608E+08	.75701E+09	.29572E+06
.90000E+00	.72147E+09	.15166E+08	.14441E+08	.29608E+08	.75107E+09	.31666E+06
.10000E+01	.71594E+09	.15166E+08	.14441E+08	.29607E+08	.74555E+09	.33745E+06
.20000E+01	.67575E+09	.15158E+08	.14441E+08	.29599E+08	.70535E+09	.53896E+06
.30000E+01	.65043E+09	.15151E+08	.14441E+08	.29592E+08	.68002E+09	.73138E+06
.40000E+01	.63216E+09	.15143E+08	.14441E+08	.29585E+08	.66174E+09	.91773E+06
.50000E+01	.61783E+09	.15136E+08	.14441E+08	.29577E+08	.64741E+09	.10996E+07
.60000E+01	.60590E+09	.15129E+08	.14441E+08	.29570E+08	.63547E+09	.12777E+07
.70000E+01	.59553E+09	.15121E+08	.14441E+08	.29562E+08	.62509E+09	.14528E+07
.80000E+01	.58624E+09	.15114E+08	.14441E+08	.29555E+08	.61579E+09	.16252E+07
.90000E+01	.57774E+09	.15106E+08	.14441E+08	.29547E+08	.60729E+09	.17950E+07
.10000E+02	.56987E+09	.15099E+08	.14441E+08	.29540E+08	.59941E+09	.19626E+07
.11000E+02	.56251E+09	.15091E+08	.14441E+08	.29533E+08	.59204E+09	.21281E+07
.12000E+02	.55560E+09	.15084E+08	.14441E+08	.29525E+08	.58513E+09	.22916E+07
.13000E+02	.54909E+09	.15077E+08	.14441E+08	.29518E+08	.57861E+09	.24532E+07
.14000E+02	.54295E+09	.15069E+08	.14441E+08	.29510E+08	.57246E+09	.26131E+07
.15000E+02	.53713E+09	.15062E+08	.14441E+08	.29503E+08	.56663E+09	.27713E+07
.16000E+02	.53161E+09	.15054E+08	.14441E+08	.29496E+08	.56111E+09	.29279E+07
.17000E+02	.52639E+09	.15047E+08	.14441E+08	.29488E+08	.55587E+09	.30831E+07
.18000E+02	.52142E+09	.15040E+08	.14441E+08	.29481E+08	.55090E+09	.32368E+07
.19000E+02	.51671E+09	.15032E+08	.14441E+08	.29473E+08	.54618E+09	.33892E+07
.20000E+02	.51222E+09	.15025E+08	.14441E+08	.29466E+08	.54169E+09	.35403E+07
.21000E+02	.50795E+09	.15018E+08	.14441E+08	.29459E+08	.53741E+09	.36901E+07

TIME (SEC)	FP (BTU/HR)	U-239 (BTU/HR)	NP-239 (BTU/HR)	U239+NP239 (BTU/HR)	TOTAL (BTU/HR)	INTEGRAL (BTU)
.22000E+02	.50389E+09	.15010E+08	.14441E+08	.29451E+08	.53334E+09	.38389E+07
.23000E+02	.50002E+09	.15003E+08	.14441E+08	.29444E+08	.52946E+09	.39865E+07
.24000E+02	.49632E+09	.14995E+08	.14441E+08	.29437E+08	.52576E+09	.41330E+07
.25000E+02	.49279E+09	.14988E+08	.14441E+08	.29429E+08	.52222E+09	.42786E+07
.26000E+02	.48942E+09	.14981E+08	.14441E+08	.29422E+08	.51884E+09	.44232E+07
.27000E+02	.48619E+09	.14973E+08	.14441E+08	.29414E+08	.51560E+09	.45668E+07
.28000E+02	.48310E+09	.14966E+08	.14441E+08	.29407E+08	.51251E+09	.47096E+07
.29000E+02	.48014E+09	.14959E+08	.14441E+08	.29400E+08	.50954E+09	.48516E+07
.30000E+02	.47730E+09	.14951E+08	.14441E+08	.29392E+08	.50669E+09	.49927E+07
.31000E+02	.47457E+09	.14944E+08	.14441E+08	.29385E+08	.50396E+09	.51331E+07
.32000E+02	.47195E+09	.14937E+08	.14441E+08	.29378E+08	.50133E+09	.52727E+07
.33000E+02	.46944E+09	.14929E+08	.14441E+08	.29370E+08	.49881E+09	.54116E+07
.34000E+02	.46701E+09	.14922E+08	.14441E+08	.29363E+08	.49637E+09	.55498E+07
.35000E+02	.46467E+09	.14915E+08	.14441E+08	.29356E+08	.49403E+09	.56874E+07
.36000E+02	.46242E+09	.14907E+08	.14441E+08	.29348E+08	.49177E+09	.58243E+07
.37000E+02	.46024E+09	.14900E+08	.14441E+08	.29341E+08	.48958E+09	.59606E+07
.38000E+02	.45814E+09	.14893E+08	.14441E+08	.29334E+08	.48747E+09	.60963E+07
.39000E+02	.45610E+09	.14885E+08	.14441E+08	.29327E+08	.48543E+09	.62314E+07
.40000E+02	.45413E+09	.14878E+08	.14441E+08	.29319E+08	.48345E+09	.63660E+07
.41000E+02	.45222E+09	.14871E+08	.14441E+08	.29312E+08	.48154E+09	.65000E+07
.42000E+02	.45037E+09	.14863E+08	.14441E+08	.29305E+08	.47968E+09	.66335E+07
.43000E+02	.44857E+09	.14856E+08	.14441E+08	.29297E+08	.47787E+09	.67665E+07
.44000E+02	.44683E+09	.14849E+08	.14441E+08	.29290E+08	.47612E+09	.68990E+07
.45000E+02	.44513E+09	.14842E+08	.14441E+08	.29283E+08	.47441E+09	.70310E+07
.46000E+02	.44347E+09	.14834E+08	.14441E+08	.29275E+08	.47275E+09	.71626E+07
.47000E+02	.44186E+09	.14827E+08	.14441E+08	.29268E+08	.47113E+09	.72937E+07
.48000E+02	.44029E+09	.14820E+08	.14441E+08	.29261E+08	.46955E+09	.74243E+07
.49000E+02	.43876E+09	.14812E+08	.14441E+08	.29254E+08	.46801E+09	.75546E+07
.50000E+02	.43726E+09	.14805E+08	.14441E+08	.29246E+08	.46651E+09	.76844E+07
.51000E+02	.43580E+09	.14798E+08	.14441E+08	.29239E+08	.46504E+09	.78137E+07
.52000E+02	.43437E+09	.14791E+08	.14441E+08	.29232E+08	.46360E+09	.79427E+07
.53000E+02	.43297E+09	.14783E+08	.14441E+08	.29225E+08	.46219E+09	.80713E+07
.54000E+02	.43159E+09	.14776E+08	.14441E+08	.29217E+08	.46081E+09	.81995E+07
.55000E+02	.43025E+09	.14769E+08	.14441E+08	.29210E+08	.45946E+09	.83273E+07

TIME (SEC)	FP (BTU/HR)	U-239 (BTU/HR)	NP-239 (BTU/HR)	U239+NP239 (BTU/HR)	TOTAL (BTU/HR)	INTEGRAL (BTU)
.56000E+02	.42893E+09	.14762E+08	.14441E+08	.29203E+08	.45813E+09	.84547E+07
.57000E+02	.42763E+09	.14754E+08	.14441E+08	.29196E+08	.45683E+09	.85818E+07
.58000E+02	.42636E+09	.14747E+08	.14441E+08	.29188E+08	.45555E+09	.87085E+07
.59000E+02	.42511E+09	.14740E+08	.14441E+08	.29181E+08	.45429E+09	.88349E+07
.60000E+02	.42388E+09	.14733E+08	.14441E+08	.29174E+08	.45306E+09	.89609E+07
.61000E+02	.42268E+09	.14725E+08	.14441E+08	.29167E+08	.45184E+09	.90866E+07
.62000E+02	.42149E+09	.14718E+08	.14441E+08	.29159E+08	.45065E+09	.92120E+07
.63000E+02	.42032E+09	.14711E+08	.14441E+08	.29152E+08	.44947E+09	.93370E+07
.64000E+02	.41916E+09	.14704E+08	.14441E+08	.29145E+08	.44831E+09	.94617E+07
.65000E+02	.41802E+09	.14697E+08	.14441E+08	.29138E+08	.44716E+09	.95860E+07
.66000E+02	.41690E+09	.14689E+08	.14441E+08	.29130E+08	.44603E+09	.97101E+07
.67000E+02	.41580E+09	.14682E+08	.14441E+08	.29123E+08	.44492E+09	.98338E+07
.68000E+02	.41470E+09	.14675E+08	.14441E+08	.29116E+08	.44382E+09	.99573E+07
.69000E+02	.41362E+09	.14668E+08	.14441E+08	.29109E+08	.44273E+09	.10080E+08
.70000E+02	.41256E+09	.14661E+08	.14441E+08	.29102E+08	.44166E+09	.10203E+08
.71000E+02	.41151E+09	.14653E+08	.14441E+08	.29094E+08	.44060E+09	.10326E+08
.72000E+02	.41047E+09	.14646E+08	.14441E+08	.29087E+08	.43955E+09	.10448E+08
.73000E+02	.40944E+09	.14639E+08	.14441E+08	.29080E+08	.43852E+09	.10570E+08
.74000E+02	.40842E+09	.14632E+08	.14441E+08	.29073E+08	.43749E+09	.10692E+08
.75000E+02	.40741E+09	.14625E+08	.14441E+08	.29066E+08	.43648E+09	.10813E+08
.76000E+02	.40642E+09	.14617E+08	.14441E+08	.29058E+08	.43548E+09	.10934E+08
.77000E+02	.40543E+09	.14610E+08	.14441E+08	.29051E+08	.43448E+09	.11055E+08
.78000E+02	.40446E+09	.14603E+08	.14441E+08	.29044E+08	.43350E+09	.11176E+08
.79000E+02	.40349E+09	.14596E+08	.14441E+08	.29037E+08	.43253E+09	.11296E+08
.80000E+02	.40253E+09	.14589E+08	.14441E+08	.29030E+08	.43156E+09	.11416E+08
.81000E+02	.40158E+09	.14582E+08	.14441E+08	.29023E+08	.43061E+09	.11536E+08
.82000E+02	.40064E+09	.14574E+08	.14441E+08	.29015E+08	.42966E+09	.11655E+08
.83000E+02	.39971E+09	.14567E+08	.14441E+08	.29008E+08	.42872E+09	.11774E+08
.84000E+02	.39879E+09	.14560E+08	.14441E+08	.29001E+08	.42779E+09	.11893E+08
.85000E+02	.39787E+09	.14553E+08	.14441E+08	.28994E+08	.42687E+09	.12012E+08
.86000E+02	.39697E+09	.14546E+08	.14441E+08	.28987E+08	.42595E+09	.12130E+08
.87000E+02	.39607E+09	.14539E+08	.14441E+08	.28980E+08	.42504E+09	.12249E+08
.88000E+02	.39517E+09	.14532E+08	.14441E+08	.28973E+08	.42414E+09	.12366E+08
.89000E+02	.39429E+09	.14524E+08	.14441E+08	.28965E+08	.42325E+09	.12484E+08

TIME (SEC)	FP (BTU/HR)	U-239 (BTU/HR)	NP-239 (BTU/HR)	U239+NP239 (BTU/HR)	TOTAL (BTU/HR)	INTEGRAL (BTU)
.90000E+02	.39341E+09	.14517E+08	.14441E+08	.28958E+08	.42236E+09	.12602E+08
.91000E+02	.39253E+09	.14510E+08	.14441E+08	.28951E+08	.42149E+09	.12719E+08
.92000E+02	.39167E+09	.14503E+08	.14441E+08	.28944E+08	.42061E+09	.12836E+08
.93000E+02	.39081E+09	.14496E+08	.14441E+08	.28937E+08	.41975E+09	.12953E+08
.94000E+02	.38996E+09	.14489E+08	.14441E+08	.28930E+08	.41889E+09	.13069E+08
.95000E+02	.38911E+09	.14482E+08	.14441E+08	.28923E+08	.41803E+09	.13185E+08
.96000E+02	.38827E+09	.14475E+08	.14441E+08	.28916E+08	.41718E+09	.13301E+08
.97000E+02	.38743E+09	.14467E+08	.14441E+08	.28908E+08	.41634E+09	.13417E+08
.98000E+02	.38660E+09	.14460E+08	.14441E+08	.28901E+08	.41551E+09	.13533E+08
.99000E+02	.38578E+09	.14453E+08	.14441E+08	.28894E+08	.41468E+09	.13648E+08
.10000E+03	.38496E+09	.14446E+08	.14441E+08	.28887E+08	.41385E+09	.13763E+08
.11000E+03	.37708E+09	.14375E+08	.14441E+08	.28816E+08	.40590E+09	.14901E+08
.12000E+03	.36968E+09	.14305E+08	.14441E+08	.28746E+08	.39843E+09	.16019E+08
.13000E+03	.36272E+09	.14235E+08	.14441E+08	.28676E+08	.39139E+09	.17116E+08
.14000E+03	.35614E+09	.14165E+08	.14441E+08	.28606E+08	.38475E+09	.18194E+08
.15000E+03	.34994E+09	.14096E+08	.14441E+08	.28537E+08	.37848E+09	.19254E+08
.16000E+03	.34408E+09	.14027E+08	.14441E+08	.28468E+08	.37255E+09	.20297E+08
.17000E+03	.33854E+09	.13958E+08	.14441E+08	.28399E+08	.36694E+09	.21324E+08
.18000E+03	.33329E+09	.13890E+08	.14441E+08	.28330E+08	.36163E+09	.22336E+08
.19000E+03	.32833E+09	.13822E+08	.14441E+08	.28262E+08	.35660E+09	.23333E+08
.20000E+03	.32364E+09	.13754E+08	.14441E+08	.28195E+08	.35183E+09	.24317E+08
.21000E+03	.31919E+09	.13687E+08	.14441E+08	.28127E+08	.34732E+09	.25288E+08
.22000E+03	.31498E+09	.13620E+08	.14441E+08	.28060E+08	.34304E+09	.26247E+08
.23000E+03	.31099E+09	.13553E+08	.14441E+08	.27993E+08	.33898E+09	.27194E+08
.24000E+03	.30720E+09	.13486E+08	.14440E+08	.27927E+08	.33513E+09	.28130E+08
.25000E+03	.30361E+09	.13420E+08	.14440E+08	.27861E+08	.33147E+09	.29056E+08
.26000E+03	.30021E+09	.13355E+08	.14440E+08	.27795E+08	.32800E+09	.29972E+08
.27000E+03	.29697E+09	.13289E+08	.14440E+08	.27730E+08	.32470E+09	.30879E+08
.28000E+03	.29390E+09	.13224E+08	.14440E+08	.27664E+08	.32156E+09	.31776E+08
.29000E+03	.29097E+09	.13159E+08	.14440E+08	.27600E+08	.31857E+09	.32665E+08
.30000E+03	.28820E+09	.13095E+08	.14440E+08	.27535E+08	.31573E+09	.33546E+08
.31000E+03	.28555E+09	.13031E+08	.14440E+08	.27471E+08	.31302E+09	.34420E+08
.32000E+03	.28304E+09	.12967E+08	.14440E+08	.27407E+08	.31044E+09	.35286E+08
.33000E+03	.28064E+09	.12904E+08	.14440E+08	.27343E+08	.30798E+09	.36145E+08

TIME (SEC)	FP (BTU/HR)	U-239 (BTU/HR)	NP-239 (BTU/HR)	U239+NP239 (BTU/HR)	TOTAL (BTU/HR)	INTEGRAL (BTU)
.34000E+03	.27835E+09	.12840E+08	.14440E+08	.27280E+08	.30564E+09	.36997E+08
.35000E+03	.27618E+09	.12777E+08	.14440E+08	.27217E+08	.30339E+09	.37843E+08
.36000E+03	.27410E+09	.12715E+08	.14440E+08	.27154E+08	.30125E+09	.38682E+08
.37000E+03	.27211E+09	.12653E+08	.14440E+08	.27092E+08	.29920E+09	.39516E+08
.38000E+03	.27021E+09	.12591E+08	.14440E+08	.27030E+08	.29724E+09	.40345E+08
.39000E+03	.26840E+09	.12529E+08	.14439E+08	.26968E+08	.29536E+09	.41168E+08
.40000E+03	.26666E+09	.12468E+08	.14439E+08	.26907E+08	.29357E+09	.41986E+08
.41000E+03	.26500E+09	.12406E+08	.14439E+08	.26846E+08	.29184E+09	.42799E+08
.42000E+03	.26340E+09	.12346E+08	.14439E+08	.26785E+08	.29019E+09	.43607E+08
.43000E+03	.26187E+09	.12285E+08	.14439E+08	.26724E+08	.28860E+09	.44411E+08
.44000E+03	.26040E+09	.12225E+08	.14439E+08	.26664E+08	.28707E+09	.45211E+08
.45000E+03	.25899E+09	.12165E+08	.14439E+08	.26604E+08	.28560E+09	.46006E+08
.46000E+03	.25764E+09	.12106E+08	.14439E+08	.26544E+08	.28418E+09	.46797E+08
.47000E+03	.25633E+09	.12046E+08	.14439E+08	.26485E+08	.28282E+09	.47585E+08
.48000E+03	.25508E+09	.11987E+08	.14439E+08	.26426E+08	.28150E+09	.48369E+08
.49000E+03	.25387E+09	.11929E+08	.14438E+08	.26367E+08	.28023E+09	.49149E+08
.50000E+03	.25270E+09	.11870E+08	.14438E+08	.26309E+08	.27901E+09	.49926E+08
.51000E+03	.25157E+09	.11812E+08	.14438E+08	.26250E+08	.27782E+09	.50699E+08
.52000E+03	.25048E+09	.11754E+08	.14438E+08	.26192E+08	.27668E+09	.51469E+08
.53000E+03	.24943E+09	.11697E+08	.14438E+08	.26135E+08	.27557E+09	.52236E+08
.54000E+03	.24841E+09	.11639E+08	.14438E+08	.26077E+08	.27449E+09	.53000E+08
.55000E+03	.24743E+09	.11582E+08	.14438E+08	.26020E+08	.27345E+09	.53761E+08
.56000E+03	.24647E+09	.11526E+08	.14438E+08	.25963E+08	.27243E+09	.54519E+08
.57000E+03	.24554E+09	.11469E+08	.14438E+08	.25907E+08	.27145E+09	.55275E+08
.58000E+03	.24464E+09	.11413E+08	.14437E+08	.25850E+08	.27049E+09	.56027E+08
.59000E+03	.24377E+09	.11357E+08	.14437E+08	.25794E+08	.26956E+09	.56777E+08
.60000E+03	.24292E+09	.11301E+08	.14437E+08	.25739E+08	.26865E+09	.57525E+08
.61000E+03	.24209E+09	.11246E+08	.14437E+08	.25683E+08	.26777E+09	.58270E+08
.62000E+03	.24128E+09	.11191E+08	.14437E+08	.25628E+08	.26691E+09	.59013E+08
.63000E+03	.24049E+09	.11136E+08	.14437E+08	.25573E+08	.26607E+09	.59753E+08
.64000E+03	.23973E+09	.11082E+08	.14437E+08	.25518E+08	.26525E+09	.60491E+08
.65000E+03	.23898E+09	.11027E+08	.14437E+08	.25464E+08	.26444E+09	.61226E+08
.66000E+03	.23825E+09	.10973E+08	.14436E+08	.25410E+08	.26366E+09	.61960E+08
.67000E+03	.23753E+09	.10920E+08	.14436E+08	.25356E+08	.26289E+09	.62691E+08

TIME (SEC)	FP (BTU/HR)	U-239 (BTU/HR)	NP-239 (BTU/HR)	U239+NP239 (BTU/HR)	TOTAL (BTU/HR)	INTEGRAL (BTU)
.68000E+03	.23683E+09	.10866E+08	.14436E+08	.25302E+08	.26213E+09	.63420E+08
.69000E+03	.23615E+09	.10813E+08	.14436E+08	.25249E+08	.26139E+09	.64148E+08
.70000E+03	.23547E+09	.10760E+08	.14436E+08	.25196E+08	.26067E+09	.64873E+08
.71000E+03	.23482E+09	.10707E+08	.14436E+08	.25143E+08	.25996E+09	.65596E+08
.72000E+03	.23417E+09	.10655E+08	.14436E+08	.25090E+08	.25926E+09	.66317E+08
.73000E+03	.23354E+09	.10603E+08	.14435E+08	.25038E+08	.25857E+09	.67036E+08
.74000E+03	.23291E+09	.10551E+08	.14435E+08	.24986E+08	.25790E+09	.67753E+08
.75000E+03	.23230E+09	.10499E+08	.14435E+08	.24934E+08	.25723E+09	.68469E+08
.76000E+03	.23170E+09	.10448E+08	.14435E+08	.24883E+08	.25658E+09	.69182E+08
.77000E+03	.23111E+09	.10396E+08	.14435E+08	.24831E+08	.25594E+09	.69894E+08
.78000E+03	.23052E+09	.10345E+08	.14435E+08	.24780E+08	.25530E+09	.70604E+08
.79000E+03	.22995E+09	.10295E+08	.14435E+08	.24729E+08	.25468E+09	.71313E+08
.80000E+03	.22938E+09	.10244E+08	.14434E+08	.24679E+08	.25406E+09	.72019E+08
.81000E+03	.22883E+09	.10194E+08	.14434E+08	.24628E+08	.25345E+09	.72724E+08
.82000E+03	.22828E+09	.10144E+08	.14434E+08	.24578E+08	.25285E+09	.73427E+08
.83000E+03	.22773E+09	.10095E+08	.14434E+08	.24528E+08	.25226E+09	.74129E+08
.84000E+03	.22720E+09	.10045E+08	.14434E+08	.24479E+08	.25167E+09	.74829E+08
.85000E+03	.22667E+09	.99959E+07	.14434E+08	.24429E+08	.25110E+09	.75527E+08
.86000E+03	.22614E+09	.99470E+07	.14433E+08	.24380E+08	.25052E+09	.76224E+08
.87000E+03	.22563E+09	.98983E+07	.14433E+08	.24331E+08	.24996E+09	.76919E+08
.88000E+03	.22512E+09	.98498E+07	.14433E+08	.24283E+08	.24940E+09	.77612E+08
.89000E+03	.22461E+09	.98015E+07	.14433E+08	.24234E+08	.24884E+09	.78304E+08
.90000E+03	.22411E+09	.97535E+07	.14433E+08	.24186E+08	.24830E+09	.78995E+08
.91000E+03	.22361E+09	.97058E+07	.14433E+08	.24138E+08	.24775E+09	.79684E+08
.92000E+03	.22312E+09	.96582E+07	.14432E+08	.24091E+08	.24721E+09	.80371E+08
.93000E+03	.22264E+09	.96109E+07	.14432E+08	.24043E+08	.24668E+09	.81057E+08
.94000E+03	.22216E+09	.95638E+07	.14432E+08	.23996E+08	.24615E+09	.81742E+08
.95000E+03	.22168E+09	.95170E+07	.14432E+08	.23949E+08	.24563E+09	.82425E+08
.96000E+03	.22121E+09	.94704E+07	.14432E+08	.23902E+08	.24511E+09	.83106E+08
.97000E+03	.22074E+09	.94240E+07	.14431E+08	.23855E+08	.24460E+09	.83787E+08
.98000E+03	.22028E+09	.93778E+07	.14431E+08	.23809E+08	.24409E+09	.84465E+08
.99000E+03	.21982E+09	.93319E+07	.14431E+08	.23763E+08	.24358E+09	.85143E+08
.10000E+04	.21936E+09	.92862E+07	.14431E+08	.23717E+08	.24308E+09	.85819E+08
.11000E+04	.19706E+09	.88413E+07	.14429E+08	.23270E+08	.22033E+09	.92255E+08

TIME (SEC)	FP (BTU/HR)	U-239 (BTU/HR)	NP-239 (BTU/HR)	U239+NP239 (BTU/HR)	TOTAL (BTU/HR)	INTEGRAL (BTU)
.12000E+04	.19329E+09	.84176E+07	.14427E+08	.22844E+08	.21613E+09	.98317E+08
.13000E+04	.18972E+09	.80143E+07	.14425E+08	.22439E+08	.21216E+09	.10427E+09
.14000E+04	.18633E+09	.76303E+07	.14422E+08	.22052E+08	.20838E+09	.11011E+09
.15000E+04	.18309E+09	.72647E+07	.14420E+08	.21684E+08	.20478E+09	.11584E+09
.16000E+04	.18000E+09	.69166E+07	.14417E+08	.21334E+08	.20133E+09	.12148E+09
.17000E+04	.17704E+09	.65852E+07	.14414E+08	.21000E+08	.19804E+09	.12703E+09
.18000E+04	.17421E+09	.62697E+07	.14411E+08	.20681E+08	.19489E+09	.13249E+09
.19000E+04	.17149E+09	.59693E+07	.14409E+08	.20378E+08	.19187E+09	.13786E+09
.20000E+04	.16889E+09	.56833E+07	.14406E+08	.20089E+08	.18898E+09	.14315E+09
.21000E+04	.16640E+09	.54110E+07	.14402E+08	.19813E+08	.18621E+09	.14836E+09
.22000E+04	.16401E+09	.51517E+07	.14399E+08	.19551E+08	.18356E+09	.15350E+09
.23000E+04	.16171E+09	.49049E+07	.14396E+08	.19301E+08	.18101E+09	.15856E+09
.24000E+04	.15951E+09	.46699E+07	.14393E+08	.19062E+08	.17857E+09	.16355E+09
.25000E+04	.15740E+09	.44461E+07	.14389E+08	.18835E+08	.17624E+09	.16848E+09
.26000E+04	.15538E+09	.42331E+07	.14386E+08	.18619E+08	.17400E+09	.17335E+09
.27000E+04	.15343E+09	.40303E+07	.14382E+08	.18412E+08	.17184E+09	.17815E+09
.28000E+04	.15157E+09	.38371E+07	.14378E+08	.18216E+08	.16978E+09	.18290E+09
.29000E+04	.14977E+09	.36533E+07	.14375E+08	.18028E+08	.16780E+09	.18758E+09
.30000E+04	.14805E+09	.34782E+07	.14371E+08	.17849E+08	.16590E+09	.19222E+09
.31000E+04	.14640E+09	.33116E+07	.14367E+08	.17679E+08	.16408E+09	.19680E+09
.32000E+04	.14481E+09	.31529E+07	.14363E+08	.17516E+08	.16232E+09	.20133E+09
.33000E+04	.14328E+09	.30019E+07	.14359E+08	.17361E+08	.16064E+09	.20582E+09
.34000E+04	.14181E+09	.28580E+07	.14356E+08	.17214E+08	.15902E+09	.21026E+09
.35000E+04	.14039E+09	.27211E+07	.14352E+08	.17073E+08	.15747E+09	.21466E+09
.36000E+04	.13903E+09	.25907E+07	.14348E+08	.16938E+08	.15597E+09	.21901E+09
.37000E+04	.13772E+09	.24666E+07	.14343E+08	.16810E+08	.15453E+09	.22332E+09
.38000E+04	.13646E+09	.23484E+07	.14339E+08	.16688E+08	.15315E+09	.22759E+09
.39000E+04	.13525E+09	.22359E+07	.14335E+08	.16571E+08	.15182E+09	.23183E+09
.40000E+04	.13408E+09	.21287E+07	.14331E+08	.16460E+08	.15054E+09	.23603E+09
.41000E+04	.13295E+09	.20267E+07	.14327E+08	.16354E+08	.14930E+09	.24019E+09
.42000E+04	.13186E+09	.19296E+07	.14323E+08	.16252E+08	.14811E+09	.24432E+09
.43000E+04	.13081E+09	.18372E+07	.14318E+08	.16155E+08	.14697E+09	.24842E+09
.44000E+04	.12980E+09	.17491E+07	.14314E+08	.16063E+08	.14586E+09	.25249E+09
.45000E+04	.12882E+09	.16653E+07	.14310E+08	.15975E+08	.14480E+09	.25653E+09

TIME (SEC)	FP (BTU/HR)	U-239 (BTU/HR)	NP-239 (BTU/HR)	U239+NP239 (BTU/HR)	TOTAL (BTU/HR)	INTEGRAL (BTU)
.46000E+04	.12788E+09	.15855E+07	.14305E+08	.15891E+08	.14377E+09	.26054E+09
.47000E+04	.12697E+09	.15096E+07	.14301E+08	.15811E+08	.14278E+09	.26452E+09
.48000E+04	.12609E+09	.14372E+07	.14297E+08	.15734E+08	.14182E+09	.26847E+09
.49000E+04	.12524E+09	.13684E+07	.14292E+08	.15661E+08	.14090E+09	.27239E+09
.50000E+04	.12442E+09	.13028E+07	.14288E+08	.15591E+08	.14001E+09	.27630E+09
.51000E+04	.12362E+09	.12404E+07	.14283E+08	.15524E+08	.13915E+09	.28017E+09
.52000E+04	.12285E+09	.11810E+07	.14279E+08	.15460E+08	.13831E+09	.28403E+09
.53000E+04	.12211E+09	.11244E+07	.14274E+08	.15399E+08	.13751E+09	.28786E+09
.54000E+04	.12138E+09	.10705E+07	.14270E+08	.15340E+08	.13673E+09	.29167E+09
.55000E+04	.12069E+09	.10192E+07	.14265E+08	.15284E+08	.13597E+09	.29545E+09
.56000E+04	.12001E+09	.97038E+06	.14261E+08	.15231E+08	.13524E+09	.29922E+09
.57000E+04	.11935E+09	.92388E+06	.14256E+08	.15180E+08	.13453E+09	.30297E+09
.58000E+04	.11871E+09	.87961E+06	.14252E+08	.15131E+08	.13384E+09	.30669E+09
.59000E+04	.11809E+09	.83747E+06	.14247E+08	.15084E+08	.13318E+09	.31040E+09
.60000E+04	.11749E+09	.79734E+06	.14242E+08	.15040E+08	.13253E+09	.31409E+09
.61000E+04	.11691E+09	.75914E+06	.14238E+08	.14997E+08	.13190E+09	.31777E+09
.62000E+04	.11634E+09	.72276E+06	.14233E+08	.14956E+08	.13129E+09	.32142E+09
.63000E+04	.11579E+09	.68813E+06	.14229E+08	.14917E+08	.13070E+09	.32506E+09
.64000E+04	.11525E+09	.65516E+06	.14224E+08	.14879E+08	.13013E+09	.32868E+09
.65000E+04	.11472E+09	.62377E+06	.14219E+08	.14843E+08	.12957E+09	.33229E+09
.66000E+04	.11422E+09	.59388E+06	.14215E+08	.14809E+08	.12902E+09	.33588E+09
.67000E+04	.11372E+09	.56543E+06	.14210E+08	.14775E+08	.12849E+09	.33946E+09
.68000E+04	.11324E+09	.53834E+06	.14205E+08	.14744E+08	.12798E+09	.34302E+09
.69000E+04	.11276E+09	.51254E+06	.14201E+08	.14713E+08	.12748E+09	.34657E+09
.70000E+04	.11230E+09	.48798E+06	.14196E+08	.14684E+08	.12699E+09	.35010E+09
.71000E+04	.11185E+09	.46460E+06	.14191E+08	.14656E+08	.12651E+09	.35362E+09
.72000E+04	.11142E+09	.44234E+06	.14187E+08	.14629E+08	.12604E+09	.35713E+09
.73000E+04	.11099E+09	.42115E+06	.14182E+08	.14603E+08	.12559E+09	.36063E+09
.74000E+04	.11057E+09	.40097E+06	.14177E+08	.14578E+08	.12515E+09	.36411E+09
.75000E+04	.11016E+09	.38176E+06	.14172E+08	.14554E+08	.12471E+09	.36758E+09
.76000E+04	.10976E+09	.36347E+06	.14168E+08	.14531E+08	.12429E+09	.37104E+09
.77000E+04	.10937E+09	.34605E+06	.14163E+08	.14509E+08	.12388E+09	.37448E+09
.78000E+04	.10898E+09	.32947E+06	.14158E+08	.14488E+08	.12347E+09	.37792E+09
.79000E+04	.10861E+09	.31368E+06	.14154E+08	.14467E+08	.12308E+09	.38134E+09

TIME (SEC)	FP (BTU/HR)	U-239 (BTU/HR)	NP-239 (BTU/HR)	U239+NP239 (BTU/HR)	TOTAL (BTU/HR)	INTEGRAL (BTU)
.80000E+04	.10824E+09	.29865E+06	.14149E+08	.14448E+08	.12269E+09	.38476E+09
.81000E+04	.10788E+09	.28434E+06	.14144E+08	.14428E+08	.12231E+09	.38816E+09
.82000E+04	.10752E+09	.27072E+06	.14139E+08	.14410E+08	.12193E+09	.39155E+09
.83000E+04	.10718E+09	.25775E+06	.14135E+08	.14392E+08	.12157E+09	.39493E+09
.84000E+04	.10684E+09	.24540E+06	.14130E+08	.14375E+08	.12121E+09	.39831E+09
.85000E+04	.10650E+09	.23364E+06	.14125E+08	.14359E+08	.12086E+09	.40167E+09
.86000E+04	.10617E+09	.22245E+06	.14120E+08	.14343E+08	.12052E+09	.40502E+09
.87000E+04	.10585E+09	.21179E+06	.14116E+08	.14328E+08	.12018E+09	.40836E+09
.88000E+04	.10553E+09	.20164E+06	.14111E+08	.14313E+08	.11984E+09	.41170E+09
.89000E+04	.10522E+09	.19198E+06	.14106E+08	.14298E+08	.11952E+09	.41502E+09
.90000E+04	.10491E+09	.18278E+06	.14101E+08	.14284E+08	.11920E+09	.41834E+09
.91000E+04	.10461E+09	.17402E+06	.14097E+08	.14271E+08	.11888E+09	.42164E+09
.92000E+04	.10431E+09	.16568E+06	.14092E+08	.14258E+08	.11857E+09	.42494E+09
.93000E+04	.10402E+09	.15775E+06	.14087E+08	.14245E+08	.11826E+09	.42823E+09
.94000E+04	.10373E+09	.15019E+06	.14082E+08	.14233E+08	.11796E+09	.43151E+09
.95000E+04	.10344E+09	.14299E+06	.14078E+08	.14221E+08	.11766E+09	.43478E+09
.96000E+04	.10316E+09	.13614E+06	.14073E+08	.14209E+08	.11737E+09	.43805E+09
.97000E+04	.10289E+09	.12962E+06	.14068E+08	.14198E+08	.11708E+09	.44131E+09
.98000E+04	.10261E+09	.12341E+06	.14063E+08	.14187E+08	.11680E+09	.44455E+09
.99000E+04	.10234E+09	.11749E+06	.14059E+08	.14176E+08	.11652E+09	.44779E+09
.10000E+05	.10208E+09	.11186E+06	.14054E+08	.14166E+08	.11624E+09	.45103E+09
.11000E+05	.99584E+08	.68462E+05	.14006E+08	.14075E+08	.11366E+09	.48296E+09
.12000E+05	.97336E+08	.41900E+05	.13959E+08	.14001E+08	.11134E+09	.51421E+09
.13000E+05	.95270E+08	.25643E+05	.13911E+08	.13937E+08	.10921E+09	.54484E+09
.14000E+05	.93347E+08	.15694E+05	.13864E+08	.13880E+08	.10723E+09	.57490E+09
.15000E+05	.91541E+08	.96050E+04	.13817E+08	.13827E+08	.10537E+09	.60443E+09
.16000E+05	.89834E+08	.58784E+04	.13770E+08	.13776E+08	.10361E+09	.63345E+09
.17000E+05	.88214E+08	.35977E+04	.13723E+08	.13727E+08	.10194E+09	.66200E+09
.18000E+05	.86673E+08	.22018E+04	.13676E+08	.13679E+08	.10035E+09	.69009E+09
.19000E+05	.85203E+08	.13475E+04	.13630E+08	.13631E+08	.98835E+08	.71776E+09
.20000E+05	.83801E+08	.82472E+03	.13583E+08	.13584E+08	.97385E+08	.74501E+09
.21000E+05	.82460E+08	.50474E+03	.13537E+08	.13538E+08	.95998E+08	.77187E+09
.22000E+05	.81179E+08	.30891E+03	.13491E+08	.13491E+08	.94670E+08	.79835E+09
.23000E+05	.79953E+08	.18906E+03	.13445E+08	.13445E+08	.93398E+08	.82447E+09

TIME (SEC)	FP (BTU/HR)	U-239 (BTU/HR)	NP-239 (BTU/HR)	U239+NP239 (BTU/HR)	TOTAL (BTU/HR)	INTEGRAL (BTU)
.24000E+05	.78779E+08	.11570E+03	.13399E+08	.13400E+08	.92179E+08	.85025E+09
.25000E+05	.77656E+08	.70813E+02	.13354E+08	.13354E+08	.91010E+08	.87569E+09
.26000E+05	.76581E+08	.43338E+02	.13308E+08	.13308E+08	.89889E+08	.90082E+09
.27000E+05	.75551E+08	.26524E+02	.13263E+08	.13263E+08	.88814E+08	.92564E+09
.28000E+05	.74564E+08	.16233E+02	.13218E+08	.13218E+08	.87782E+08	.95016E+09
.29000E+05	.73619E+08	.99348E+01	.13173E+08	.13173E+08	.86792E+08	.97441E+09
.30000E+05	.72713E+08	.60802E+01	.13128E+08	.13128E+08	.85841E+08	.99839E+09
.31000E+05	.71844E+08	.37212E+01	.13083E+08	.13083E+08	.84927E+08	.10221E+10
.32000E+05	.71011E+08	.22774E+01	.13039E+08	.13039E+08	.84050E+08	.10456E+10
.33000E+05	.70212E+08	.13938E+01	.12995E+08	.12995E+08	.83207E+08	.10688E+10
.34000E+05	.69446E+08	.85303E+00	.12950E+08	.12950E+08	.82396E+08	.10918E+10
.35000E+05	.68711E+08	.52207E+00	.12906E+08	.12906E+08	.81617E+08	.11146E+10
.36000E+05	.68005E+08	.31951E+00	.12862E+08	.12862E+08	.80867E+08	.11372E+10
.37000E+05	.67327E+08	.19555E+00	.12818E+08	.12818E+08	.80146E+08	.11595E+10
.38000E+05	.66677E+08	.11968E+00	.12775E+08	.12775E+08	.79451E+08	.11817E+10
.39000E+05	.66052E+08	.73244E-01	.12731E+08	.12731E+08	.78783E+08	.12037E+10
.40000E+05	.65451E+08	.44826E-01	.12688E+08	.12688E+08	.78139E+08	.12255E+10
.41000E+05	.64874E+08	.27434E-01	.12645E+08	.12645E+08	.77519E+08	.12471E+10
.42000E+05	.64319E+08	.16790E-01	.12602E+08	.12602E+08	.76921E+08	.12685E+10
.43000E+05	.63785E+08	.10276E-01	.12559E+08	.12559E+08	.76344E+08	.12898E+10
.44000E+05	.63272E+08	.62890E-02	.12516E+08	.12516E+08	.75788E+08	.13109E+10
.45000E+05	.62778E+08	.38489E-02	.12473E+08	.12473E+08	.75252E+08	.13319E+10
.46000E+05	.62303E+08	.23556E-02	.12431E+08	.12431E+08	.74734E+08	.13527E+10
.47000E+05	.61845E+08	.14417E-02	.12389E+08	.12389E+08	.74233E+08	.13734E+10
.48000E+05	.61404E+08	.88232E-03	.12347E+08	.12347E+08	.73750E+08	.13940E+10
.49000E+05	.60979E+08	.53999E-03	.12305E+08	.12305E+08	.73283E+08	.14144E+10
.50000E+05	.60569E+08	.33048E-03	.12263E+08	.12263E+08	.72832E+08	.14347E+10
.51000E+05	.60174E+08	.20226E-03	.12221E+08	.12221E+08	.72395E+08	.14549E+10
.52000E+05	.59793E+08	.12379E-03	.12179E+08	.12179E+08	.71972E+08	.14749E+10
.53000E+05	.59425E+08	.75758E-04	.12138E+08	.12138E+08	.71563E+08	.14949E+10
.54000E+05	.59070E+08	.46365E-04	.12097E+08	.12097E+08	.71166E+08	.15147E+10
.55000E+05	.58727E+08	.28376E-04	.12055E+08	.12055E+08	.70782E+08	.15344E+10
.56000E+05	.58396E+08	.17367E-04	.12014E+08	.12014E+08	.70410E+08	.15540E+10
.57000E+05	.58075E+08	.10629E-04	.11973E+08	.11973E+08	.70049E+08	.15735E+10

TIME (SEC)	FP (BTU/HR)	U-239 (BTU/HR)	NP-239 (BTU/HR)	U239+NP239 (BTU/HR)	TOTAL (BTU/HR)	INTEGRAL (BTU)
.58000E+05	.57766E+08	.65049E-05	.11933E+08	.11933E+08	.69698E+08	.15929E+10
.59000E+05	.57466E+08	.39811E-05	.11892E+08	.11892E+08	.69358E+08	.16122E+10
.60000E+05	.57176E+08	.24365E-05	.11852E+08	.11852E+08	.69028E+08	.16315E+10
.61000E+05	.56896E+08	.14912E-05	.11811E+08	.11811E+08	.68707E+08	.16506E+10
.62000E+05	.56624E+08	.91261E-06	.11771E+08	.11771E+08	.68395E+08	.16696E+10
.63000E+05	.56360E+08	.55853E-06	.11731E+08	.11731E+08	.68091E+08	.16886E+10
.64000E+05	.56105E+08	.34183E-06	.11691E+08	.11691E+08	.67796E+08	.17075E+10
.65000E+05	.55857E+08	.20920E-06	.11651E+08	.11651E+08	.67508E+08	.17263E+10
.66000E+05	.55616E+08	.12803E-06	.11612E+08	.11612E+08	.67228E+08	.17450E+10
.67000E+05	.55383E+08	.78359E-07	.11572E+08	.11572E+08	.66955E+08	.17636E+10
.68000E+05	.55156E+08	.47957E-07	.11533E+08	.11533E+08	.66689E+08	.17822E+10
.69000E+05	.54936E+08	.29350E-07	.11493E+08	.11493E+08	.66429E+08	.18007E+10
.70000E+05	.54722E+08	.17963E-07	.11454E+08	.11454E+08	.66176E+08	.18191E+10
.71000E+05	.54514E+08	.10994E-07	.11415E+08	.11415E+08	.65929E+08	.18374E+10
.72000E+05	.54311E+08	.67282E-08	.11376E+08	.11376E+08	.65687E+08	.18557E+10
.73000E+05	.54114E+08	.41177E-08	.11338E+08	.11338E+08	.65451E+08	.18739E+10
.74000E+05	.53921E+08	.25201E-08	.11299E+08	.11299E+08	.65220E+08	.18921E+10
.75000E+05	.53734E+08	.15423E-08	.11261E+08	.11261E+08	.64995E+08	.19101E+10
.76000E+05	.53552E+08	.94394E-09	.11222E+08	.11222E+08	.64774E+08	.19282E+10
.77000E+05	.53373E+08	.57770E-09	.11184E+08	.11184E+08	.64557E+08	.19461E+10
.78000E+05	.53200E+08	.35356E-09	.11146E+08	.11146E+08	.64346E+08	.19640E+10
.79000E+05	.53030E+08	.21638E-09	.11108E+08	.11108E+08	.64138E+08	.19819E+10
.80000E+05	.52864E+08	.13243E-09	.11070E+08	.11070E+08	.63934E+08	.19997E+10
.81000E+05	.52702E+08	.81050E-10	.11033E+08	.11033E+08	.63735E+08	.20174E+10
.82000E+05	.52544E+08	.49603E-10	.10995E+08	.10995E+08	.63539E+08	.20351E+10
.83000E+05	.52389E+08	.30358E-10	.10958E+08	.10958E+08	.63347E+08	.20527E+10
.84000E+05	.52238E+08	.18580E-10	.10920E+08	.10920E+08	.63158E+08	.20703E+10
.85000E+05	.52089E+08	.11371E-10	.10883E+08	.10883E+08	.62973E+08	.20878E+10
.86000E+05	.51944E+08	.69592E-11	.10846E+08	.10846E+08	.62790E+08	.21053E+10
.87000E+05	.51802E+08	.42591E-11	.10809E+08	.10809E+08	.62611E+08	.21227E+10
.88000E+05	.51662E+08	.26066E-11	.10772E+08	.10772E+08	.62435E+08	.21400E+10
.89000E+05	.51526E+08	.15953E-11	.10736E+08	.10736E+08	.62261E+08	.21574E+10
.90000E+05	.51391E+08	.97634E-12	.10699E+08	.10699E+08	.62091E+08	.21746E+10
.91000E+05	.51260E+08	.59754E-12	.10663E+08	.10663E+08	.61922E+08	.21919E+10

TIME (SEC)	FP (BTU/HR)	U-239 (BTU/HR)	NP-239 (BTU/HR)	U239+NP239 (BTU/HR)	TOTAL (BTU/HR)	INTEGRAL (BTU)
.92000E+05	.51130E+08	.36570E-12	.10626E+08	.10626E+08	.61757E+08	.22090E+10
.93000E+05	.51003E+08	.22381E-12	.10590E+08	.10590E+08	.61594E+08	.22262E+10
.94000E+05	.50879E+08	.13698E-12	.10554E+08	.10554E+08	.61433E+08	.22433E+10
.95000E+05	.50756E+08	.83832E-13	.10518E+08	.10518E+08	.61274E+08	.22603E+10
.96000E+05	.50635E+08	.51306E-13	.10482E+08	.10482E+08	.61118E+08	.22773E+10
.97000E+05	.50517E+08	.31400E-13	.10447E+08	.10447E+08	.60963E+08	.22942E+10
.98000E+05	.50400E+08	.19217E-13	.10411E+08	.10411E+08	.60811E+08	.23112E+10
.99000E+05	.50285E+08	.11761E-13	.10376E+08	.10376E+08	.60660E+08	.23280E+10
.10000E+06	.50172E+08	.71981E-14	.10340E+08	.10340E+08	.60512E+08	.23449E+10
.11000E+06	.49122E+08	.53068E-16	.99937E+07	.99937E+07	.59116E+08	.25110E+10
.12000E+06	.48192E+08	.39124E-18	.96587E+07	.96587E+07	.57851E+08	.26735E+10
.13000E+06	.47348E+08	.28844E-20	.93349E+07	.93349E+07	.56683E+08	.28325E+10
.14000E+06	.46570E+08	.21265E-22	.90219E+07	.90219E+07	.55591E+08	.29885E+10
.15000E+06	.45843E+08	.15678E-24	.87194E+07	.87194E+07	.54563E+08	.31415E+10
.16000E+06	.45160E+08	.11558E-26	.84271E+07	.84271E+07	.53587E+08	.32917E+10
.17000E+06	.44514E+08	.85215E-29	.81446E+07	.81446E+07	.52659E+08	.34392E+10
.18000E+06	.43901E+08	.62824E-31	.78716E+07	.78716E+07	.51773E+08	.35843E+10
.19000E+06	.43318E+08	.46317E-33	.76077E+07	.76077E+07	.50925E+08	.37269E+10
.20000E+06	.42761E+08	.34232E-35	.73526E+07	.73526E+07	.50114E+08	.38673E+10
.21000E+06	.42230E+08	.21262E-37	.71061E+07	.71061E+07	.49337E+08	.40054E+10
.22000E+06	.41723E+08	.00000E+00	.68679E+07	.68679E+07	.48591E+08	.41414E+10
.23000E+06	.41238E+08	.00000E+00	.66376E+07	.66376E+07	.47876E+08	.42754E+10
.24000E+06	.40774E+08	.00000E+00	.64151E+07	.64151E+07	.47189E+08	.44074E+10
.25000E+06	.40329E+08	.00000E+00	.62000E+07	.62000E+07	.46529E+08	.45376E+10
.26000E+06	.39904E+08	.00000E+00	.59922E+07	.59922E+07	.45896E+08	.46659E+10
.27000E+06	.39496E+08	.00000E+00	.57913E+07	.57913E+07	.45287E+08	.47926E+10
.28000E+06	.39104E+08	.00000E+00	.55971E+07	.55971E+07	.44702E+08	.49176E+10
.29000E+06	.38729E+08	.00000E+00	.54095E+07	.54095E+07	.44139E+08	.50410E+10
.30000E+06	.38369E+08	.00000E+00	.52281E+07	.52281E+07	.43597E+08	.51628E+10
.31000E+06	.38024E+08	.00000E+00	.50529E+07	.50529E+07	.43076E+08	.52832E+10
.32000E+06	.37692E+08	.00000E+00	.48835E+07	.48835E+07	.42575E+08	.54021E+10
.33000E+06	.37373E+08	.00000E+00	.47198E+07	.47198E+07	.42092E+08	.55197E+10
.34000E+06	.37066E+08	.00000E+00	.45615E+07	.45615E+07	.41627E+08	.56360E+10
.35000E+06	.36771E+08	.00000E+00	.44086E+07	.44086E+07	.41179E+08	.57510E+10

TIME (SEC)	FP (BTU/HR)	U-239 (BTU/HR)	NP-239 (BTU/HR)	U239+NP239 (BTU/HR)	TOTAL (BTU/HR)	INTEGRAL (BTU)
.36000E+06	.36487E+08	.00000E+00	.42608E+07	.42608E+07	.40748E+08	.58648E+10
.37000E+06	.36213E+08	.00000E+00	.41180E+07	.41180E+07	.40331E+08	.59774E+10
.38000E+06	.35950E+08	.00000E+00	.39799E+07	.39799E+07	.39930E+08	.60889E+10
.39000E+06	.35696E+08	.00000E+00	.38465E+07	.38465E+07	.39543E+08	.61993E+10
.40000E+06	.35451E+08	.00000E+00	.37175E+07	.37175E+07	.39169E+08	.63086E+10
.41000E+06	.35215E+08	.00000E+00	.35929E+07	.35929E+07	.38808E+08	.64169E+10
.42000E+06	.34987E+08	.00000E+00	.34724E+07	.34724E+07	.38460E+08	.65242E+10
.43000E+06	.34767E+08	.00000E+00	.33560E+07	.33560E+07	.38123E+08	.66306E+10
.44000E+06	.34554E+08	.00000E+00	.32435E+07	.32435E+07	.37797E+08	.67360E+10
.45000E+06	.34348E+08	.00000E+00	.31348E+07	.31348E+07	.37483E+08	.68406E+10
.46000E+06	.34149E+08	.00000E+00	.30297E+07	.30297E+07	.37178E+08	.69443E+10
.47000E+06	.33956E+08	.00000E+00	.29281E+07	.29281E+07	.36884E+08	.70471E+10
.48000E+06	.33769E+08	.00000E+00	.28299E+07	.28299E+07	.36599E+08	.71492E+10
.49000E+06	.33588E+08	.00000E+00	.27351E+07	.27351E+07	.36323E+08	.72505E+10
.50000E+06	.33412E+08	.00000E+00	.26434E+07	.26434E+07	.36056E+08	.73510E+10
.51000E+06	.33242E+08	.00000E+00	.25548E+07	.25548E+07	.35797E+08	.74508E+10
.52000E+06	.33076E+08	.00000E+00	.24691E+07	.24691E+07	.35545E+08	.75499E+10
.53000E+06	.32916E+08	.00000E+00	.23863E+07	.23863E+07	.35302E+08	.76483E+10
.54000E+06	.32759E+08	.00000E+00	.23063E+07	.23063E+07	.35066E+08	.77460E+10
.55000E+06	.32607E+08	.00000E+00	.22290E+07	.22290E+07	.34836E+08	.78431E+10
.56000E+06	.32459E+08	.00000E+00	.21543E+07	.21543E+07	.34614E+08	.79396E+10
.57000E+06	.32315E+08	.00000E+00	.20821E+07	.20821E+07	.34397E+08	.80354E+10
.58000E+06	.32175E+08	.00000E+00	.20123E+07	.20123E+07	.34187E+08	.81307E+10
.59000E+06	.32038E+08	.00000E+00	.19448E+07	.19448E+07	.33983E+08	.82254E+10
.60000E+06	.31905E+08	.00000E+00	.18796E+07	.18796E+07	.33784E+08	.83195E+10
.61000E+06	.31774E+08	.00000E+00	.18166E+07	.18166E+07	.33591E+08	.84130E+10
.62000E+06	.31647E+08	.00000E+00	.17557E+07	.17557E+07	.33403E+08	.85061E+10
.63000E+06	.31523E+08	.00000E+00	.16968E+07	.16968E+07	.33219E+08	.85986E+10
.64000E+06	.31401E+08	.00000E+00	.16399E+07	.16399E+07	.33041E+08	.86907E+10
.65000E+06	.31282E+08	.00000E+00	.15850E+07	.15850E+07	.32867E+08	.87822E+10
.66000E+06	.31166E+08	.00000E+00	.15318E+07	.15318E+07	.32698E+08	.88733E+10
.67000E+06	.31052E+08	.00000E+00	.14805E+07	.14805E+07	.32532E+08	.89639E+10
.68000E+06	.30940E+08	.00000E+00	.14308E+07	.14308E+07	.32371E+08	.90540E+10
.69000E+06	.30831E+08	.00000E+00	.13829E+07	.13829E+07	.32214E+08	.91437E+10

TIME (SEC)	FP (BTU/HR)	U-239 (BTU/HR)	NP-239 (BTU/HR)	U239+NP239 (BTU/HR)	TOTAL (BTU/HR)	INTEGRAL (BTU)
.70000E+06	.30724E+08	.00000E+00	.13365E+07	.13365E+07	.32060E+08	.92330E+10
.71000E+06	.30618E+08	.00000E+00	.12917E+07	.12917E+07	.31910E+08	.93218E+10
.72000E+06	.30515E+08	.00000E+00	.12484E+07	.12484E+07	.31763E+08	.94103E+10
.73000E+06	.30414E+08	.00000E+00	.12065E+07	.12065E+07	.31620E+08	.94983E+10
.74000E+06	.30314E+08	.00000E+00	.11661E+07	.11661E+07	.31480E+08	.95859E+10
.75000E+06	.30216E+08	.00000E+00	.11270E+07	.11270E+07	.31343E+08	.96732E+10
.76000E+06	.30119E+08	.00000E+00	.10892E+07	.10892E+07	.31209E+08	.97601E+10
.77000E+06	.30025E+08	.00000E+00	.10527E+07	.10527E+07	.31077E+08	.98466E+10
.78000E+06	.29931E+08	.00000E+00	.10174E+07	.10174E+07	.30949E+08	.99327E+10
.79000E+06	.29839E+08	.00000E+00	.98330E+06	.98330E+06	.30823E+08	.10019E+11
.80000E+06	.29749E+08	.00000E+00	.95033E+06	.95033E+06	.30699E+08	.10104E+11
.81000E+06	.29660E+08	.00000E+00	.91847E+06	.91847E+06	.30578E+08	.10189E+11
.82000E+06	.29572E+08	.00000E+00	.88768E+06	.88768E+06	.30459E+08	.10274E+11
.83000E+06	.29485E+08	.00000E+00	.85792E+06	.85792E+06	.30343E+08	.10358E+11
.84000E+06	.29400E+08	.00000E+00	.82916E+06	.82916E+06	.30229E+08	.10442E+11
.85000E+06	.29315E+08	.00000E+00	.80136E+06	.80136E+06	.30117E+08	.10526E+11
.86000E+06	.29232E+08	.00000E+00	.77450E+06	.77450E+06	.30006E+08	.10610E+11
.87000E+06	.29150E+08	.00000E+00	.74853E+06	.74853E+06	.29898E+08	.10693E+11
.88000E+06	.29068E+08	.00000E+00	.72344E+06	.72344E+06	.29792E+08	.10776E+11
.89000E+06	.28988E+08	.00000E+00	.69918E+06	.69918E+06	.29687E+08	.10858E+11
.90000E+06	.28909E+08	.00000E+00	.67574E+06	.67574E+06	.29585E+08	.10941E+11
.91000E+06	.28830E+08	.00000E+00	.65309E+06	.65309E+06	.29483E+08	.11023E+11
.92000E+06	.28753E+08	.00000E+00	.63119E+06	.63119E+06	.29384E+08	.11105E+11
.93000E+06	.28676E+08	.00000E+00	.61003E+06	.61003E+06	.29286E+08	.11186E+11
.94000E+06	.28600E+08	.00000E+00	.58958E+06	.58958E+06	.29190E+08	.11267E+11
.95000E+06	.28525E+08	.00000E+00	.56981E+06	.56981E+06	.29095E+08	.11348E+11
.96000E+06	.28451E+08	.00000E+00	.55071E+06	.55071E+06	.29002E+08	.11429E+11
.97000E+06	.28377E+08	.00000E+00	.53225E+06	.53225E+06	.28909E+08	.11509E+11
.98000E+06	.28304E+08	.00000E+00	.51441E+06	.51441E+06	.28819E+08	.11590E+11
.99000E+06	.28232E+08	.00000E+00	.49716E+06	.49716E+06	.28729E+08	.11669E+11
.10000E+07	.28161E+08	.00000E+00	.48049E+06	.48049E+06	.28641E+08	.11749E+11
.11000E+07	.27479E+08	.00000E+00	.34166E+06	.34166E+06	.27821E+08	.12533E+11
.12000E+07	.26848E+08	.00000E+00	.24294E+06	.24294E+06	.27091E+08	.13296E+11
.13000E+07	.26257E+08	.00000E+00	.17274E+06	.17274E+06	.26430E+08	.14039E+11

TIME (SEC)	FP (BTU/HR)	U-239 (BTU/HR)	NP-239 (BTU/HR)	U239+NP239 (BTU/HR)	TOTAL (BTU/HR)	INTEGRAL (BTU)
.14000E+07	.25701E+08	.00000E+00	.12283E+06	.12283E+06	.25824E+08	.14765E+11
.15000E+07	.25175E+08	.00000E+00	.87340E+05	.87340E+05	.25262E+08	.15475E+11
.16000E+07	.24676E+08	.00000E+00	.62104E+05	.62104E+05	.24738E+08	.16169E+11
.17000E+07	.24201E+08	.00000E+00	.44160E+05	.44160E+05	.24245E+08	.16849E+11
.18000E+07	.23749E+08	.00000E+00	.31400E+05	.31400E+05	.23781E+08	.17516E+11
.19000E+07	.23319E+08	.00000E+00	.22327E+05	.22327E+05	.23341E+08	.18171E+11
.20000E+07	.22909E+08	.00000E+00	.15876E+05	.15876E+05	.22924E+08	.18813E+11
.21000E+07	.22517E+08	.00000E+00	.11289E+05	.11289E+05	.22528E+08	.19445E+11
.22000E+07	.22143E+08	.00000E+00	.80270E+04	.80270E+04	.22151E+08	.20065E+11
.23000E+07	.21786E+08	.00000E+00	.57077E+04	.57077E+04	.21792E+08	.20676E+11
.24000E+07	.21445E+08	.00000E+00	.40585E+04	.40585E+04	.21449E+08	.21276E+11
.25000E+07	.21119E+08	.00000E+00	.28858E+04	.28858E+04	.21122E+08	.21867E+11
.26000E+07	.20807E+08	.00000E+00	.20520E+04	.20520E+04	.20809E+08	.22450E+11
.27000E+07	.20509E+08	.00000E+00	.14591E+04	.14591E+04	.20510E+08	.23024E+11
.28000E+07	.20223E+08	.00000E+00	.10375E+04	.10375E+04	.20224E+08	.23589E+11
.29000E+07	.19950E+08	.00000E+00	.73772E+03	.73772E+03	.19951E+08	.24147E+11
.30000E+07	.19688E+08	.00000E+00	.52456E+03	.52456E+03	.19688E+08	.24698E+11
.31000E+07	.19436E+08	.00000E+00	.37300E+03	.37300E+03	.19437E+08	.25241E+11
.32000E+07	.19195E+08	.00000E+00	.26522E+03	.26522E+03	.19195E+08	.25778E+11
.33000E+07	.18964E+08	.00000E+00	.18859E+03	.18859E+03	.18964E+08	.26308E+11
.34000E+07	.18742E+08	.00000E+00	.13410E+03	.13410E+03	.18742E+08	.26832E+11
.35000E+07	.18528E+08	.00000E+00	.95351E+02	.95351E+02	.18528E+08	.27349E+11
.36000E+07	.18323E+08	.00000E+00	.67800E+02	.67800E+02	.18323E+08	.27861E+11
.37000E+07	.18126E+08	.00000E+00	.48210E+02	.48210E+02	.18126E+08	.28367E+11
.38000E+07	.17936E+08	.00000E+00	.34280E+02	.34280E+02	.17936E+08	.28868E+11
.39000E+07	.17753E+08	.00000E+00	.24375E+02	.24375E+02	.17753E+08	.29364E+11
.40000E+07	.17577E+08	.00000E+00	.17332E+02	.17332E+02	.17577E+08	.29855E+11
.41000E+07	.17408E+08	.00000E+00	.12324E+02	.12324E+02	.17408E+08	.30340E+11
.42000E+07	.17244E+08	.00000E+00	.87632E+01	.87632E+01	.17244E+08	.30822E+11
.43000E+07	.17086E+08	.00000E+00	.62312E+01	.62312E+01	.17086E+08	.31299E+11
.44000E+07	.16934E+08	.00000E+00	.44307E+01	.44307E+01	.16934E+08	.31771E+11
.45000E+07	.16786E+08	.00000E+00	.31505E+01	.31505E+01	.16786E+08	.32239E+11
.46000E+07	.16644E+08	.00000E+00	.22402E+01	.22402E+01	.16644E+08	.32704E+11
.47000E+07	.16506E+08	.00000E+00	.15929E+01	.15929E+01	.16506E+08	.33164E+11

TIME (SEC)	FP (BTU/HR)	U-239 (BTU/HR)	NP-239 (BTU/HR)	U239+NP239 (BTU/HR)	TOTAL (BTU/HR)	INTEGRAL (BTU)
.48000E+07	.16373E+08	.00000E+00	.11327E+01	.11327E+01	.16373E+08	.33621E+11
.49000E+07	.16244E+08	.00000E+00	.80539E+00	.80539E+00	.16244E+08	.34074E+11
.50000E+07	.16119E+08	.00000E+00	.57268E+00	.57268E+00	.16119E+08	.34523E+11
.51000E+07	.15997E+08	.00000E+00	.40721E+00	.40721E+00	.15997E+08	.34969E+11
.52000E+07	.15880E+08	.00000E+00	.28955E+00	.28955E+00	.15880E+08	.35412E+11
.53000E+07	.15766E+08	.00000E+00	.20589E+00	.20589E+00	.15766E+08	.35852E+11
.54000E+07	.15655E+08	.00000E+00	.14640E+00	.14640E+00	.15655E+08	.36288E+11
.55000E+07	.15547E+08	.00000E+00	.10410E+00	.10410E+00	.15547E+08	.36721E+11
.56000E+07	.15443E+08	.00000E+00	.74019E-01	.74019E-01	.15443E+08	.37152E+11
.57000E+07	.15341E+08	.00000E+00	.52632E-01	.52632E-01	.15341E+08	.37579E+11
.58000E+07	.15241E+08	.00000E+00	.37424E-01	.37424E-01	.15241E+08	.38004E+11
.59000E+07	.15145E+08	.00000E+00	.26611E-01	.26611E-01	.15145E+08	.38426E+11
.60000E+07	.15051E+08	.00000E+00	.18922E-01	.18922E-01	.15051E+08	.38845E+11
.61000E+07	.14959E+08	.00000E+00	.13455E-01	.13455E-01	.14959E+08	.39262E+11
.62000E+07	.14870E+08	.00000E+00	.95670E-02	.95670E-02	.14870E+08	.39677E+11
.63000E+07	.14782E+08	.00000E+00	.68027E-02	.68027E-02	.14782E+08	.40088E+11
.64000E+07	.14697E+08	.00000E+00	.48371E-02	.48371E-02	.14697E+08	.40498E+11
.65000E+07	.14614E+08	.00000E+00	.34395E-02	.34395E-02	.14614E+08	.40905E+11
.66000E+07	.14532E+08	.00000E+00	.24457E-02	.24457E-02	.14532E+08	.41310E+11
.67000E+07	.14453E+08	.00000E+00	.17390E-02	.17390E-02	.14453E+08	.41712E+11
.68000E+07	.14375E+08	.00000E+00	.12365E-02	.12365E-02	.14375E+08	.42113E+11
.69000E+07	.14299E+08	.00000E+00	.87926E-03	.87926E-03	.14299E+08	.42511E+11
.70000E+07	.14224E+08	.00000E+00	.62520E-03	.62520E-03	.14224E+08	.42907E+11
.71000E+07	.14151E+08	.00000E+00	.44456E-03	.44456E-03	.14151E+08	.43301E+11
.72000E+07	.14079E+08	.00000E+00	.31611E-03	.31611E-03	.14079E+08	.43693E+11
.73000E+07	.14009E+08	.00000E+00	.22477E-03	.22477E-03	.14009E+08	.44083E+11
.74000E+07	.13940E+08	.00000E+00	.15982E-03	.15982E-03	.13940E+08	.44472E+11
.75000E+07	.13873E+08	.00000E+00	.11364E-03	.11364E-03	.13873E+08	.44858E+11
.76000E+07	.13806E+08	.00000E+00	.80808E-04	.80808E-04	.13806E+08	.45242E+11
.77000E+07	.13741E+08	.00000E+00	.57459E-04	.57459E-04	.13741E+08	.45625E+11
.78000E+07	.13677E+08	.00000E+00	.40857E-04	.40857E-04	.13677E+08	.46006E+11
.79000E+07	.13614E+08	.00000E+00	.29052E-04	.29052E-04	.13614E+08	.46385E+11
.80000E+07	.13552E+08	.00000E+00	.20657E-04	.20657E-04	.13552E+08	.46762E+11
.81000E+07	.13491E+08	.00000E+00	.14689E-04	.14689E-04	.13491E+08	.47138E+11

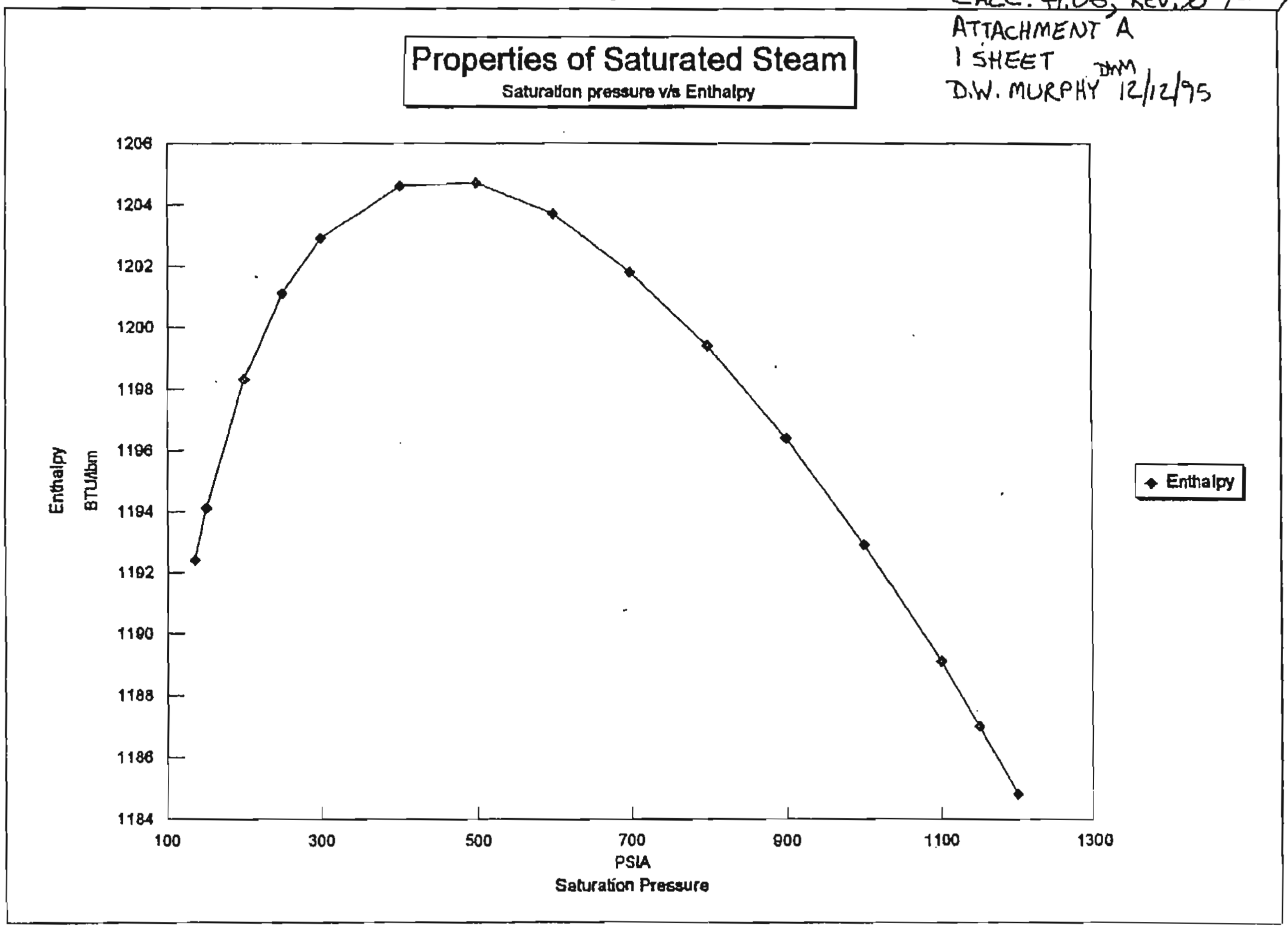
TIME (SEC)	FP (BTU/HR)	U-239 (BTU/HR)	NP-239 (BTU/HR)	U239+NP239 (BTU/HR)	TOTAL (BTU/HR)	INTEGRAL (BTU)
.82000E+07	.13432E+08	.00000E+00	.10445E-04	.10445E-04	.13432E+08	.47512E+11
.83000E+07	.13373E+08	.00000E+00	.74267E-05	.74267E-05	.13373E+08	.47884E+11
.84000E+07	.13315E+08	.00000E+00	.52808E-05	.52808E-05	.13315E+08	.48255E+11
.85000E+07	.13258E+08	.00000E+00	.37550E-05	.37550E-05	.13258E+08	.48624E+11
.86000E+07	.13201E+08	.00000E+00	.26700E-05	.26700E-05	.13201E+08	.48991E+11
.87000E+07	.13146E+08	.00000E+00	.18985E-05	.18985E-05	.13146E+08	.49357E+11
.88000E+07	.13091E+08	.00000E+00	.13500E-05	.13500E-05	.13091E+08	.49721E+11
.89000E+07	.13038E+08	.00000E+00	.95990E-06	.95990E-06	.13038E+08	.50084E+11
.90000E+07	.12985E+08	.00000E+00	.68255E-06	.68255E-06	.12985E+08	.50446E+11
.91000E+07	.12932E+08	.00000E+00	.48533E-06	.48533E-06	.12932E+08	.50806E+11
.92000E+07	.12881E+08	.00000E+00	.34510E-06	.34510E-06	.12881E+08	.51164E+11
.93000E+07	.12830E+08	.00000E+00	.24539E-06	.24539E-06	.12830E+08	.51521E+11
.94000E+07	.12780E+08	.00000E+00	.17448E-06	.17448E-06	.12780E+08	.51877E+11
.95000E+07	.12730E+08	.00000E+00	.12407E-06	.12407E-06	.12730E+08	.52231E+11
.96000E+07	.12681E+08	.00000E+00	.88220E-07	.88220E-07	.12681E+08	.52584E+11
.97000E+07	.12633E+08	.00000E+00	.62730E-07	.62730E-07	.12633E+08	.52936E+11
.98000E+07	.12585E+08	.00000E+00	.44604E-07	.44604E-07	.12585E+08	.53286E+11
.99000E+07	.12538E+08	.00000E+00	.31716E-07	.31716E-07	.12538E+08	.53635E+11
.10000E+08	.12491E+08	.00000E+00	.22552E-07	.22552E-07	.12491E+08	.53983E+11

Attachment "A" Sheet 1 of 1

FNP Units 1 & 2

Calculation No. BM-95-0961-001, Rev. 6

CALC. 41.06, REV. 4 AVP 3/2/99
ATTACHMENT A
1 SHEET
D.W. MURPHY DWM 12/12/95



file - c:\...ao\enthalpy.wk4

Jennings, Willie J.

From: Nesbit, Thomas H.
Sent: Wednesday, June 27, 2012 4:32 PM
To: Jennings, Willie J.
Cc: Williams, Clarence Daniel; Isler, Jerry Lee
Subject: RE: CST Sizing Verification - MSLB and MFWLB Events (Mass Flow Question)

Willie,

We ran simulator scenarios this morning, but I've been on a teleconference all day since. All scenarios were done with a three man crew and intentionally done at a slow pace to bias the timeline towards a longer completion. There were no complicating failures.

The first scenario was a 12 mpph (million pounds mass per hour) MSLB in 1B SG upstream of the MSIVs with RCPs in service. The time line was as follows:

07:37:30 Event start (MSIVs automatically close)
07:42:00 AFW isolated to 1B SG per early action request by UO
07:43:00 EEP-0 steps 8 & 9 reached (these steps direct the actions which the UO performed at 07:42:00)
07:46:30 Transition from EEP-0 to EEP-2
07:53:00 Final 1B SG isolation complete per EEP-2

The second scenario was a 20 mpph MFWLB inside CTMT with RCPs in service. The time line was as follows:

08:02:00 Event start (MSIVS automatically close; automatic SI occurs during EEP-0 immediate actions requiring longer time for completion)
08:08:00 AFW isolated to 1B SG per EEP-0 (early UO action intentionally not allowed)
08:10:00 Transition from EEP-0 to EEP-2
08:16:00 Final 1B SG isolation complete per EEP-2

I was not able to talk to you this morning before the simulator runs so our break sizes differ from those used in your calculations. Also, I dropped the ball and left the RCPs on during the MFWLB. I don't think that either of these differences would measurably affect the time lines up to AFW isolation to the faulted SG. As you can see, AFW flow to the faulted SG was isolated in 6 minutes or less in each case and there was only ~1 minute difference when early operator action was allowed instead of forcing the crew to wait for procedure direction. Please review these results and let me know if you need more data, but I believe these time lines support a 30 minute time for AFW isolation to the faulted SG as a conservative value. As an aside, the initial total AFW flow rate to all three SGs was ~1100 gpm in each case and the final throttled total AFW flow rate to the two intact SGs was ~180 gpm with essentially stable SG levels and RCS temperature.

Turbo

From: Jennings, Willie J.
Sent: Wednesday, June 27, 2012 10:49 AM
To: Nesbit, Thomas H.
Subject: RE: CST Sizing Verification - MSLB and MFWLB Events (Mass Flow Question)

Thom;

Here's the mass flow rates taken from the AFW flow balance which defines flows to the faulted S?G as well as the intact S/Gs. I've taken these flow in gpm and converted them to mass flow rates at the max. temperature of the CST. I not sure if you should just use the flow to the faulted S/G or flow to all S/Gs. But here is flow to both.

MFWLB: Faulted S/G – 2.47 X 10^5 LBm/Hr.; All S/Gs – 3.25 x 10^5 LBm/Hr. ; the difference is what is flowing to the intact S/Gs.

MSLB w/o LOSP: Faulted S/G – 3.79 x 10^5 LBm/Hr.; All S/Gs – 1.02 x 10^6 Lbm/Hr. ; the difference is what is flowing to the intact S/Gs.

-----Original Appointment-----
From: Nesbit, Thomas H.
Sent: Friday, June 22, 2012 9:30 AM
To: Jennings, Willie J.
Subject: Accepted: CST Sizing Verification - MSLB and MFWLB Events
When: Monday, June 25, 2012 9:30 AM-10:30 AM (GMT-06:00) Central Time (US & Canada).
Where: Conference Call