ENCLOSURE 1

SONGS 1 RCS Inventory Analysis for Station Blackout

Calculation # DC-3601

CALCULATION TITLE PAGE

Sheet 1

SONGS Unit 1 DCP/MMP No. & Rev. N/A Calc. No. DC-3601

Subject SONGS 1 RCS Inventory Analysis for Station Blackout

Engineering System Number N/A Primary Station System Designator RCS Q-Class SR

Tech Spec Effecting ☐ YES ☒ NO Section No. N/A Equipment Tag No. N/A

Computer Program	STANDARD COMPUTER PROGRAM	PROGRAM NO.(S)	VERSION/RELEASE NO.
	☒ YES ☐ NO	RETRAN-02	MOD 004

RECORD OF ISSUES

SCE DISC. or ESC	REV.	DESCRIPTION	TOTAL NO. of SHEETS	LAST SHEET NO.	ORIG.	IRE	GS	DM	DATE
NEDO	O-A	Issued for Comments	59	59	VFN	WHA			5/17/91
NFM	O	Original Issue	62	62	VFN	WHA		TRJ	6/21/91

Space for RPE Stamp, reference alternate calc., and notes as applicable.

This calc. was prepared for the identified DCP/MMP. DCP completion and turnover acceptance to be verified by receipt of a memorandum directing DCN Conversion. Upon receipt, this calc. represents the as-built condition. Memo date _____ by _____.

CALCULATION CROSS-INDEX

Subject Calculation No. DC-3601

Subject Calculation Revision No.	Superseded By Calc. No.	INPUTS These interfacing calculations and /or documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		OUTPUTS Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents.		Does the output interface calc/document require revision?	Identify output interface calc/document CCN or DCN TCN/Rev.	Group Supervisor or Station Technical Group Supervising Engineer Signature/Date
		Calc/ Document No.	Rev. No.	Calc/ Document No.	Rev. No.	YES / NO		
0	N/A	DC-3533	0	N/A		NO	N/A	
0	N/A	EOI-SO1-1.0-60	9	N/A		NO	N/A	
0	N/A	DC-2836	0	N/A		NO	N/A	
0	N/A	DC-3460	0	N/A		NO	N/A	

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE___ OF___
CCN CONVERSION: CCN NO. CCN --	

Project or DCP/MMP_____ Calc. No. **DC - 3601**

Subject **SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT** Sheet No. 3

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	V. F. Nazareth VFN	6/21/91	W. Alhassani WA	6/21/91						↓

TABLE OF CONTENTS

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE___ OF___
	CCN CONVERSION: CCN NO. CCN --

Project or DCP/MMP_____ Calc. No. **DC - 3601**

Subject **SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT** Sheet No. 4

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						

I. PURPOSE

10 CFR 50.63[1] requires that SCE demonstrate the ability of SONGS Unit 1 to cope with a Loss of all AC power (Station Blackout). Regulatory Guide 1.155 provides NRC guidance for addressing this situation[2]. This guide states that the NUMARC (NUclear Management And Resource Council) published guidelines[3] to demonstrate ability to cope with a station blackout (NUMARC 87-00) is compatible with the Reg. Guide. The basic NUMARC/REG. GUIDE criteria are as follows:

(i) procedures and equipment relied upon in station blackout should ensure that satisfactory performance of necessary decay heat removal systems is maintained for the required station blackout coping duration,

(ii) the core must be kept covered for the coping duration, and

(iii) appropriate containment integrity should be provided in a blackout to the extent that isolation valves perform their intended function without AC power.

The purpose of this calculation is to determine whether adequate RCS water inventory exists to perform the decay heat removal function and keep the core covered during a station blackout for the NUMARC defined coping duration.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						

II. RESULTS/CONCLUSIONS AND RECOMMENDATIONS

A. RESULTS/CONCLUSIONS

The significant events occurring during a station blackout including operator actions are shown on Table II-1. A trend of some of the important parameters during the critical times of the coping duration are shown in Table II-2.

On initiation of the blackout, the Pressurizer begins to empty rapidly due to the RCS leakage (171 gpm (cold) for the first 2 minutes and 101 gpm (cold) thereafter) and coolant shrinkage. In 21 minutes the pressurizer has emptied. Thereafter, the Reactor vessel upper head begins to drain resulting in a steam bubble in the upper head of the vessel. In 45 minutes the vessel upper head is completely voided. The outlet plenum then begins to drain causing the steam bubble to expand into the outlet plenum. The mixture level in the outlet plenum drops to just above the top of the hot leg at the end of one hour. During this one hour period natural circulation removes the core decay heat and keeps the core covered.

At one hour after the initiation of the blackout the charging pumps when powered by the DSD will provide makeup flow to the RCS. Thereafter the RCS inventory will be maintained (or will increase) for the remaining three hours of the coping duration. Again the core decay heat continues to be removed and the core remains covered for this period.

B. RECOMMENDATIONS

1. The Technical Specification leakage allowance of 6 gpm (total identified & unidentified) remains valid for Station Blackout. No changes to the Technical Specifications are thus required.
2. The allowable letdown isolation valve leakage of 20 gpm remains acceptable.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						

TABLE II-1
SEQUENCE OF MAJOR EVENTS FOR STATION BLACKOUT

TIME (MINUTES)	EVENT/ACTION
0	Loss of all on and offsite AC power accompanied by reactor and turbine trip
3	Operator takes manual control of ADV's
4.7	Auxiliary Feedwater Flow injected into the S.G.'s through turbine driven pump (G-10) to achieve and maintain S.G. level between 50% and 70% NR.
20.8	Pressurizer empty; Voiding begins in the upper Reactor head
45	Upper Reactor head completely voided; Voiding begins in the outlet plenum
60	Outlet plenum* approximately 40% voided; No voiding in the hot legs
60.1	RCS charging restored through powering north charging pump by the DSD diesel generator; RCS inventory reduction stops
240	End of coping duration

* Outlet plenum extends from the reactor head flange to the top of the core

NES&L DEPARTMENT

CALCULATION SHEET

Subject or DCP/MMP _____ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 7

REV	ORIGINATOR	DATE	IRE	DATE
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91

ICCN NO./ PRELIM. CCN NO. | PAGE __ OF __

CCN CONVERSION: CCN NO. CCN --

TABLE II-2
SIGNIFICANT PARAMETER TRENDS DURING A SBO+

TIME min	ACTIVITY/EVENT	RCS LEAKAGE lbm/sec	RCS CHARGING lbm/sec	RCS PRESSURE psia	RCS T_{cold} F	RCS T_{hot} F	RCS FLOW* % flow	RCS SUBCOOL -ING(F)
0	Steady State full power	0	0	2100	527.0	576.0	100	66.9
0.1	Reactor at 10% power	24.2	0	2062	526.5	572	68	68.2
2.1	letdown leakage reduced	14.6	0	1885	515.1	557.3	10	70.3
3.1	manual ADV control**	14.3	0	1838	515.8	539.7	7	84.3
4.7	AFW flow starts	14.2	0	1870	528.3	539.6	4.9	86.8
20.8	Pressurizer empty	14.0	0	1587	535.4	558.1	4.4	45.8
27	RCS at Saturation	13.9	0	1133	534.7	559.6	4.7	0
45	RV upper head voided	13.9	0	1073	535.3	553.1	4.4	0
55	Intermediate condition	13.9	0	1061	535.5	551.6	4.0	0
60	Outlet plenum 40% voided	13.9	0	1067	535.4	551.0	4.1	0
60.3	Charging starts	13.9	26.9***	1065	520.2	552.0	4.8	0

* 100% flow = 20,278 lbm/sec ** ADV in automatic mode prior to this time
*** Based on an estimated charging flow of 150 gpm

+ from Fiche ECFUELA J1262

TABLE II-2 (continued)
SIGNIFICANT PARAMETER TRENDS DURING A SBO+

TIME min	ACTIVITY/EVENT	S. G. SECONDARY PRESSURE psia	S. G. SECONDARY TEMP. F	PRESSUR -IZER LEVEL %	VESSEL MIXTURE HEIGHT** ft.	S.G. SECONDARY LEVEL++ % NR	AUXILIARY FEEDWATER FLOW++ gpm
0	Steady state full power	547	476.0	37.5	35.82	30	0
0.1	Reactor at 10% power	670	497.9	35	35.82	28.8	0
2.1	letdown leakage reduced	717	505.4	19.6	35.82	0	0
3.1	manual ADV control	856	525.6	15.9	35.82	0	0
4.7	AFW flow starts	895	530.8	17.0	35.82	0	370
20.8	Pressurizer empty	927	535.0	0	35.82	61	167.8
27	RCS at saturation	927	535.0	0	35.25	65	84.2
45	RV upper head voided	926	535.0	0	29.26	65	93.4
55	Intermediate condition	926	535.0	0	26.80	64	104.1
60	outlet plenum 40% voided	925	535.0	0	25.58	67	54.7
60.3	Charging starts	925	535.0	0	25.54	67	48.0

** Top of the core = 19.82 ft. Top of hot leg = 25.55 ft. Top of Lower head = 29.32 ft.
+ from Fiche ECFUELA J1262
++ Actual AFW flow would be as little as 270 gpm at S.G. Pressure of 923 psia. The RETRAN analysis used 370 gpm during the period of S.G. recovery (15 min.) after which flow is manually throttled. Use of actual minimum flows have negligible impact on analysis results. AFW flows used are best estimate values and should not be considered design basis values.

REV	ORIGINATOR	DATE	IRE	DATE
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91

NES&L DEPARTMENT
CALCULATION SHEET
Project or DCP/MMP _____ Calc. No. DC-3601
Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 8
CCN NO./ PRELIM. CCN NO. N-1 PAGE 3 OF 5
CCN CONVERSION: CCN NO. CCN -

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth VFN	6/21/91	W. Alhassani WJHA	6/21/91						

III. ASSUMPTIONS

A) NUMARC[2] BASED

1. The reactor is operating at 100% power for 100 days and at normal operating conditions at the time of the blackout.
2. All reactor support systems are within normal operating ranges.
3. The blackout does not occur during a design basis event.
4. Single failure criteria are not considered since SBO is not considered a design basis event.
5. The RCS pump seal leakage (cold) will not be greater than 25 gpm/pump.
6. **The coping duration is four (4) hours[6].**
7. The initiating event is a loss of offsite power.

B) OPERATIONS BASED

1. The Nominal pressurizer level at 100% power is 37.5%. This is the expected Pressurizer level at 551.5 F (i.e. based on the reduced Tavg program - see assumption B.2)[22] (confirmed by E-mail from Operations -- see Appendix B). NUMARC permits use of the nominal pressurizer level as the initial condition of the blackout (see assumption A.1 & A.2).
2. The plant is using a Reduced Tavg program (due to the steam generator tube corrosion and plugging)[20].
3. The total unidentified and identified leakage is less than 6 gpm (requirement from Section 3.1.4 of the tech. specs.[7]).

C) EOI[4,5] BASED

1. Steam generator level will be maintained between 50% and 70% NR during the blackout.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						↓

2. Auxiliary feedwater flow will be provided to the steam generators to maintain the steam generator level between the above limits. Auxiliary feedwater flow is provided through the turbine driven pump (G-10). The operator can throttle flow to the steam generators to maintain the Steam generators within these limits[14].
3. **The DSD can be powered up to restore charging capacity within one hour after the initiation of the blackout[6].**
4. The number of steam generator tubes plugged will be less than 20%[20]. The safety analysis for Unit 1 cycle 11 assumes S.G. tube plugging of 20%. Therefore this assumption is used here.
5. The atmospheric dump valves are placed in manual mode to maintain plant subcooling conditions 3 minutes after initiation of the event. This is an expected operator action. However, this assumption will not compromise the conservatism of this calculation. If the manual operation of the ADV's were not credited, decay heat removal will still occur through automatic control of the ADV's and also through the Main Steam Safety Valves (MSSV).
6. The letdown leakage for the first two minutes after the blackout will be less than 90 gpm (i.e. 70 gpm greater than the leakage after blackout initiation). The 90 gpm value is the normal maximum letdown leakage (Section 9.3.4 of Reference 10). The letdown valve closure time is expected to be less than 30 seconds[8]. Therefore the assumption of a 90 gpm letdown leakage for 2 minutes since the initiation of the SBO is conservative.
7. The total letdown system leakage (cold) after the first two minutes is less than 20 gpm. This is the maximum expected leakage from the letdown orifice isolation valves after the letdown system is isolated[18].
8. Control rods are fully inserted within 3 seconds after initiation of the blackout[12].
9. No other leakage resulting in RCS water inventory drain exists.
10. The reactor trip is caused by the instantaneous loss of all AC. This produces the

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						

loss of the turbine bypass system which causes the initial opening of the ADV's. The ADV's are air operated and have Nitrogen backup. Therefore they will continue to be operable during a blackout.

11. Control room adequacy and battery are assured to function during the entire coping duration[19].

12. The minimum Auxiliary Feedwater flow delivered to all three steam generators at a secondary side pressure of approximately 923 psia, when driven by pump G-10 will be at least 270 gpm. The actual minimum deliverable flow is expected to be between 288 gpm and 300 gpm. Therefore, it is conservative to assume a minimum deliverable flow of 270 gpm.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						

IV. DESIGN INPUT

Table IV-1 shows the design inputs used to determine the RCS inventory during the station blackout. The auxiliary feedwater flow that will be automatically delivered to each S.G. by means of the steam driven auxiliary feedwater pump (G10) is shown in Table IV-2. Some of the significant external inputs that require further explanation are described as follows:

(i) RCS Leakage -- NUMARC 87-00 suggests using the assumption of leakage rates of 25 gpm per pump seal (i.e. total seal leakage of 75 gpm). The Unit 1 technical specification 3.1.4 permits a maximum allowable unidentified and identified leakage of 6 gpm. The letdown leakage limit is assumed to be 90 gpm until the letdown isolation valves are closed (i.e. for the first 2 minutes of the blackout) and subsequently 20 gpm for the remaining duration of the transient. Therefore the total leakage assumed is 171 gpm for the first 2 minutes of the blackout and 101 gpm for the rest of the coping duration. On a loss of all ac power, the letdown system is automatically isolated. This occurs by closure of valves CV-202, CV-203 & CV-204 along with CV-525 and CV-526 (See note in letdown system drawing[21]). The closure time for the letdown isolation valves is less than 30 seconds[8]. For conservatism the closure time of 2 minutes is used in this calculation.

(ii) Auxiliary Feedwater -- After initiation of the blackout, main feedwater is not available as a decay heat removal system. Auxiliary feedwater however is available since it is driven by the steam driven auxiliary feedwater pump (G-10). AFW flow is automatically initiated when the SG level reaches a setpoint value of 5% NR (Table 5.5-3 of Reference 10). It is then assumed that the delay time for the pump to be available to deliver flow into the S.G.'s is 3 minutes (Section 6.5.2.2.3 of Reference 10). Thereafter once the S.G. level has reached between 50% and 70% NR, the operator manually throttles the AFW flow to maintain this level in the

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						

S.G.'s[4]. The philosophy employed here is to maintain temperature and Pressure control in the Secondary side and consequently in the primary side and thus continue to have this system available for decay heat removal.

(iii) Charging Flow -- After one hour the charging pump when powered by the DSD restores charging flow to the Reactor. From Table II-2, the RCS pressure at this time will be 1067 psia. The charging flow capable of being delivered at this pressure will be at least 198.5 gpm[9]. However for this calculation a conservative value of 150 gpm charging flow is used*. This minimum charging flow will be maintained from 1 hour to the end of the coping duration (i.e. 4 hours).

* Note that in this analysis it is only important that the charging flow delivered be greater than 101 gpm so that the RCS water that is lost due to the leakage can be made up.

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE___ OF___
	CCN CONVERSION: CCN NO. CCN –

Project or DCP/MMP_____ Calc. No. **DC - 3601**

Subject **SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT** Sheet No. 14

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						

TABLE IV-1
DESIGN INPUT FOR STATION BLACKOUT

A. **INITIAL CONDITIONS**

#	PARAMETER	VALUE	REFERENCE	COMMENTS
1.	Core Power	1347 MW	10	100% Rated Power
2.	Core Average Temp.	551.5 F	11	At 100% power
3.	RCS Pressure	2100 psia	10	
4.	Pressurizer level	37.5%	--	Nominal level
5.	S.G. Pressure	547 psia	11	at 100% power
6.	S.G. Mass	43,000 lbm	17	per S.G.
7.	S.G. Tubes plugged	20%	11,20	
8.	S.G. Level	30% NR	--	Nominal
9.	Vessel Flow Rate	195,000 gpm	10,20	
10.	Vessel mass flow	$73*10^6$ lb/h	10	
11.	Core mass flow	$69.7*10^6$ lb/h	10	
12.	Core bypass flow	4.5%	10	
13.	Heat generated in Fuel	97.4%	10	
14.	No load Ref. Temp.	535 F	11	

B. **AFTER BLACKOUT INITIATION**

#	PARAMETER	VALUE	REFERENCE	COMMENTS
1.	RCS leakage for initial 2 min.	171 gpm	--	see Section IV discussion
2.	RCS Leakage after initial 2 min.	101 gpm	--	see Section IV discussion
3.	S.G. NR Level	50%-70%	4	Manually maintained
4.	Auxiliary Feedwater Auto. initiation	5% NR	10	see Section IV discussion
5.	Aux. Feedwater Auto initiation delay	3 min.	10	see Section IV discussion
6.	ADV manual initiation time delay	3 min.	4,5	Assumption
7.	ADV relief Capacity	$1.468x10^6$ lbm/hr	12	
8.	RCP flywheel inertia	45,000 lbm/ft^2	12	
9.	Charging Initiation	1 hour	--	See Section IV discussion
10.	Charging flow	150 gpm	--	See Section IV discussion

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						

TABLE IV-2
AUXILIARY FEEDWATER FLOW FOR STATION BLACKOUT[16]

PUMP DISCHARGE PRESSURE (Psia)	AFW FLOW* (Gpm)
0.0	123.3
995.0	123.3
1030.0	115.0
1055.0	108.3
1125.0	88.3
1155.0	64.3
1185.0	50.0
1240.0	33.3

* The AFW flow shown in this table was derived from Figure 2-1 of Reference 16 and used in the RETRAN case. However, the actual flow expected to be delivered to each S.G. through the steam driven AFW pump G-10 will be at least 90 gpm. This will not significantly affect the results of this calculation since reduced AFW flow has a negligible effect on RCS water inventory change and the reduced flow remains sufficient to meet decay heat removal requirements. The lower initial AFW flow will slightly delay the recovery of S.G. secondary side level relative to the RETRAN results. However, once the S.G. level has reached 50% NR, the operator will throttle the AFW flow to maintain S.G. level. The secondary side results will then be consistent with the RETRAN values. For these reasons the lower AFW flow will not impact the RCS water inventory level nor will it significantly impact the ability of the system to remove core decay heat. AFW flows used are best estimate values and should not be considered design basis values.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth VFN	6/21/91	W. Alhassani WA	6/21/91						

V. METHODOLOGY

A. GENERAL

The RCS Inventory Analysis is performed based on the expected operator actions during a blackout as enumerated in EOI S01-1.0-60 and the expected Plant responses described in the Background Document for this EOI[5]. The simulation of the blackout and consequent plant actions and response is modeled using the RETRAN computer code. The results of the computer code will then be verified by a simplified hand calculation.

B. RETRAN CODE MODEL

The basic RETRAN model for Station Blackout was developed for the analysis performed to demonstrate the adequacy of the leakage technical specification (T.S. 3.1.4) and in response to LER 90-004[18]. A complete description of the input model used for this LER analysis is documented in Reference 12. The RETRAN nodal diagram describing the control volumes and junctions used in this analysis is shown in figure V-1. The code control systems for auxiliary feedwater flow and steam bypass are described in Figures V-2 and V-3.

The modifications made to the basic model[12] for this analysis are shown on Table V-1. The primary modifications along with the reasons for the changes are described as follows:

1. RCS Leakage -- The base model had the total RCS leakage only from one loop (i.e. volume 18). This approach is acceptable until such a time as the Pressurizer is drained. Thereafter the imbalance in the leakage appears to affect the convergence of the code. Therefore, a new junction (junction 51) was added for leakage from the other loops (i.e. volume 36). The amount of leakage through junction 50 will thus be reduced to one third of the total leakage and through junction 51 will be two thirds of the total leakage (since loops A & C are modeled

together as one loop). The HOT leakage is determined as follows:

$L_{hot} = L_{cold} * (d_{cold}/d_{hot})$

where,

L_{hot} = Hot leakage (gpm)

L_{cold} = Cold leakage (gpm)

d_{hot} = density of water at 535 F

= 47.7 lbm/ft^3

d_{cold} = density of water at 80 F

= 62.6 lbm/ft^3

The HOT leakage per RCS loop thus becomes 74.67 gpm (171*1.31/3) for the first 2 minutes of the SBO and 44.1 gpm (101*1.31/3) thereafter for the coping duration of 4 hours.

2. Charging -- The base model does not account for charging flow into the RCS system one hour after the SBO initiation. Therefore two extra junctions were added to provide this function (junctions 48 and 49). The amount of charging through these junctions will be one third through junction 48 and two thirds through junction 49. The hot charging flow per RCS loop will thus be 65.5 gpm (150*1.31/3) to be initiated one hour after the initiation of the SBO for the remaining 3 hours of the coping duration. In addition a charging initialization card was included to permit the initiation of charging flow.
3. RCS Flow Rates & Temperatures -- The base model flow rates were recalculated here based on the values from Table 4.4-1 of the FSAR[10]. Table V-2 shows the vessel flow rate, core flow rate and the calculation of the vessel inlet and outlet temperatures with the caveat that the Tavg will be maintained at 551.5 F (i.e. the Reduced Tavg program).
4. Bubble Rise Models -- The base model was developed for a RCS leakage of only 27 gpm. The criteria used was Pressurizer drain. Since the criteria here is core

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth VFN	6/21/91	W. Alhassani WAA	6/21/91						

uncovery and the outlet plenum and upper head drain, a bubble rise model is included for the outlet plenum volume 6 (a bubble model in the upper head was in the original model). The model parameters are the same as for the upper head (i.e. Volume 7).

5. Volume overlaps -- Due to the occurrence of bubbles in Volumes 6 & 7, RETRAN was not converging at the time that volume 7 was drained. Therefore, the volume height of volume 6 was adjusted to 9.6 inches to produce an overlap of 0.1 inches (old value was 9.5 inches). For the same reason the volume height of volumes 11, 16, 29 & 34 were also adjusted to 8.605 inches to produce an overlap of 0.1 inches (old value was 8.505 inches).

6. Steam Generator Adjustments -- The mass of water in the secondary side of each S.G. is 43,000 lbm. However, the code model is set up to accept only volumes. Therefore, the volume of the S.G.'s are adjusted to result in this S.G. water mass (i.e. Volume 50 = 1395, Volume 60 = 2906). In addition the initial S.G. liquid level and gain are adjusted to 22.2938 and 0.1044 to obtain an initial S.G. liquid level of 30% NR.

7. AFW control block -- The automatic AFW flow injection is modeled to inject water into the S.G.'s when the S.G. low level reaches 5% NR with a time delay of 3 minutes to account for valve stroking, transit time and time for the pump to get to full speed. The base model erroneously set the trip function for AFW initiation on a parameter for ADV control. This error was conservative in Reference 12 since the AFW would be actuated later than if it was correct. However, for this analysis this error is corrected (Card # 040030).

8. Time step -- In order to reduce the unnecessary time steps and consequently the code execution time, the time steps after the first hour of the transient are changed from 0.05 sec to 0.10 sec.. This will not compromise any of the results or conclusions of the code.

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE___ OF___
CCN CONVERSION: CCN NO. CCN --	

Project or DCP/MMP_____ Calc. No. **DC - 3601**

Subject **SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT** Sheet No. 19

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						↓

9. Problem Run Time -- The NUMARC guideline coping duration is 4 hours. However, the charging flow powered by the DSD diesel is restored after one hour. Therefore, the simulation need be performed only for one hour. This simulation is performed for 30 minutes more (i.e. 90 minutes) to simulate some of the recovery process once the charging is restored.

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO. | PAGE___ OF___

Project or DCP/MMP_____ Calc. No. DC - 3601

CCN CONVERSION: CCN NO. CCN --

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 20

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth VFN	6/21/91	W. Alhassani WA	6/21/91						↓

TABLE V-1
LIST OF MODIFICATIONS TO BASIC SBO MODEL

No.	Card #	Parameter	Modified value	Base Value	Purpose
1.	010001	No. of minor edits printed	-54	-40	More detail output
2.	010001	No. of trip functions	20	19	Additional trip for charging actuation
3.	010001	Number of bubble Sets	10	9	Addition of set for outlet plenum vol 6
4.	010001	Number of junctions	51	48	Addition of junctions for second leakage path and charging(2)
5.	010002	Number of fill tables	14	13	Addition of fill table for charging
6.	02000x	Minor Edits	--	--	Printing more output variables
7.	0300x0	Edit frequency	--	--	Changes in output edit print frequency
8.	030060	Time steps	.10	.05	less frequent time steps after 1 hr.
9.	040010	Problem run time	4800	7200	Running problem for 1.5 hrs.
10.	040030	Control block	-20	-13	Correction of AFW error
11.	040200	Charging trip	--	--	New charging initialization card
12.	050011	Vessel inlet temp.	527	528	corrected value
13.	050061	Bubble set	10	--	Assigning new bubble model set for vol 6

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO. | PAGE___ OF___

Project or DCP/MMP_____ Calc. No. **DC - 3601**

CCN CONVERSION: CCN NO. CCN --

Subject **SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT** Sheet No. 21

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
1	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91	1					↓
2					2					

No.	Card #	Parameter	Modified value	Base Value	Purpose
14.	050061	Volume 6 height	9.6	9.5	Changed to get .1" vol 6/7 overlap
15.	050071	Vessel outlet temp.	576	575	corrected value
16.	050111	Volume 11 height	8.605	8.505	Increased to get 0.1 in. vol 11/12 overlap
17.	050161	Volume 16 height	8.605	8.505	Increased to get 0.1 in. vol 15/16 overlap
18.	050291	Volume 29 height	8.605	8.505	Increased to get 0.1 in. vol 29/30 overlap
19.	050341	Volume 34 height	8.605	8.505	Increased to get 0.1 in. vol 33/34 overlap
20.	050501	S.G. "B" Volume	1395	1310	water vol. adjusted to 43,000 lbm
21.	050601	S.G. "A+C" volume	2906	2620	Water vol. adjusted to 86,000 lbm
22.	060101	Bubble set	--	--	Bubble rise model for vol 6 same as vol 7
23.	080011	Junction 1 flow rate	19,361	20,583	Corrected core flow rate
24.	080081	Junction 8 flow rate	6,759	7,110	Corrected Loop "B" flow rate
25.	080091	Junction 9 flow rate	6,759	7,110	Corrected Loop "B" flow rate
26.	080211	Junction 21 flow rate	20,278	21,330	Corrected vessel flow rate
27.	080311	Junction 31 flow rate	13,519	14,220	Corrected Loop "A+C" flow rate
28.	080511	Junction 51	36	--	New RCS leakage path from volume 36

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO. | PAGE___ OF___

Project or DCP/MMP_____ Calc. No. DC - 3601

CCN CONVERSION: CCN NO. CCN --

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 22

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						

No.	Card #	Parameter	Modified value	Base Value	Purpose
29.	080511	Junction 51	2.0	--	Area doubled to double leakage
30.	080512	Junction 51	--	--	continuation card for new junction 51
31.	131301	RCS leakage	-74.67	-35.4	total leakage per RCS loop for first 2 min
32.	131302	RCS leakage	-74.67	-35.4	total leakage per RCS loop for first 2 min
33.	131303	RCS leakage	-44.1	-35.4	total leakage per RCS loop after 2 min
34.	131304	RCS leakage	-44.1	-35.4	total leakage per RCS loop after 2 min
35.	131401	Charging flow	0.0	--	No charging flow at initiation of SBO
36.	131402	Charging flow	0.0	--	No charging flow for one hour of SBO
37.	131403	Charging flow	65.5	--	Charging flow after one hour
38.	131404	Charging flow	65.5	--	Charging flow after one hour
39.	702003	RCS Flow Rate	$4.93*10^{-5}$	$4.69*10^{-5}$	Adjust initial gain (1/vessel flow)
40.	702007	Vessel outlet temp.	576.0	575.01	Corrected value
41.	702008	Vessel inlet temperature	527.0	528.02	Corrected value
42.	702009	S.G. Liquid level	22.2938	22.3838	Adjusted to match steady state value
43.	703020	S.G. Level Gain	0.1044	0.1012	Adjusted to get initial 30% NR

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91					

REV

TABLE V-2
CALCULATION OF RCS FLOWS AND TEMPERATURES

The basic equation to calculate heat transfer in the core is:

$$DH_c = Q / M_c \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{Equation 5.1}$$

where,

DH_c = Enthalpy Rise in the Core

Q = Heat generated in core
= $(4.596 * 10^9) * 0.974 = 4.477 * 10^9$ Btu/hr . (Reference 10*)

M_c = Core mass flow rate
= $69.7 * 10^6$ lbm/hr . . . . . (Reference 10*)

Therefore substituting in Equation 5.1,

DH_c = 64.2 Btu/lbm

The enthalpy changes in the core can be stated as:

$$h_{avg} = (h_{ov} + h_{in}) / 2.0 \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{Equation 5.2}$$

and

$$DH_c = h_{oc} - h_{in} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{Equation 5.3}$$

where,

h_{avg} = average enthalpy in the core
= h(P=2100 psia, T_{avg}=551.5 F) (This is an approximation)
= 549.3 Btu/lbm (from steam tables)

h_{ov} = Vessel outlet enthalpy
h_{in} = Vessel inlet enthalpy
h_{oc} = Core outlet enthalpy

Therefore combining equations 5.2 and 5.3 and substituting for known quantities,

$$h_{ov} + h_{oc} = (2 * 549.3) + 64.2$$
$$= 1162.8 \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{Equation 5.4}$$

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
1	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						
2										

From Reference 10* the difference between the vessel temperature rise and the core temperature rise at full power is 2 F (i.e. 49.3 - 47.3)

Therefore, assuming that the core exit temperature and the vessel exit temperature are between 570 and 580 F and interpolating from the steam tables for a pressure of 2100 psia,

$$h_{ov} - h_{oc} = -2.6 \quad \text{. . . . . Equation 5.5}$$

Combining Equations 5.4 and 5.5 results in,

$$h_{ov} = 1160.2/2 = 580.1$$

Therefore,

T_{ov} = Vessel outlet Temperature
= T (P=2100 psia, h_{ov}=580.1 Btu/lbm)
= 575.4 F

Substituting in Equation 5.2,

$h_{in} = (2 * 549.3) - 580.1$
= 518.5

Therefore,

T_{in} = Vessel inlet temperature
= T(P=2100 psia, h_{in}=518.5 Btu/lbm)
= 526.4 F

Subsequently,

Calculated T_{avg} = (575.4 + 526.4) / 2.0
= 550.9 F

Since the actual T_{avg} = 551.5 F, the values of T_{in} and T_{ov} are adjusted by +0.6 F.

Therefore the values input into RETRAN are as follows:

T_{in} = 527 F

T_{ov} = 576 F

h_{in} = h(p=2100 psia, T=527 F)
= 519.3 Btu/lbm

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE___ OF___
	CCN CONVERSION: CCN NO. CCN --

Project or DCP/MMP_____ Calc. No. **DC - 3601**

Subject **SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT** Sheet No. 25

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						

h_{ov} = h(p=2100 psia, T=576 F)
= 580.8 Btu/lbm

M_c = Core mass flow rate
= (69.7 * 10^6 lbm/hr) / (3600 Sec/hr)
= 19,361 lbm/sec

M_v = Vessel mass flow rate
= (73 * 10^6 lbm/hr) / (3600 Sec/hr) . . . . . (Reference 10*)
= 20,278 lbm/sec
= 6,759 lbm/sec per RCS loop

* from Table 4.4-1

NES&L DEPARTMENT

CALCULATION SHEET

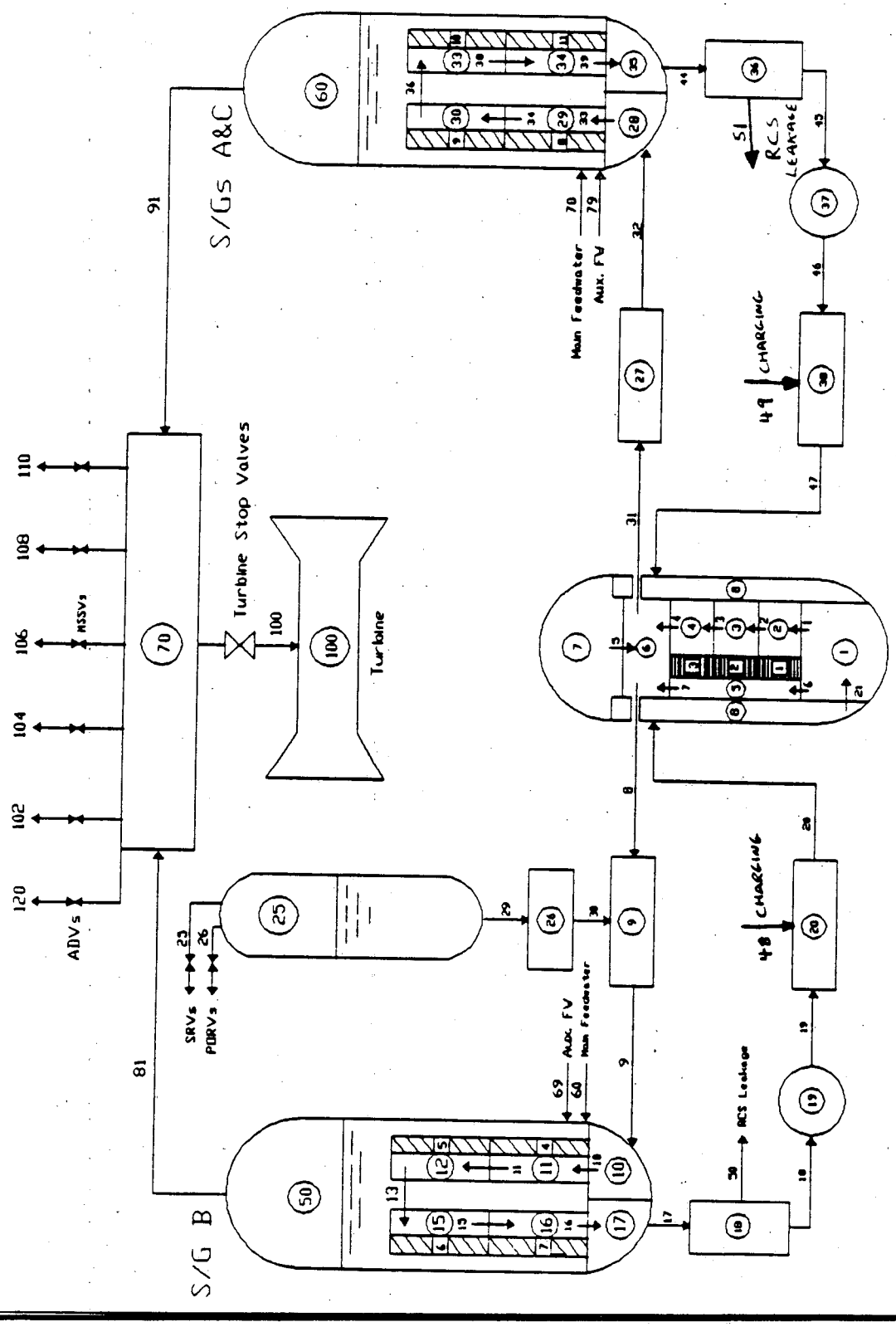
ICCN NO./ PRELIM. CCN NO.	PAGE___ OF___
	CCN CONVERSION: CCN NO. CCN --

Project or DCP/MMP_____ Calc. No. **DC - 3601**

Subject **SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT** Sheet No. 26

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						

Fig. V-1 SONGS 1 RETRAN Nodal Diagram For SBO



NES&L DEPARTMENT

CALCULATION SHEET

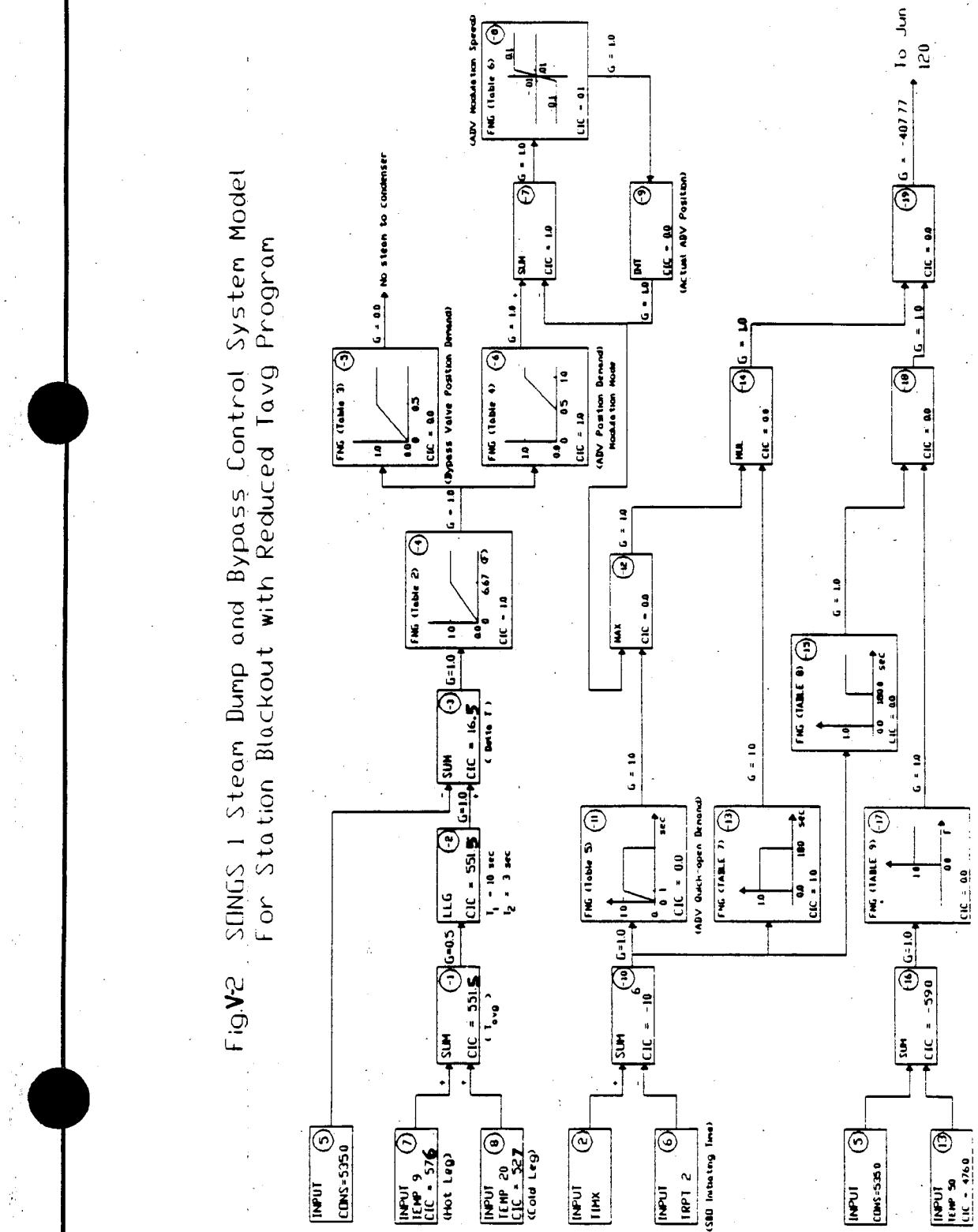
ICCN NO./ PRELIM. CCN NO.	PAGE___ OF___
	CCN CONVERSION: CCN NO. CCN --

Project or DCP/MMP_____ Calc. No. **DC - 3601**

Subject **SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT** Sheet No. 27

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						

Fig.V-2 SONGS 1 Steam Dump and Bypass Control System Model For Station Blackout with Reduced Tavg Program



NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE___ OF___
CCN CONVERSION: CCN NO. CCN --	

Project or DCP/MMP_____ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						

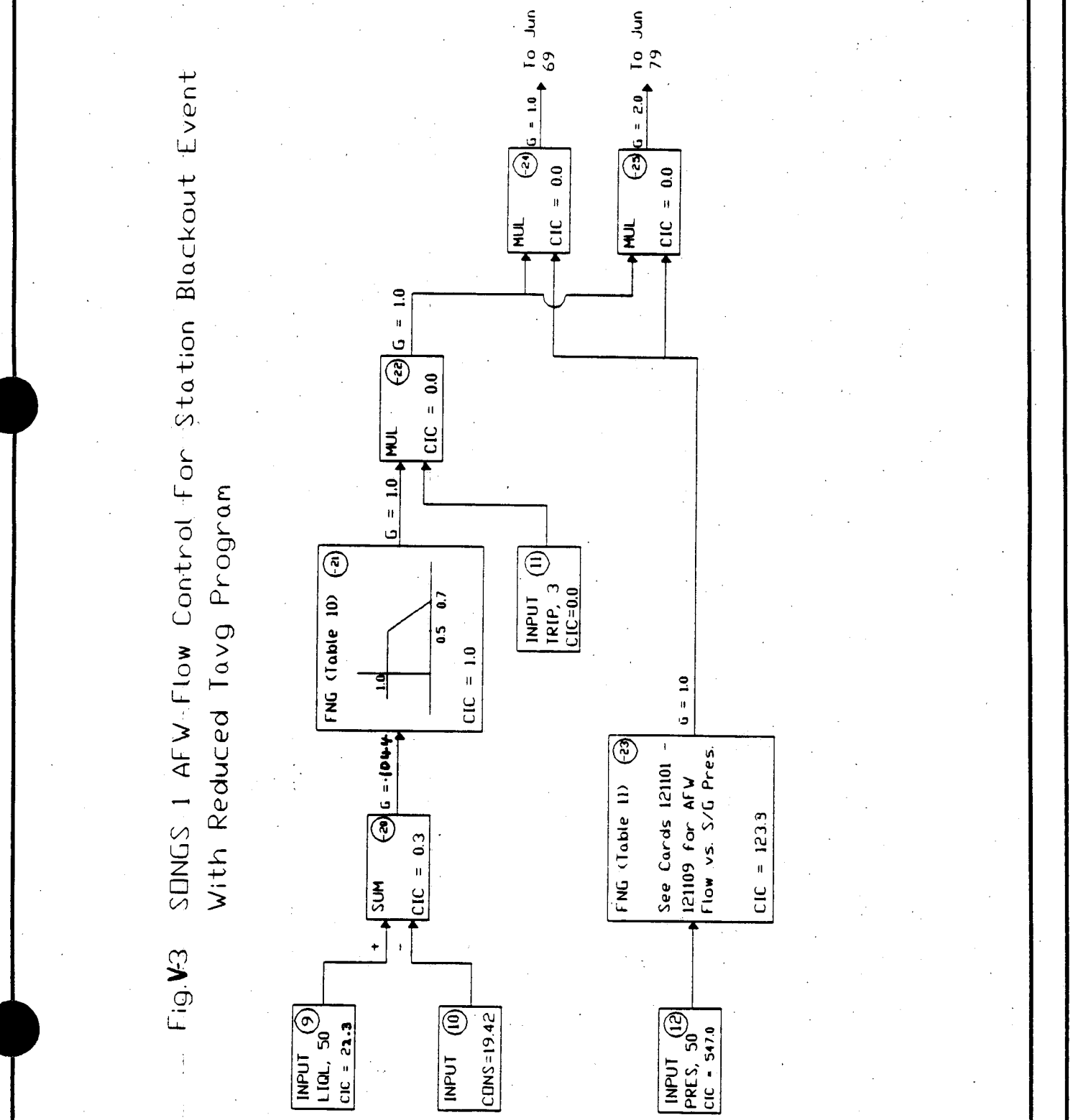


Fig. V-3 SONGS 1 AFW Flow Control For Station Blackout Event With Reduced Tavg Program

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
1	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91	1					
2					2					

VI. REFERENCES

1. Code of Federal Regulations, 10CFR50.63.
2. NUREG 1.155, "Station Blackout", August 1988.
3. NUMARC 87-00, "Guidelines and Technical Bases for NUMARC initiatives addressing Station Blackout at Light Water Reactors", November 1987.
4. EOI S01-1.0-60, Rev. 9, "Loss of all AC power", February 13, 1991.
5. EOI S01-1.0-60.1, Rev. 2, "Background Document for Loss of all AC power", April 10, 1990.
6. Letter for M.O. Medford (SCE) to NRC "Docket Nos. 50-206, 50-361, 50-362; Response to 10 CFR 50.63, Loss of all alternating current power; San Onofre Nuclear Generating Station Units 1, 2 and 3", April 17, 1989.
7. SONGS Unit 1 Technical Specifications, Amendment 143.
8. MMP 1-3645.005N, Revision 0 (See sheet 437).
9. DC-3460, "CRS and Charging System Performance", P. Biba, January 9, 1991 (Attachment 46)
10. SONGS Unit 1 Updated Final Safety Analysis Report (UFSAR)
11. PFC # 1-89-003, "Unit 1 Cycle 10 Core Reload", January 23, 1989 (Attachment J).
12. DC-3533, "SONGS 1 RCS Leakage During Station Blackout", Y.P.Ting, March 8, 1991.
13. Intentionally Blank
14. Songs Unit 1 drawing 5178220-16.
15. Crane Reference Manual "Flow of Fluids through valves, fittings and pipe", 1981 (See chapter 1)
16. DC-2836, Supplement B, "AFW Flow Venturi Sizing", May 21, 1990.
17. Letter from H.C. Calton (Westinghouse) to L.K. Carlisle (SCE),"Southern California Edison Company, San Onofre Nuclear Generating Station Unit 1, Main Steamline

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	V. F. Nazareth VFN	6/21/91	W. Alhassani WAH	6/21/91						

Break M & E Releases for SONGS-1", NS-OPS-OPL-I-90-613, October 26, 1990.

18. LER 90-004, "Potential for Reactor System Leakage greater than Technical Specification Basis, San Onofre Nuclear Generating Station, Unit 1", April 25, 1990.
19. Letter from F.R. Nandy (SCE) to NRC, "Supplemental Response to 10CFR 50.63, Loss of All Alternating Current Power, Station Blackout (TAC No. 68599/600), San Onofre Nuclear Generating Station Units 1,2 and 3", May 1, 1990.
20. Letter from M.F. Muenks (Westinghouse) to P.D. Myers(SCE), "Southern California Edison San Onofre Unit No. 1 Cycle 11 Reload Safety Evaluation Report", 90SC-G-0025, 9/26/90.
21. Songs Unit 1 drawing 5178130-13.
22. SONGS Unit 1 Systems Descriptions, SD-S01-280-3-3, Revision 2 (See Figure 3).

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE___ OF___
	CCN CONVERSION: CCN NO. CCN --

Project or DCP/MMP_____ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 31

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	V. F. Nazareth VFN	6/21/91	W. Alhassani WHA	6/21/91						

V11. NOMENCLATURE

ADV	Atmospheric dump Valve
AFW	Auxiliary Feedwater Flow
AOV	Air Operated Valves
DSD	Dedicated Shutdown Diesel
EOI	Emergency Operating Instruction
LER	Licensing Event Report
MOV	Motor Operated Valves
NR	Narrow Range (SG level)
NRC	Nuclear Regulatory commission
NUMARC	Nuclear Management and Resource Council
RCP	Reactor Coolant Pump
RCS	Reactor Coolant System
RV	Reactor Vessel
SBO	Station Blackout
SG	Steam Generator

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE___ OF___
	CCN CONVERSION: CCN NO. CCN --

Project or DCP/MMP_____ Calc. No. **DC - 3601**

Subject **SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT** Sheet No. 32

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						

VIII. CALCULATIONS

A. HAND VERIFICATION

In order to verify the accuracy of the RETRAN code results a simplified hand calculation will be performed. The purpose of this calculation is strictly to verify that the results are in the realm of reasonableness. The RCS inventory calculated during the station blackout is described in Table VIII-1. As shown on this Table the results of the hand verification calculation compare quite favorably with the results of RETRAN. Therefore it is concluded that the RETRAN results are acceptable.

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO. | PAGE___ OF___

Project or DCP/MMP_____ Calc. No. DC - 3601

CCN CONVERSION: CCN NO. CCN --

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 33

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	V. F. Nazareth VFN	6/21/91	W. Alhassani WA	6/21/91						
1										

TABLE VIII-1
VERIFICATION OF RCS INVENTORY BY HAND ESTIMATE

NO.	CONTROL VOLUME NAME	RETRAN VOLUME NO.	LIQUID MASS[a] lbm	LEAKAGE[b]		DRAIN TIME (min.)[d]		RETRAN DRAIN TIME[e] min.
				INITIAL[c] lb/sec	REGULAR lb/sec	CONTROL VOLUME	CUMULATIVE SYSTEM	
1.	Pressur -izer	25	18,447	24.2	14.2	20.2	20.2	20.8
2.	Surge Line	26	927	0	14.0	1.1	21.3	22.0
3.	R.V. Upper head	7	17,261	0	13.9	20.7	42.0	45.0
4.	R.V. Outlet Plenum[f]	6	13,105	0	13.9	15.8	57.8	60.0

(a) from RETRAN model at steady state (i.e. at time = 0)
(b) from Table II-2
(c) for first 2 minutes of SBO only

(d) $t = \{[M - (L_i * c * k)] / (L_r * k)\} + c$

where,
- t = Drain time (minutes)
- M = Liquid mass
- L_i = Initial leakage Rate (i.e. for first 2 minutes of SBO)
- L_r = Regular leakage Rate (i.e. after first 2 minutes of SBO)
- k = conversion constant from seconds to minutes (i.e. 60.0)
- c = initial leakage time in minutes (i.e. 2.0 if initial leakage is greater than 0 or 0.0 otherwise)

(e) from Table II-1
(f) ONLY UNTIL TOP OF HOT LEG (i.e. 39.7% of outlet plenum)

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE___ OF___
CCN CONVERSION: CCN NO. CCN --	

Project or DCP/MMP_____ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 34

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	V. F. Nazareth VFN	6/21/91	W. Alhassani WA	6/21/91						

APPENDIX A

LISTING OF RETRAN CODE MODEL

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
△	V. F. Nazareth VFN	6/21/91	W. Alhassani WA	6/21/91	△					
△					△					

```
= RETRAN ANALYSIS OF SONGS 1 STATION BLACK OUT EVENT (PHASE 2)
*
*     CASE 2: CHARGING SYSTEM MAKEUP
*
*     ***********************************************************
*     *                                                         *
*     *  1. 'REDUCED TAVG' PROGRAM WITH 20% TUBE PLUGGING       *
*     *  2. RCS LEAKAGE = 171.0 GPM (COLD) FOR 2 MINUTES        *
*     *                 = 101.0 GPM (COLD) THEREAFTER           *
*     *  3. ADV(S) ARE MANUALLY OPERATED AFTER 3 MINUTES        *
*     *     INTO THE SBO EVENT.                                 *
*     *  4. SG LEVEL(S) ARE MANUALLY MAINTAINED BETWEEN 50      *
*     *     AND 70% NR LEVEL.                                   *
*     *  5. PRESSURIZER INITIAL LEVEL = 37.5%                   *
*     *  6. STEAM GENERATOR INITIAL LEVEL = 30% NR              *
*     *  7. RCS CHARGING = 150.0 GPM (COLD) AFTER 1 HOUR        *
*     *                                                         *
*     ***********************************************************
*
*     D1( AT  80F ) = 62.6 LBM/FT**3
*     D2( AT 535F ) = 47.7 LBM/FT**3
*
*     HOT LEAKAGE = ( D1 / D2 ) * COLD LEAKAGE
*                 = (62.6 / 47.7) * COLD LEAKAGE
*                 = 1.31 * COLD LEAKAGE
*
*     FOR A COLD LEAKAGE OF 101 GPM (171 GPM),
*     HOT LEAKAGE = 1.31 * 101 GPM (171 GPM)
*                 = 132.31 GPM (224.01 GPM)
*                 = 44.1 GPM (74.67 GPM) PER RCS LOOP
*
*    HOT CHARGING = ( D1 / D2 ) * COLD CHARGING
*                 = (62.6 / 47.7) * COLD CHARGING
*                 = 1.31 * COLD CHARGING
*
*     FOR A COLD CHARGING OF 150 GPM,
*    HOT CHARGING = 1.31 * 150 GPM
*                 = 196.5 GPM
*                 = 65.5 GPM PER RCS LOOP
*
* ASSUMPTIONS:
*
* (1) THE AUXILIARY FEEDWATER IS DELIVERED TO THE SG(S) BY THE STEAM-
*     DRIVEN PUMP (G-10) WITH 3 MINUTES DELAY AFTER SBO.
* (2) THE RCS LEAKAGE IS MEASURED AT COLD CONDITION (80 F).
* (3) FOLLOWING A SBO EVENT, OPERATORS WILL MAINTAIN THE S/G NR LEVEL
*     AT BETWEEN 50% AND 70% BY OPERATING THE AUXILIARY FEEDWATER
*     PUMP PER EOI SO1-1.0-60.
*
*
* PLANT INITIAL CONDITIONS:
*
* REF. : (1) RELOAD SAFETY EVALUATION, SAN ONOFRE NUCLEAR GENERATING
*            STATION, UNIT 1 CYCLE 10.
*        (2) ACCIDENT ANALYSIS BASIS DOCUMENTATION: MODULE 11, STEAMLINE
*            RUPTURE FOR SONGS1, WCAP12567, MAY, 1990
*        (3) SD-SO1-280, REVISION 2, FIG. 3.
*
```

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE__ OF__
CCN CONVERSION: CCN NO. CCN --	

Project or DCP/MMP________ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 36

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						

```
* (1) [illegible]AL POWER  = 1347.0 MWT (100%)
* (2) TAVG             = 551.5 F
* (3) PZR PRESSURE     = 2100 PSIA
* (4) PZR LEVEL        = 37.5% (REF.3)
* (5) S/G PRESSURE     = 547.0 PSIA
* (6) S/G NR LEVEL     = 30%
* (7) S/G MASS         = 43,000 LBM (FROM FLB ANALYSIS BY W)
* (8) S/G TUBE PLUGGING LEVEL <= 20%
*
*          **************************************
*          *                                    *
*          *     CODE VERSION: RETRAN02-MOD4    *
*          *                                    *
*          **************************************
*
*
************* PROBLEM CONTROL AND DESCRIPTION DATA - 01000Y ************
*
*
*----Y------1-----2-----3-----4-----5-----6-----7-----8-----9----10----
*
010001      0   -40     6    19    34     9     1    48     2     1
010001      0   -54     6    20    34    10     1    51     2     1          *** THIS CARD IS A REPLACEMENT CARD.
*
*
*----------11----12----13----14----15----16----17----18----19----20----
*
010002     11    13    11     2     4     3     0     0     2     0
010002     11    14    11     2     4     3     0     0     2     0          *** THIS CARD IS A REPLACEMENT CARD.
*
*
*----------21----22----23----24----25----26----27----28----29----30----
*
010003      0     0     0     0     0     1     0     0     1     1
*
*
*----------31----32----33----34----35----36----37----38----39----40----
*
*10004      0     0     1     4     0     0     0     1     0     0
010004      0     0     1     0     0     0     0     1     0     0
*
*
************************ POWER (NUCLEAR ONLY) *************************
*
*
010005     1347.00      * MEGWATTS (100% POWER)
*
*
******************** MINOR EDIT VARIABLES - 02000Y ********************
*
*    $$$$$ VFN MODIFIED $$$$$
*    THESE EDITS HAVE BEEN MODIFIED TO INCLUDE MORE OUTPUT EDITS
*    AND ALSO DELETE SOME IRRELEVANT EDITS
*    $$$$$ VFN MODIFIED $$$$$
*
020001 PNRM,   0  PRES,  25  MIXL,  25  MIXL,  26  MIXL,   7  TEMP,   9
020002 TEMP,  20  PRES,  60  SPED,   1  SPED,   2  AVEX,   6  AVEX,   7
020003 AVEX,  26  AVEX,  11  AVEX,  12  AVEX,  15  AVEX,  16  WP**,  50
020004 WP**,  60  WP**,  70  WP**,  79  WP**,  81  WP**,  91  WP**, 100
020004 WP**,  51  AVEX,   9  WP**,  79  WP**,  81  WP**,  91  WP**, 100          *** THIS CARD IS A REPLACEMENT CARD.
```

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE__ OF__
CCN CONVERSION: CCN NO. CCN -	

Project or DCP/MMP________ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 37

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
△	V. F. Nazareth VFN	6/21/91	W. Alhassani	6/21/91	△					
△					△					

```
020005 [illegible], 120  COUT,   1  COUT,   3  COUT,  -1  COUT,  -2  COUT, -19
020006 COUT, -20  COUT, -24  COUT, -25  PRES,  50  LIQL,  50  MIXL,  50
*20007 WP**,  69  WP**, 102  MIXL,  12  MIXL,  15  * $$ VFN REPLACED $$
020007 WP**,  69  WP**, 102  MIXL,  12  MIXL,  15  TEMP,  26  MIXL,  11
*
*  $$$ VFN NEW MINOR EDIT CARDS ADDED $$$
*
020008 TEMP,  12  TEMP,  50  MIXL,  10  MIXL,  17  PRES,   4  TEMP,   4
020009 MIXL,   4  AVEX,   4  TEMP,   6  MIXL,   6  PRES,   6  TEMP,  11
020009 MIXL,   4  AVEX,   4  TEMP,   6  MIXL,   6  WP**,  48  WP**,  49      *** THIS CARD IS A REPLACEMENT CARD.
*
*      COUT,   1 = NORMALIZED PZR LEVEL,
*      COUT,   3 = NORMALIZED RCS FLOW,
*      COUT,  -2 = TAVG,
*      COUT, -19 = ADV RELIEVING CAPACITY,
*      COUT, -20 = S/G NR LEVEL,
*      COUT, -24 = AUXFW FLOW TO S/G A,
*      COUT, -25 = AUXFW FLOW TO S/G B&C.
*
*
*************** TIME-STEP ALGORITHM CONSTANTS - 030001 *****************
*
*
*          FC3       FC4       FC5       FC6       FC7       FC8       FC9
*
*030001     0.0       0.0      10.0      10.0       0.0       0.0       0.0
*
*
*
*********************** TIME STEPS DATA - 03XXX0 **********************
*
*   $$$  VFN CHANGES MADE  $$$
*   BETWEEN 1000 AND 3600 SECS
*        --  NO CHANGES TO EXECUTION TIME STEPS
*        --  MAJOR EDIT PRINTED EVERY 100 SECS (WAS 200 SECS)
*   BETWEEN 3600 SECS AND END OF EXECUTION
*        --  EXECUTION TIME STEPS EVERY 10 SECS (WAS 5 SECS)
*        --  MAJOR EDIT PRINTED EVERY 400 SECS (WAS 500 SECS)
*   $$$  VFN CHANGES MADE  $$$
*
*
*          NMIN     NMAJ     NDMP    NCHK    DELTM     DTMIN      TLAST
*
030010     100        5     9000      0      0.01       0.0       10.0
030020     100       25     9000      0      0.01       0.0      100.0
030030     100       50     9000      0      0.02       0.0      500.0
030040     250       20     9000      0      0.02       0.0     1000.0
030050     200       20     9000      0      0.05       0.0     3000.0
030060     400       25     9000      0      0.05       0.0     1.0E+6
030050     200       10     9000      0      0.05       0.0     3600.0      *** THIS CARD IS A REPLACEMENT CARD.
030060     200       20     9000      0      0.10       0.0     1.0E+6      *** THIS CARD IS A REPLACEMENT CARD.
*
*
*********************** TRIP CONTROLS - 04XXX0 ************************
*
*
*       TRIP  SIG
*4XXX0   ID    ID    IX1   IX2    SETPT    DELAY
*
040010   1     1     0     0    7200.0     0.0  * PROBLEM RUNNING TIME
```

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE__ OF__
CCN CONVERSION: CCN NO. CCN --	

Project or DCP/MMP________ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 38

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
△	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91	△				
△					△				

```
040010       1    0    0   4800.0    0.0  * PROBLEM RUNNING TIME        *** THIS CARD IS A REPLACEMENT CARD.
*
040020   2   1    0    0      0.01   0.0  * SBO OCCURS/RCPS TRIP
*
040030   3 -14  -13    0      0.05 180.0  * STEAM-DRIVEN AFW PUMP
040030   3 -14  -20    0      0.05 180.0  * STEAM-DRIVEN AFW PUMP      *** THIS CARD IS A REPLACEMENT CARD.
                                            OPERATION
040040   4   1    0    0      0.0    0.0  * MFW OPERATION
*
*        ---------- PRIMARY PORVS AND SRVS -----------
*
040050   5   4   25    0   2215.0    0.0  * PORV SETPOINT (2 VALVES)
040060  -5  -4   25    0   2190.0    0.0  * RESET (ASSUMPTION)
*
*       PORV SETPOINTS = 2200/2215 PSIA (PAGE 17, SD-S01-280)
*
040070   6   4   25    0   2525.0    0.0  * SRV SETPOINT (2 VALVES)
040080  -6  -4   25    0   2450.0    0.0  * RESET (ASSUMPTION)
*
*       PZR SRV SETPOINTS = 2500/2525 PSIA (PAGE 19, SD-S01-280)
*
*
*        ---------- SECONDARY SAFETY VALVES ---------
*
040090   7   4   70    0   1000.0    0.0  * MSSV #1 SETPOINT
040100  -7  -4   70    0    950.0    0.0  * RESET (ASSUMPTION)
*
040110   8   4   70    0   1015.0    0.0  * MSSV #2 SETPOINT
040120  -8  -4   70    0    965.0    0.0  * RESET (ASSUMPTION)
*
040130   9   4   70    0   1035.0    0.0  * MSSV #3 SETPOINT
040140  -9  -4   70    0    985.0    0.0  * RESET (ASSUMPTION)
*
040150  10   4   70    0   1045.0    0.0  * MSSV #4 SETPOINT
040160 -10  -4   70    0    995.0    0.0  * RESET (ASSUMPTION)
*
040170  11   4   70    0   1050.0    0.0  * MSSV #5 SETPOINT
040180 -11  -4   70    0   1000.0    0.0  * RESET (ASSUMPTION)
*
040190  25   1    0    0      0.01   0.0  * LEAKAGE INITIALIZATION
*
*     $$$   VFN CHANGES   $$$
*      NEW TRIP SEQUENCE ADDED FOR CHARGING ACTUATION
*     $$$   VFN CHANGES   $$$
*
040200  26   1    0    0      0.01   0.0  * CHARGING INITIALIZATION
*
*
*
******************* VOLUME DATA - 05XXXY (Y=1) ***********************
*
*     $$$  VFN CHANGES MADE   $$$
*     IN VOLUME 6 (LOWER REACTOR VESSEL HEAD)
*        -- BUBBLE RISE MODEL INCLUDED (HAD NO B.R. MODEL)
*        -- INCLUDED OVERLAP OF 0.1 INCHES BETWEEN VOLUME 6 & 7
*           (HAD NO OVERLAP)
*     INLET AND OUTLET TEMPERATURES CORRECTED
*        -- VOLUME 1 TEMPERATURE 527 F (WAS 528 F)
*        -- VOLUME 9 TEMPERATURE 576 F (WAS 575 F)
*     IN VOLUMES 11, 16, 29, 34
```

```
*          INCLUDED OVERLAP OF 0.1 INCHES IN VERTICAL JUNCTIONS
*          BETWEEN THESE JUNCTIONS AND THOSE ABOVE THEM (I.E.
*          JUNCTIONS 12, 15, 30, 33)  (HAD NO OVERLAP)
*    $$$  VFN CHANGES MADE  $$$
*
*
*          1  2     3      4      5      6       7       8       9       10
*    Y   IB IR      P      H    X OR     VOL     ZVOL     ZM    FLOWL   FLOWA
*                                 XM
050011    0  0    0.0   520.1    0.0   758.7    9.82    9.82    9.82  1.0E+9
*                      (528.0 F)
050011    0  0    0.0   519.3    0.0   758.7    9.82    9.82    9.82  1.0E+9   *** THIS CARD IS A REPLACEMENT CARD.
*                      (527.0 F)
050021    0  0    0.0     0.0    0.0   117.0    3.33    3.33    3.33   46.60
050031    0  0    0.0     0.0    0.0   117.0    3.34    3.34    3.34   46.60
050041    0  0    0.0     0.0    0.0   117.0    3.33    3.33    3.33   46.60
050051    0  0    0.0     0.0    0.0   135.5    10.0    10.0    10.0    1.94
050061    0  0    0.0     0.0    0.0   734.0     9.5     9.5     9.5  1.0E+6
050061   10  0    0.0     0.0    0.0   734.0     9.6     9.6     9.6  1.0E+6   *** THIS CARD IS A REPLACEMENT CARD.
050071    4  0    0.0   579.9    0.0   383.1     6.5     6.5     6.5  1.0E+6
*                      (575.0 F)
050071    4  0    0.0   580.8    0.0   383.1     6.5     6.5     6.5  1.0E+6   *** THIS CARD IS A REPLACEMENT CARD.
*                      (576.0 F)
050081    0  0    0.0     0.0    0.0   393.0   23.25   23.25   18.33    16.9
050091    0  0    0.0     0.0    0.0    76.7     2.3     2.3     2.3    4.12
050101    0  0    0.0     0.0    0.0   103.7     7.5     7.5     7.5  1.0E+6
*
*50111    0  0    0.0     0.0    0.0   73.95   8.505   8.505   8.505     7.2
*50121    6  0    0.0     0.0    0.0   73.95   8.505   8.505   8.505     7.2
*50151    7  0    0.0     0.0    0.0   73.95   8.505   8.505   8.505     7.2
*50161    0  0    0.0     0.0    0.0   73.95   8.505   8.505   8.505     7.2
*
050111    0  0    0.0     0.0    0.0   59.25   8.505   8.505   8.505     5.8
050111    0  0    0.0     0.0    0.0   59.25   8.605   8.605   8.605     5.8   *** THIS CARD IS A REPLACEMENT CARD.
050121    0  0    0.0     0.0    0.0   59.25   8.505   8.505   8.505     5.8
050151    0  0    0.0     0.0    0.0   59.25   8.505   8.505   8.505     5.8
050161    0  0    0.0     0.0    0.0   59.25   8.505   8.505   8.505     5.8
050161    0  0    0.0     0.0    0.0   59.25   8.605   8.605   8.605     5.8   *** THIS CARD IS A REPLACEMENT CARD.
*                                    (20% TUBE PLUGGING)
*
050171    0  0    0.0     0.0    0.0   103.3     7.5     7.5     7.5  1.0E+6
050181    0  0    0.0     0.0    0.0   106.5     2.3     2.3     2.3    4.12
050191    0  0    0.0     0.0    0.0   133.0     5.0     5.0     5.0  1.0E+6
050201    0  0    0.0     0.0    0.0    53.5     2.3     2.3     2.3    4.12
050251    1  0 2100.0     0.0    0.0  1300.0   37.20   13.95   37.20   34.91
*
*         PZR NOMINAL WATER LEVEL  = 37.2 FT * 37.5% = 13.95
*
050261    5  0    0.0     0.0    0.0    24.5    5.13    5.13    5.13    0.55
050271    0  0 2105.53    0.0    0.0   153.4    2.30    2.30    2.30    8.24
050281    0  0    0.0     0.0    0.0   207.4     7.5     7.5     7.5  1.0E+6
*
*50291    0  0    0.0     0.0    0.0   147.9   8.505   8.505   8.505    14.4
*50301    8  0    0.0     0.0    0.0   147.9   8.505   8.505   8.505    14.4
*50331    9  0    0.0     0.0    0.0   147.9   8.505   8.505   8.505    14.4
*50341    0  0    0.0     0.0    0.0   147.9   8.505   8.505   8.505    14.4
*
050291    0  0    0.0     0.0    0.0   118.3   8.505   8.505   8.505    11.5
050291    0  0    0.0     0.0    0.0   118.3   8.605   8.605   8.605    11.5   *** THIS CARD IS A REPLACEMENT CARD.
050301    0  0    0.0     0.0    0.0   118.3   8.505   8.505   8.505    11.5
```

NES&L DEPARTMENT

CALCULATION SHEET

Project or DCP/MMP _____ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 39

REV	ORIGINATOR	DATE	IRE	DATE
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91

REV	ORIGINATOR	DATE	IRE	DATE

ICCN NO./ PRELIM. CCN NO.

CCN CONVERSION: CCN NO. CCN --

PAGE ___ OF ___

```
299   050331    0   0.0    0.0    0.0   118.3    8.505   8.505   8.505   11.5
300   050341    0   0.0    0.0    0.0   118.3    8.505   8.505   8.505   11.5
301   050341    0   0.0    0.0    0.0   118.3    8.605   8.605   8.605   11.5     *** THIS CARD IS A REPLACEMENT CARD.
302   *                                 (20% TUBE PLUGGING)
303   *
304   050351    0   0.0    0.0    0.0   206.6    7.5     7.5     7.5     1.0E+6
305   050361    0   0.0    0.0    0.0   213.0    2.3     2.3     2.3       8.24
306   050371    0   0.0    0.0    0.0   266.0    5.0     5.0     5.0     1.0E+9
307   050381    0   0.0    0.0    0.0   107.0    2.3     2.3     2.3       8.24
308   *
309   *  S/G VOLUME FLOW AREA WAS DIVIDED BY AN ASSUMED RECIRCULATION RATIO
310   *  (5.0 AT 100% POWER) TO ACCOUNT FOR THE MASS FLUX IN THE S/G 2ND SIDE.
311   *
312   *  S/G VOLUME WAS ADJUSTED IN SUCH A WAY THAT THE RETRAN CALCULATED MASS
313   *  INVENTORY AT STEADY-STATE FULL POWER IS EQUAL TO 43,000 LBM.
314   *
315   *    $$$  VFN CHANGES MADE  $$$
316   *     S.G. VOLUME (VOL. 50) ADJUSTED TO PRODUCE MASS OF 43,000 LBM
317   *     S.G. VOLUME (VOL. 60) ADJUSTED TO PRODUCE MASS OF 86,000 LBM
318   *    $$$  VFN CHANGES MADE  $$$
319   *
320   050501    2   0  547.0    0.0   -1.0  1310.0   37.0    24.2    37.0     7.66
321   050601    3   0  547.0    0.0   -1.0  2620.0   37.0    24.2    37.0    15.32
322   050501    2   0  547.0    0.0   -1.0  1395.0   37.0    24.2    37.0     7.66    *** THIS CARD IS A REPLACEMENT CARD.
323   050601    3   0  547.0    0.0   -1.0  2906.0   37.0    24.2    37.0    15.32    *** THIS CARD IS A REPLACEMENT CARD.
324   *
325   *
326   050701    0   0  520.0    0.0    0.0  1960.0   20.0    20.0   200.0     4.76
327   *           (ASSUMPTION)
328   051001    0   1    0.0    0.0    0.0  1.0E+6   10.0    10.0   100.0   1.0E+6
329   *
330   *
331   *
332   * ----  VOLUME DATA - 05XXXY (Y=2)
333   *
334   *              11        12        13        14        15        16
335   *     Y      DIAMV      ELEV      INEQ     VRAIN     VLHTC     MESH
336   *
337   050012         0.0     -24.40       0       0.0       0.0       0
338   050022      0.0454     -14.58       0       0.0       0.0       0
339   050032      0.0454     -11.25       0       0.0       0.0       0
340   050042      0.0454      -7.91       0       0.0       0.0       0
341   050052         0.0     -14.58       0       0.0       0.0       0
342   050062         0.0      -4.58       0       0.0       0.0       0
343   050072         0.0       4.92       0       0.0       0.0       0
344   050082         0.0     -18.33       0       0.0       0.0       0
345   050092         2.3      -1.15       0       0.0       0.0       0
346   050102         0.0      -1.15       0       0.0       0.0       0
347   050112      0.0533       6.35       0       0.0       0.0       0
348   050122      0.0533     14.855       0       0.0       0.0       0
349   050152      0.0533     14.855       0       0.0       0.0       0
350   050162      0.0533       6.35       0       0.0       0.0       0
351   050172         0.0      -1.15       0       0.0       0.0       0
352   050182         2.3      -1.15       0       0.0       0.0       0
353   050192         0.0      -1.15       0       0.0       0.0       0
354   050202         2.3      -1.15       0       0.0       0.0       0
355   *
356   050252        6.67       6.18       1       4.0       0.0       0
357   *  252        6.67       6.18       0       0.0       0.0       0
358   *
```

NES&L DEPARTMENT

CALCULATION SHEET

Project or DCP/MMP _____ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 40

REV	ORIGINATOR	DATE	IRE	DATE
	V. F. Nazarety	6/21/91	W. Alhassani	6/21/91

ICCN NO./ PRELIM. CCN NO. | PAGE __ OF __

CCN CONVERSION: CCN NO. CCN --

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE___ OF___
CCN CONVERSION: CCN NO. CCN --	

Project or DCP/MMP_____ Calc. No. **DC - 3601**

Subject **SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT** Sheet No. 41

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	V. F. Nazareth VFN	6/21/91	W. Alhassani WA	6/21/91						

```
050262      .833      1.15        0      0.0      0.0        0
050272       0.0      -1.15       0      0.0      0.0        0
050282       0.0      -1.15       0      0.0      0.0        0
050292    0.0754       6.35       0      0.0      0.0        0
050302    0.0754      14.855      0      0.0      0.0        0
050332    0.0754      14.855      0      0.0      0.0        0
050342    0.0754       6.35       0      0.0      0.0        0
050352       0.0      -1.15       0      0.0      0.0        0
050362      3.25      -1.15       0      0.0      0.0        0
050372       0.0      -1.15       0      0.0      0.0        0
050382      3.25      -1.25       0      0.0      0.0        0
050502       0.0       6.35       0      0.0      0.0        0
050602       0.0       6.35       0      0.0      0.0        0
050702       0.0       40.0       0      0.0      0.0        0
051002       0.0       35.0       0      0.0      0.0        0
*
*
*********************** BUBBLE DATA - 06XXX1 ***************************
*
*   $$$ VFN CHANGES MADE  $$$
*   BUBBLE RISE MODEL INCLUDED FOR VOLUME 6 (HAD NO B.R. MODEL)
*   $$$ VFN CHANGES MADE  $$$
*
*
*
* XXX     ALPH     VBUB    IDALPH   IDVBUB
*
060011     1.00     3.00       0        0      * PZR (VOL 25) - ASSUMPTION
*
060021     1.00    58.50       0        0      * S/G (VOL 50)
060031     1.00    58.50       0        0      * S/G (VOL 60)
*
060041     1.00     3.00       0        0      * R.V. UPPER HEAD (VOL 7)
*
060051     1.00     3.00       0        0      * SURGE LINE (VOL 26)
*
060061     1.00     3.00       0        0      * UPPER TUBE (VOL 12)
060071     1.00     3.00       0        0      * UPPER TUBE (VOL 15)
060081     1.00     3.00       0        0      * UPPER TUBE (VOL 30)
060091     1.00     3.00       0        0      * UPPER TUBE (VOL 33)
060101     1.00     3.00       0        0      * R.V. LOWER HEAD (VOL 6)
*
*     CALCULATION OF VBUB FOR VOL 50 AND VOL 60:
*
*     STEAM FLOWRATE = VOL. FLOW AREA * VBUB * STEAM DENSITY
*
*                          528.3
*     VBUB = ------------------------- (SEE DATA CARD 050501)
*                 7.66 * 1.1793
*
*          = 58.5  FT/SEC
*
*
********************* TIME-DEPENDENT VOLUME DATA - 07XXYY ******************
*
*     ---------- TURBINE-GENERATOR ----------
*
*
*
*          TIME        PRES        TEMP        AVG.        MIXL
```

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE___ OF___
	CCN CONVERSION: CCN NO. CCN --

Project or DCP/MMP _____ Calc. No. **DC - 3601**

Subject **SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT** Sheet No. **42**

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						

```
*** THIS CARD IS A REPLACEMENT CARD.
```

```
*** THIS CARD IS A REPLACEMENT CARD.
*** THIS CARD IS A REPLACEMENT CARD.
```

```
*
*
070101  2                                  (SEC)     (PSIA)      (F)        X         (FT)
070102                                      0.0       250.0       0.0       1.0        10.0
                                          1.0E+6      250.0       0.0       1.0        10.0
*
*
*       NOTE: THE TURBINE VOLUME IS TREATED AS A TDV IN ORDER TO
*             AVOID THE MASS FLOW IMBLANCE OCCURRING AT THE STEADY-
*             STATE.
*
*
*
*********************** JUNCTION DATA - 08XXXY (Y=1) **************************
*
*       $$$  VFN CHANGES MADE  $$$
*       RCS FLOW RATES CORRECTED (NO ADJUSTMENTS MADE TO MATCH
*       VENDOR THOT DATA)
*         -- JUNCTION 1 WP 19,361 LBM/SEC (WAS 20583)
*         -- JUNCTION 8 WP 6,759 LBM/SEC (WAS 7,110)
*         -- JUNCTION 9 WP 6,759 LBM/SEC (WAS 7,110)
*         -- JUNCTION 21 WP 20,278 LBM/SEC (WAS 21,330)
*         -- JUNCTION 31 WP 13,519 LBM/SEC (WAS 14,220)
*       NEW LEAKAGE JUNCTION (JUNCTION 51) INCLUDED FOR VOLUME 36 IN
*       ORDER TO BETTER REPRESENT THE ACTUAL LEAKAGE IN THE PLANT
*       THEREFORE :
*         -- JUNCTION 50 : ONE THIRD OF TOTAL LEAKAGE
*         -- JUNCTION 51 : TWO THIRDS OF TOTAL LEAKAGE
*       NEW JUNCTIONS (JUNCTIONS 48 & 49) INCLUDED FOR
*       VOLUMES 20 AND 38 TO REPRESENT CHARGING MAKEUP
*       THEREFORE :
*         -- JUNCTION 48 : ONE THIRD OF TOTAL CHARGING
*         -- JUNCTION 49 : TWO THIRDS OF TOTAL CHARGING
*       $$$  VFN CHANGES MADE  $$$
*
*
*
*       1  2  3  4     5        6        7        8        9        10
* XXXY  VI VO IP IV    WP       AJUN     ZJUN     INERTA   FJUNF    FJUNR
*
080011  1  2  0  0  20583.0     46.60    -14.58    0.034    0.45     1.0
080011  1  2  0  0  19361.0     46.60    -14.58    0.034    0.45     1.0
*
*       ASSUMING CORE BYPASS FLOW = 4.5% OF TOTAL CORE FLOW.
*
080021  2  3  0  0      0.0     46.60    -11.25    0.068    0.0      0.0
080031  3  4  0  0      0.0     46.60     -7.91    0.068    0.0      0.0
080041  4  6  0  0      0.0     48.60     -4.58    0.034    1.0      0.45
080051  7  6  0  0      0.0     50.00      4.92    0.100    0.0      0.0
080061  1  5  0  0      0.0     13.55    -14.58    0.357    0.45     1.0
080071  5  6  0  0      0.0     13.55     -4.58    0.357   -1.0      0.45
080081  6  9  0  0   7110.0      4.15      0.0     2.241   -1.0      1.0
080091  9 10  0  0   7110.0      4.15      0.0     2.241    0.2      0.2
080081  6  9  0  0   6759.0      4.15      0.0     2.241   -1.0      1.0
080091  9 10  0  0   6759.0      4.15      0.0     2.241    0.2      0.2
*
*       THE CORE FLOWRATE HAS BEEN ADJUSTED TO MATCH THE THOT WITH
*       VENDOR'S RESULT.
*
080101 10 11  0  0      0.0      7.2      6.35     0.788    0.45     1.0
080111 11 12  0  0      0.0      7.2     14.855    1.182    0.0      0.0
080131 12 15  0  0      0.0      7.2     20.50     1.182    0.2      0.2
080151 15 16  0  0      0.0      7.2     14.855    1.182    0.0      0.0
```

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO. | PAGE___ OF___

Project or DCP/MMP_____ Calc. No. **DC - 3601**

CCN CONVERSION: CCN NO. CCN --

Subject **SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT** Sheet No. 43

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
1	V. F. Nazareth VFN	6/21/91	W. Alhassani WAA	6/21/91						

*** THIS CARD IS A REPLACEMENT CARD.

*** THIS CARD IS A REPLACEMENT CARD.

```
080161   17  0  0      0.0     7.2      6.35     0.788     1.0     0.45
080171   17  18 0  0   0.0     4.15     0.0      2.961     0.2     0.2
080181   18  19 -1 0   0.0     4.15     0.0      2.961     0.0     7.5
080191   19  20 1  0   0.0     4.15     0.0      1.578     0.0     7.5
080201   20  8  0  0   0.0     4.15     0.0      1.578     0.2     0.45
080211   8   1  0  0 21330.0   16.9   -18.33     1.376     0.0     0.0
080211   8   1  0  0 20278.0   16.9   -18.33     1.376     0.0     0.0
*
080251   0   25 5  0   0.0     1.0      43.3     0.0       0.0     0.0
080261   0   25 6  0   0.0     1.0      43.3     0.0       0.0     0.0
*
080291   25  26 0  0   0.0     0.55     6.18     40.818    1.0     1.0
080301   26  9  0  0   0.0     0.55     1.15     40.818    1.0     1.0
080311   6   27 0  0 14220.0   8.30     0.0      1.129    -1.0     1.0
080311   6   27 0  0 13519.0   8.30     0.0      1.129    -1.0     1.0
080321   27  28 0  0   0.0     8.30     0.0      1.129     0.2     0.2
080331   28  29 0  0   0.0     14.4     6.35     0.394     0.45    1.0
080341   29  30 0  0   0.0     14.4     14.855   0.788     0.0     0.0
080361   30  33 0  0   0.0     14.4     20.50    0.788     0.2     0.2
080381   33  34 0  0   0.0     14.4     14.855   0.788     0.0     0.0
080391   34  35 0  0   0.0     14.4     6.35     0.394     0.2     0.2
080441   35  36 0  0   0.0     8.3      0.0      1.480     0.0     0.0
080451   36  37 -2 0   0.0     8.3      0.0      1.480     0.0     7.5
080461   37  38 2  0   0.0     8.3      0.0      0.789     0.2     7.5
080471   38  8  0  0   0.0     8.3      0.0      0.789    -1.0     0.45
*
080481   0   20 14 0   0.0     1.0      0.0      0.0       0.0     0.0
080491   0   38 14 0   0.0     2.0      0.0      0.0       0.0     0.0
*
080501   0   18 13 0   0.0     1.0      0.0      0.0       0.0     0.0
080511   0   36 13 0   0.0     2.0      0.0      0.0       0.0     0.0
*
080601   0   50 1  0   0.0     1.0      6.4      0.0       0.0     0.0
080691   0   50 3  0   0.0     1.0      6.4      0.0       0.0     0.0
*
080701   0   60 2  0   0.0     1.0      6.4      0.0       0.0     0.0
080791   0   60 4  0   0.0     1.0      6.4      0.0       0.0     0.0
*
080811   50  70 0  0 528.3     4.76     43.35    21.01    -1.0    -1.0
080911   60  70 0  0 1056.6    4.76     43.35    21.01    -1.0    -1.0
*
081001   70  100 0 1   0.0     9.52     43.35    21.01    -1.0    -1.0
*
081021   0   70 7  0   0.0     1.0      60.0     0.0       0.0     0.0
081041   0   70 8  0   0.0     1.0      60.0     0.0       0.0     0.0
081061   0   70 9  0   0.0     1.0      60.0     0.0       0.0     0.0
081081   0   70 10 0   0.0     1.0      60.0     0.0       0.0     0.0
081101   0   70 11 0   0.0     1.0      60.0     0.0       0.0     0.0
*
081201   0   70 12 0   0.0     1.0      60.0     0.0       0.0     0.0
*
*
****** JUNCTION DATA - 08XXXY (Y=2)
*   $$$ VFN CHANGES MADE  $$$
*   NEW JUNCTION 51 CARD IN THIS SECTION-
*   $$$ VFN CHANGES MADE  $$$
*
*
*       11  12   13  14  15    16   17   18    19    20  21
*   Y JVERT CHOK JCA MIX DIAMJ CNTR REGM 2PHS ANGL INDEX ISP
```

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE___ OF___
	CCN CONVERSION: CCN NO. CCN --

Project or DCP/MMP_____ Calc. No. **DC - 3601**

Subject **SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT** Sheet No. **44**

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	V. F. Nazareth VFN	6/21/91	W. Alhassani WA	6/21/91						

```
*
080012  -1  0  0  0.0445  1.0  0  0  0.0  2  0
080022   0  0  0  0.0445  1.0  0  0  0.0  3  0
080032  -1  0  0  0.0445  1.0  0  0  0.0  3  0
080042  -1  0  0  0.0445  1.0  0  0  0.0  1  0
080052  -1  0  0  8.00    1.0  0  0  0.0  0  0
080062  -1  0  0  4.22    1.0  0  0  0.0  0  0
080072  -1  0  0  4.22    1.0  0  0  0.0  0  0
080082   1  0  0  2.30    1.0  0  0  0.0  0  0
080092   1  0  0  2.30    1.0  0  0  0.0  0  0
080102  -1  0  0  0.0533  1.0  0  0  0.0  2  0
080112  -1  0  0  0.0533  1.0  0  0  0.0  3  0
080132   1  0  0  0.0533  1.0  0  0  0.0  3  0
080152  -1  0  0  0.0533  1.0  0  0  0.0  3  0
080162  -1  0  0  0.0533  1.0  0  0  0.0  1  0
080172   1  0  0  2.30    1.0  0  0  0.0  0  0
080182   1  0  0  2.30    1.0  0  0  0.0  0  0
080192  -1  0  0  2.30    1.0  0  0  0.0  0  0
080202   1  0  0  2.30    1.0  0  0  0.0  0  0
080212   1  0  0  4.64    1.0  0  0  0.0  0  0
*
080252   0  -1  0  1.0     1.0  0  0  180.0  0  1
080262   0  -1  0  1.0     1.0  0  0  180.0  0  0
*
080292   1  -1  0  0.84    1.0  0  0  0.0  0  0
080302   0  -1  0  3  0.84  1.0  0  0  0.0  0  0
080312   1  -1  0  0  3.25  1.0  0  0  0.0  0  0
080322   1  -1  0  0  3.25  1.0  0  0  0.0  0  0
080332   0  -1  0  0  0.0533  1.0  0  0  0.0  2  0
080342   0  -1  0  0  0.0533  1.0  0  0  0.0  3  0
080362   1  -1  0  0  0.0533  1.0  0  0  0.0  3  0
080382   0  -1  0  0  0.0533  1.0  0  0  0.0  3  0
080392   0  -1  0  0  0.0533  1.0  0  0  0.0  1  0
080442   1  -1  0  0  3.25    1.0  0  0  0.0  0  0
080452   1  -1  0  0  3.25    1.0  0  0  0.0  0  0
080462   1  -1  0  0  3.25    1.0  0  0  0.0  0  0
080472   1  -1  0  0  3.25    1.0  0  0  0.0  0  0
*
080482   0  -1  0  0  1.0     1.0  0  0  0.0  0  0
080492   0  -1  0  0  1.0     1.0  0  0  0.0  0  0
*
080502   0  -1  0  0  1.0     1.0  0  0  180.0  0  0
080512   0  -1  0  0  1.0     1.0  0  0  180.0  0  0
*
080602   0  -1  0  0  1.0     1.0  0  0  0.0  0  0
080692   0  -1  0  0  1.0     1.0  0  0  0.0  0  0
*
080702   0  -1  0  0  1.0     1.0  0  0  0.0  0  0
080792   0  -1  0  0  1.0     1.0  0  0  0.0  0  0
*
080812   0  -1  0  0  2.46    1.0  0  0  0.0  0  0
080912   0  -1  0  0  2.46    1.0  0  0  0.0  0  0
*
081002   0  -1  0  0  1.0     1.0  0  0  0.0  0  0
*
081022   0  -1  0  0  1.0     1.0  0  0  180.0  0  0
081042   0  -1  0  0  1.0     1.0  0  0  180.0  0  0
081062   0  -1  0  0  1.0     1.0  0  0  180.0  0  0
081082   0  -1  0  0  1.0     1.0  0  0  180.0  0  0
081102   0  -1  0  0  1.0     1.0  0  0  180.0  0  0
```

```
*
081202    0   -1    0    0   1.0      1.0    0     0  180.0    0    0
*
*
****************** PUMP CURVE SET INPUT FLAGS - 100000 ******************
*
*
*       NOTE: UNIQUE PUMP CURVE SET IS USED, I.E. J = 1.
*
*            J         J
*       NPC(1)    NC(1)
*
100000    2           0
*
*
********************* PUMP DESCRIPTION DATA - 090XXY ********************
*
*       WHERE XX = IPUMP (SEE M3 ON CARDS 08XXXY),
*       AND   XX = 01 ( RCP  B ),
*                = 02 ( RCPS A & C).
*
*       REFERENCE: SONGS1 STATION MANUAL EQUIPMENT MANUAL DATA, VOL. 3.
*
*
*  XXY IPC ITPUMP IRP IPM IMT  POMGAR  PSRAT   PFLOWR   PHEADR  PTORKR
*                              (RPM)           (GPM)     (FT)  (LBF-FT)
*
090011  1     2    0   0   0   1180.0   1.0    69560.0   200.0  13887.0
*
090021  1     2    0   0   0   1180.0   1.0   139120.0   200.0  27773.0
*
*
*  XXY      PINRTA       VRHOI    TORKMR   TORKF1   TORKF2   TORKF3   TORKF4
*         (LBM-FT**2)             (LBF-FT) (S**0)   (S**1)   (S**2)   (S**3)
*
090012     45000.0       0.0      0.0       0.0      0.0      0.0      0.0
*
090022     90000.0       0.0      0.0       0.0      0.0      0.0      0.0
*                                          (-------- ASSUMPTION --------)
*
* NOTE: THE RCP FLYWHEEL INERTIA IS 45,000 LBM/FT**2 (SEE SONGS1 SYSTEM
*       DESCRIPTION SD-SO1-300, P. 5)
*
*       PUMP MOTOR TORQUE = PUMP MOTOR POWER / PUMP SPEED
*                         = 2.2E+6 (LBF-FT/SEC)/123.57 (RAD/SEC)
*                         = 1.78E+4 LBF-FT
*       WHERE
*
*            PUMP MOTOR POWER  = 4000 HORSE POWER (P. 1-6, REF.)
*                              = 4000 (HP) * 2545 (BTU/HR)/(HP) * 778.2
*                                (LBF-FT)/(BTU) * 1 (HR)/3600(SEC)
*                              = 2.2E+6 LBF-FT/SEC
*
*            PUMP SPEED        = 1180 RPM (P. 1-5, REF.)
*                              = 1180 * (2 * 3.2416/60) RAD/SEC
*                              = 123.57 RAD/SEC
*
*       HYDRAULIC TORQUE  = OVERALL EFFICIENCY (P. 1-8, REF.)
*                           * PUMP MOTOR TORQUE
*                         = 0.78 * 1.78E+4
```

NES&L DEPARTMENT

CALCULATION SHEET

Project or DCP/MMP _____ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 45

REV	ORIGINATOR	DATE	IRE	DATE
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91

REV	ORIGINATOR	DATE	IRE	DATE

ICCN NO./ PRELIM. CCN NO.

CCN CONVERSION: CCN NO. CCN --

PAGE ___ OF ___

```
*                    = 13887. LBF-FT
*
*
****************** PUMP STOP DATA - 095XX1 ****************************
*
*
*          ELAPSED TIME       FORWARD        REVERSE
*95XX1        (SEC)          RPM (MAX)      RPM (MAX)
*
095011          0.0              0.0          -1.0E-6        * B
095021          0.0              0.0          -1.0E-6        * A & C
*
*
****************** PUMP MOTOR TORQUE DATA - 097XXY ********************
*
*
*            (MAY BE USED FOR THE CASE OF PUMP RESTART)
*
*
*                      TIME      SPEED
*  XXY      NTMO         SEC       RPM
*
*097011      -3           0.0       0.0
*097012                  10.0    1180.0
*097013                1.0E+6    1180.0
*
*
************************ VALVE DATA - 11XXX0 ****************************
*
*
*            NOTE: XXX = IVALVE (W4 IN CARDS 08XXXY)
*
* XXX0   ITCV   IACV  IACV2   PCV  CV1  CV2  CV3
*      (TRIPID)
*
110010     2      1     0     0.0  0.0  0.0  0.0   * CLOSE TURBINE STOP
*                                                    VALVE - JUN 100
*
*
************************ GENERAL DATA - 12XXYY ****************************
*
*
*                          VALVE                  * ------- TABLE 1 -------
* XXYY     N      TIME     POSITION                * CLOSING CURVE FOR JUN 100
*                                                  * ON LOSS OF CONDENSER
120101    -3        0.0       1.0                 * (ASSUMPTION)
120102              1.0       0.0
120103            1.0E+6      0.0
*
*
*                 DELTA     VALVE POSI.           * ------- TABLE 2 -------
* XXYY     N      TEMP.       DEMAND              * MASTER CONTROLLER
*
120201    -4     -1.0E+6        0.0
120202              0.0          0.0
120203              6.67         1.0
120204            1.0E+6         1.0
*
*
*              VALVE POSI. "BYPASS" VALVE  * ------- TABLE 3 --------
```

NES&L DEPARTMENT

CALCULATION SHEET

Project or DCP/MMP _____ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 46

REV	ORIGINATOR	DATE	IRE	DATE
	V. F. Nazareth VFN	6/21/91	W. Alhassani	6/21/91

ICCN NO./ PRELIM. CCN NO. PAGE ___ OF ___

CCN CONVERSION: CCN NO. CCN --

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE___ OF___
CCN CONVERSION: CCN NO. CCN --	

Project or DCP/MMP_____ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 47

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth VFN	6/21/91	W. Alhassani WA	6/21/91						

```
719 * XXYY    DEMAND    POSI. DEMAND
 0  *
 1  120301  -5  -1.0E+6      0.0
/22 120302          0.0      0.0
723 120303          0.5      1.0
724 120304          1.0      1.0
725 120305      1.0E+6       1.0
726 *
727 *
728 *                  VALVE POSI.          "ADV"          * ------- TABLE 4 --------
    *              N   DEMAND           POSI. DEMAND
 0  *
 31 120401  -4  -1.0E+6      0.0
/32 120402          0.5      0.0
733 120403          1.0      1.0
734 120404      1.0E+6       1.0
735 *
736 *                                   VALVE          * ------- TABLE 5 -------
737 *              N   TIME             POSITION       * FOR QUICK-OPEN MODE
738 *                  (SEC)                           * ASSUMING FULL OPENED WITHIN
739 *
740 120501  -6  -1.0E+6      0.0                      * 1.0 SECOND AND LASTS FOR 10
741 120502          0.0      0.0                      * SECONDS.
742 120503          1.0      1.0
743 120504         10.0      1.0
744 120505         10.1      0.0
745 120506      1.0E+6       0.0
746 *
747 *
748 *                  VALVE POSI.          VALVE          * ------- TABLE 6 -------
749 *              N   ERROR                SPEED          * VALVE SPEED FOR MODULATION
750 *                                                      * MODULATION SPEED = 10 SEC
751 120601  -5  -1.0E+6     -0.1
752 120602          -1.0E-6  -0.1
753 120603          0.0      0.0
754 120604          1.0E-6   0.1
755 120605          1.0E+6   0.1
756 *
757 *
758 *                  TIME                 OUTPUT         * ------- TABLE 7 --------
759 *              N   (SEC)                               *
760 *                                                      * ADVS ARE IN AUTOMATIC MODE.
761 120701  -4  -1.0E+6      1.0
762 120702          180.0    1.0
763 120703          180.1    0.0
764 120704      1.0E+6       0.0
765 *
766 *
767 *                  TIME                 OUTPUT         * ------- TABLE 8 --------
768 *              N   (SEC)                               *
769 *                                                      * ADVS ARE MANUALLY REGULATED.
770 120801  -4  -1.0E+6      0.0
771 120802          180.0    0.0
772 120803          180.1    1.0
773 120804      1.0E+6       1.0
774 *
775 *
776 *                  DELTA T              OUTPUT         * ------- TABLE 9 --------
777 *              N   (F)
778 *
```

```
779   120901      4   -1.0E+6          0.0
780   120902          0.0              0.0
781   120903          0.1              1.0
782   120904         1.0E+6            1.0
783   *
784   *
785   *                 S/G
786   *           N     NR LEVEL       OUTPUT     * ------- TABLE 10 ------
787   *
788   121001     -4     -1.0E+6          1.0      * OPERATOR ACTION ON S/G
789   121002            0.50             1.0      * LEVEL CONTROL
790   121003            0.70             0.0      * (ASSUMPTION)
791   121004           1.0E+6            0.0
792   *
793   *
794   *                 S/G PRES.       AUXFW     * ------- TABLE 11 --------
795   *           N      (PSIA)      (GPM/SQ.FT)
796   *
797   121101     -9        0.0           123.3    * REFERENCE:
798   121102              995.0           123.3    * FIG. 21, DESIGN CALC. NO.
799   121103             1030.0           115.0    * DC-2836, SHEET R5-6A.
800   121104             1055.0           108.3
801   121105             1125.0            88.3
802   121106             1155.0            78.3
803   121107             1185.0            64.3
804   121108             1215.0            50.0
805   121109             1240.0            33.3
806   *
807   *
808   *
809   ************************** FILL TABLE - 13XXYY ************************
810   *
811   *
812   *          ---------- TABLE 1 (S/G B MFW - JUN 60) ----------
813   *
814   *
815   *              TRIP    JX        TIME       FLUX          H       PSIA
816   * XXYY   N     ID  (TIME) JY     (S)  (LB/SEC-FT**2)
817   *
818   130101  -3     4      0     0    0.0        528.3       394.0    700.0
819   130102                             1.0          0.0       394.0    700.0
820   130103                          1.0E+6          0.0       394.0    700.0
821   *
822   * NOTE: TOTAL MFW FLOWRATE AT FULL POWER IS 5.706E+6 LBM/HR (SEE P.20-1,
823   *       SONGS1 STATION MANUAL).
824   *
825   *
826   *          ---------- TABLE 2 (S/GS A&C MFW - JUN 70) ---------
827   *
828   *              TRIP    JX        TIME       FLUX          H       PSIA
829   * XXYY   N     ID  (TIME) JY     (S)  (LB/SEC-FT**2)
830   *
831   130201  -3     4      0     0    0.0       1056.6       394.0    700.0
832   130202                             1.0          0.0       394.0    700.0
833   130203                          1.0E+6          0.0       394.0    700.0
834   *
835   *
836   *          ---------- TABLE 3 (S/G B AUXFW - JUN 69) ----------
837   *
838   *
```

NES&L DEPARTMENT

CALCULATION SHEET

Project or DCP/MMP _____ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 48

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						

ICCN NO./ PRELIM. CCN NO. _____ PAGE ___ OF ___

CCN CONVERSION: CCN NO. CCN --

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE___ OF___
	CCN CONVERSION: CCN NO. CCN --

Project or DCP/MMP_____ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 49

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
△	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91	△					
△					△					↓

```
*
* XXYY  N  TRIP ID  JX-CNTL BLK ID  JY  DUMMY VALUE  FLUX (GPM/FT**2)  H  PSIA
*
130301   1  1000     -24            1   0.0          0.0                40.8  1000.0
*                                                                      (70.0 F)
*
*---------- TABLE 4 (S/GS A&C AUXFW - JUN 79) ----------
*
*---------- TABLE 5 (PORVS - JUN 25) ----------
*
*          TRIP                JX  JY  PRES      FLUX
* XXYY     N  ID               JX      JY  (PSIA)  (LBM/S-FT**2)  H  PSIA
*
130501   -4  5  1  0  0.0  0.0  1.0  1.0
130502                  2215.0  0.0  1.0  1.0
130503                  2281.5  -66.75  1.0  1.0
130504                  1.0E+6  -66.75  1.0  1.0
*                                 (2 PORVS)
*
*  A 3% OF ACCUMULATION RATIO IS ASSUMED.
*  REF: SEE P. 17 OF SD-SO1-280 FOR PORV SETPOINT AND CAPACITY.
*
*---------- TABLE 6 ( SRVS - JUN 26) ----------
*
*          TRIP                JX  JY
* XXYY     N  ID               (PSIA)      PRES  FLUX (LBM/S-FT**2)  H  PSIA
*
130601   -4  6  1  0  0.0  0.0  1.0  1.0
130602                  2525.0  0.0  1.0  1.0
130603                  2601.0  -133.33  1.0  1.0
130604                  1.0E+6  -133.33  1.0  1.0
*                                 (2 SRVS)
*
*  A 3% OF ACCUMULATION RATIO IS ASSUMED.
*  REF.: SEE P. 19 OF SD-SO1-280 FOR SRV SETPONT AND CAPACITY.
*
*---------- TABLES 7 - 11 (MSSV) ----------
*
*  REF.: SD-SO1-190
*
*          TRIP  JX                  FLUX  H  PSIA
* XXYY     N  ID  (PSIA)  JY  PRES  (LBM/FT**2-S)
*
130701   -4  7  1  0  0.0  0.0  1.0  1.0  * --JUN 102--
130702                  1000.0  0.0  1.0  1.0  * VALVES WITH
130703                  1030.0  -332.6  1.0  1.0  * SETPOINT =
130704                  1.0E+6  -332.6  1.0  1.0  * 1000.0 PSIA
*                                 (2 VALVES)
*
130801   -4  8  1  0  0.0  0.0  1.0  1.0  * --JUN 104--
130802                  1015.0  0.0  1.0  1.0  * VALVES WITH
130803                  1045.5  -337.6  1.0  1.0  * SETPOINT =
130804                  1.0E+6  -337.6  1.0  1.0  * 1015.0 PSIA
*
```

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE___ OF___
	CCN CONVERSION: CCN NO. CCN --

Project or DCP/MMP_____ Calc. No. **DC - 3601**

Subject **SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT** Sheet No. 50

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth VFN	6/21/91	W. Alhassani WA	6/21/91						

*** THIS CARD IS A REPLACEMENT CARD.
*** THIS CARD IS A REPLACEMENT CARD.

```
*
130901                9   1    0     0.0        0.0        1.0    1.0   * --JUN 106--
130902                                1035.0     0.0        1.0    1.0   * VALVES WITH
130903                                1066.0     -344.3     1.0    1.0   * SETPOINT =
130904                                1.0E+6     -344.3     1.0    1.0   * 1035.0 PSIA
*
*
131001  -4   10   1    0     0.0        0.0        1.0    1.0   * --JUN 108--
131002                                1045.0     0.0        1.0    1.0   * VALVES WITH
131003                                1076.0     -347.6     1.0    1.0   * SETPOINT =
131004                                1.0E+6     -347.6     1.0    1.0   * 1045.0 PSIA
*
*
131101  -4   11   1    0     0.0        0.0        1.0    1.0   * --JUN 110--
131102                                1050.0     0.0        1.0    1.0   * VALVES WITH
131103                                1082.0     -349.3     1.0    1.0   * SETPOINT =
131104                                1.0E+6     -349.3     1.0    1.0   * 1050.0 PSIA
*
*
*  ------------ TABLE 12 (ADV - JUN 120) ------------
*
*
*                                                CNTL BLK
*                 TRIP   JX-CNTL      DUMMY      OUTPUT
*  XXYY   N       ID     BLK ID   JY  VALUE      (LBM/S-FT**2)      H     PSIA
*
131201   1     1000      -19      0   0.0            0.0            1.0   1.0
*
*
*  ------------ TABLE 13 (LEAKAGE - JUN 50) ------------
*
*
*  $$$ VFN CHANGES MADE  $$$
*    FOR FIRST 2 MINUTES OF SBO LEAKAGE IS 74.67 GPM/S.G.
*    FOR REMAINING TIME OF SBO LEAKAGE IS 44.1 GPM/S.G.
*  $$$ VFN CHANGES MADE  $$$
*
*
*                 TRIP                 TIME       FLUX
*  XXYY   N       ID     JX   JY       (S)        (GPM/FT**2)        H     PSIA
*
131301  -2     25        0    1        0.0        -35.4              1.0   1.0
131302                                 1.0E+6     -35.4              1.0   1.0
131301  -4     25        0    1        0.0        -74.67             1.0   1.0
131302                                 120.0      -74.67             1.0   1.0
131303                                 120.1      -44.10             1.0   1.0
131304                                 1.0E+6     -44.10             1.0   1.0
*
*
*  ------ TABLE 14 (CHARGING - JUN 48 & 49) -------
*
*  $$$ VFN CHANGES MADE  $$$
*    FOR FIRST ONE HOUR OF SBO CHARGING IS 0.0 GPM/LOOP
*    FOR REMAINING TIME OF SBO CHARGING IS 65.5 GPM/LOOP
*  $$$ VFN CHANGES MADE  $$$
*
*
*                 TRIP                 TIME       FLUX
*  XXYY   N       ID     JX   JY       (S)        (GPM/FT**2)        H     PSIA
*
131401  -4     26        0    1        0.0        0.0                1.0   1.0
131402                                 3600.0     0.0                1.0   1.0
```

```
131403                    3600.1      65.5      1.0      1.0
131404                    1.0E+6      65.5      1.0      1.0
*
*
*
************************** POINT KINETICS DATA **************************
*
*
*     REF.: ANALYSIS OF ATWS FOR SONGS1, NUS REPORT, OCTOBER 1974
*
*
*         KMUL     BOVL      RHOIN      UDUF      PROMPT      LAMBDA      TAU
*
140000     0.0     596.1      0.0        1.0        1.0         0.0        0.0
*
*         BOVL = EFFECTIVE BETA / NEUTRON LIFE TIME
*              = 0.00608 / 10.2E-6 (SEE P.4-4, ABOVE REFERENCE)
*              = 596.1
*
*
* ---------------------- DELAYED NEUTRON DATA -------------------------
*
*
*         DLAMDA1   DLAMDA2   DLAMDA3   DLAMDA4   DLAMDA5   DLAMDA6
*
140001    0.0126    0.0309    0.1173    0.3149    1.2639    3.3795
*
*
*         AJOVRJ1   AJVORJ2   AJVORJ3   AJVORJ4   AJVORJ5   AJVORJ6
*
140002    0.0300    0.2080    0.1892    0.3914    0.1360    0.0454
*
*
* ---------------------- REACTIVITY COEFFICIENT ------------------------
*
*
*                                        DOPPLER TEMP.      WATER TEMP
*           DENWT          FTWT          COEF ($/F)         COEF ($/F)
*
140010      0.333          0.333         -8.3333E-4           0.0
140020      0.334          0.334         -8.3333E-4           0.0
140030      0.333          0.333         -8.3333E-4           0.0
*             (ASSUMPTION)              (SEE CALC BELOW)
*
*                                                (1)
*           AVG. FUEL TEMP                 DOPPLER REAC.
*                (F)                           ($)
*
*              1200.0                         0.5
*              1400.0                         0.0
*                                                  0.0 - 0.5
*           DOPPLER TEMPERATURE COEFFICIENT = ------------- / 3
*           (PER CORE CONDUCTOR)                 1400 - 1200
*
*                                          = -8.3333E-4 $/F
*
*       REF. (1): FIG. 4-30, A PARAMETRIC STUDY OF AN ATWS IN A W FOUR-
*                 LOOP PLANT, NSAC-91, NOVEMVER 1985.
*
```

NES&L DEPARTMENT

CALCULATION SHEET

Project or DCP/MMP _____ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 51

REV	ORIGINATOR	DATE	IRE	DATE
	V.F. Nazareth	6/21/91	W. Alhassani	6/21/91

REV	ORIGINATOR	DATE	IRE	DATE

ICCN NO./ PRELIM. CCN NO. PAGE __ OF __

CCN CONVERSION: CCN NO. CCN -

```
1019    *          E: VARIATION OF THE DOPPLER REACTIVITY RESULTS IN LITTLE
1020    *             DIFFERENCE BETWEEN PRIMARY PRESSURE PEAKS AND TOTAL
1021    *             REACTIVITY AS SHOWN IN FIGS. 4-28 AND 4-29, RESPECTIVELY,
1022    *             IN THE REF. (1).
        *
        *
1025    *       ----------------- SCRAM TABLE ------------------
1026    *
1027    *
1028    *  XYY        N        TRIP        TIME          $
1029    *                      ID         (SEC)
1030    141001       -3         2           0.0          0.0
1031    141002                             3.0        -10.0
        141003                          1.0E+6        -10.0
        *
        *
        *       ---------- DENSITY REACTIVITY TABLE ----------
1036    *
1037    *
1038    *       REF.: A PARAMETRIC STUDY OF AN ATWS IN A W FOUR-LOOP PLANT,
1039    *             NSAC-91, NOVEMBER 1985.
1040    *
1041    *
1042    *       NOTE: SEE FIG. A-2 OF THE ABOVE REFERENCE FOR THE DENSITY
1043    *             REACTIVITY CURVE.
1044    *
1045    *
1046    *                        WATER DENSITY          $
1047    *   XX        N          (LBM/FT**3)
1048    *
1049    *142000       -9             31.84           -4.37      * -4.0 PCM/F
1050    *142001                      33.40           -3.26
1051    *142002                      34.96           -2.36
1052    *142003                      36.52           -1.63
1053    *142004                      38.08           -1.11
1054    *142005                      39.64           -0.69
1055    *142006                      41.20           -0.34
1056    *142007                      42.76           -0.17
1057    *142008                      44.33            0.0
1058    *
1059    *
1060    *142000      -9             31.84           -5.67      * -8.0 PCM/F
1061    *142001                     33.40           -4.4
1062    *142002                     34.96           -3.3
1063    *142003                     36.52           -2.37
1064    *142004                     38.08           -1.6
1065    *142005                     39.64           -1.05
1066    *142006                     41.20           -0.61
1067    *142007                     42.76           -0.28
1068    *142008                     44.33            0.0
1069    *
1070    *
1071    *
1072    142000       -9             31.84           -3.02      * 0.0 PCM/F
1073    142001                      33.40           -2.15
1074    142002                      34.96           -1.43
1075    142003                      36.52           -0.91
1076    142004                      38.08           -0.50
        142005                      39.64           -0.28
        142006                      41.20           -0.11
```

NES&L DEPARTMENT

CALCULATION SHEET

Project or DCP/MMP _____ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 52

REV	ORIGINATOR	DATE	IRE	DATE
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91

REV	ORIGINATOR	DATE	IRE	DATE

ICCN NO./ PRELIM. CCN NO.

CCN CONVERSION: CCN NO. CCN --

PAGE ___ OF ___

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE___ OF___
CCN CONVERSION: CCN NO. CCN --	

Project or DCP/MMP_____ Calc. No. **DC - 3601**

Subject **SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT** Sheet No. 53

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
△	V. F. Nazareth VFN	6/21/91	W. Alhassani WA	6/21/91	△					
△					△					↓

```
142007                                  42.76          -0.05
142008                                  44.33           0.0
*
*
*  ---------- DOPPLER REACTIVITY TABLE ----------
*
*  XX     N
*
143000    0
*
*  ---------- DIRECT MODERATOR HEATING ----------
*
*  XX      QP(I)       QD(I)
*
144000     0.025        0.0          * ASSUMPTION
144001     0.025        0.0          * ASSUMPTION
144002     0.025        0.0          * ASSUMPTION
*
*
*
**********  HEAT CONDUCTOR DATA - 15XXXY **********
*
*
*          XXX = HEAT CONDUCTOR NUMBER
*
*        IVSL IVSR IGOM CELEV IMCL IMCR  ASUL      ASUR      VOLS
*         W1   W2   W3   W4    W5   W6    W7        W8        W9
* XXXY
150011    0    2    1   0.0    2    2     0.0     10407.3     91.5  * CORE
150021    0    3    1   0.0    2    2     0.0     10407.3     91.5
150031    0    4    1   0.0    2    2     0.0     10407.3     91.5
*
150041   11   50    2  4.2525  2    2    4727.5     5540.0    25.95 * S/G #B TUBES
150051   12   50    2 12.7575  2    2    4727.5     5540.0    25.95
150061   15   50    2 12.7575  2    2    4727.5     5540.0    25.95
150071   16   50    2  4.2525  2    2    4727.5     5540.0    25.95
*
150081   29   60    2  4.2525  2    2    9454.8     11080.0   51.75 * S/G A&C TUBES
150091   30   60    2 12.7575  2    2    9454.8     11080.0   51.75
150101   33   60    2 12.7575  2    2    9454.8     11080.0   51.75
150111   34   60    2  4.2525  2    2    9454.8     11080.0   51.75
*
*         HDML      HDMR      DHEL      DHER      CHNL      CHNR     IHXQF   NTUBES
*         W10       W11       W12       W13       W14       W15      W16     W17
* XXXY
150012    0.0      0.0454     0.0      0.0454     0.00      3.33      0
150022    0.0      0.0454     0.0      0.0454     0.00      3.34      0
150032    0.0      0.0454     0.0      0.0454     0.00      3.33      0
*
150042   0.0533    0.0918    0.0533    0.0980    8.505     8.505     1
150052   0.0533    0.0918    0.0533    0.0980    8.505     8.505     1
150062   0.0533    0.0918    0.0533    0.0980    8.505     8.505     1
150072   0.0533    0.0918    0.0533    0.0980    8.505     8.505     1
*
150082   0.0533    0.0918    0.0533    0.0980    8.505     8.505     2
```

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE__ OF__
CCN CONVERSION: CCN NO. CCN --	

Project or DCP/MMP_____ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 54

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	V. F. Nazareth VFN	6/21/91	W. Alhassani WA	6/21/91						
1										

```
1139  150092   0.0533   0.0918   0.0533   0.0980   8.505   8.505   2
      150102   0.0533   0.0918   0.0533   0.0980   8.505   8.505   2
      150112   0.0533   0.0918   0.0533   0.0980   8.505   8.505   2
*
*       (1) FOR FUEL ROD:
*
*           REF.: CORE PHYSICS PARAMETERS AND PLANT OPERATIONS DATA
*                 FOR SONGS1 CYCLE 9, FIG. 2-1.
*
*           NO. OF ASSEMBLY                  = 157
*           NO. OF FUEL ROD PER ASSEMBLY = 180
*           FUEL ROD I.D.                    = 0.422"
*           PELLET I.D.                      = 0.3835"
*           CLAD THICKNESS                   = 0.0165"
*
*           ASUR = 180 * 157 * PI * 0.422" * 10.0' / 3
*                = 10407.3 FT**2
*
*           VOL  = (180 * 157 * PI * 0.422" ** 2 * 10.0' / 4) / 3
*                = 91.5 FT**3
*
*       (2) FOR S/G:
*
*           REF.: VERTICAL S/G FOR SONGS1, TABLE 1-1, TECHNICAL MANUAL
*                 1440-C77, DEC. 1965.
*
*           OUTER TUBE HEATING SURFACE = 27700 FT**2
*
*           TUBE O.D.                  = 0.75"
*           TUBE AVERAGE THICKNESS = 0.055"
*           TUBE I.D.                  = 0.75" - 0.055" * 2
*                                      = 0.64"
*
*           FOR 20% TUBE PLUGGING:
*
*           INNER TUBE HEATING SURFACE = 27700 * 0.64 / 0.75
*                                      = 23637 FT**2
*
*           ASUR = 27700 / 4 = 6925.0 FT**2 PER CONDUCTOR
*           ASUL = 23637 / 4 = 5909.0 FT**2 PER CONDUCTOR
*
*           FOR 20% TUBE PLUGGING:
*
*           ASUR = 6925.0 * 0.8 = 5540.0 FT**2 / SG
*           ASUL = 5909.0 * 0.8 = 4727.5 FT**2 / SG
*
*********** CORE SECTION DATA - 16XXXO **********************************
*
*
* XXX       ISLB        CLTI          QFRAC
*
160010        1           0.0           0.336
160020        2           0.0           0.406
160030        3           0.0           0.258
*
*     NOTE: NO STEAM-METAL REACTION FOR FUEL ROD CLAD OF STAINLESS
*           STEEL.
*
*
*
********** CONDUCTOR GEOMETRY DATA - 17XXYY **************************
```

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO. | PAGE___ OF___

Project or DCP/MMP_____ Calc. No. **DC - 3601**

CCN CONVERSION: CCN NO. CCN --

Subject **SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT** Sheet No. 55

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	V. F. Nazareth VFN	6/21/91	W. Alhassani WHA	6/21/91						

```
*
*
*     TYPES OF HEAT CONDUCTOR:
*
*     XX =  1, CORE
*        =  2, STEAM GENERATOR U-TUBES
*
*     HEAT CONDUCTOR MATERIAL IDENTIFICATION:
*
*     IM =  1, UO2
*        =  2, GAP
*        =  3, STAINLESS STEEL
*        =  4, INCONEL
*
* XXYY  IG/IGP  NR   IM   NDX     XO          XR          PF
*
 170101     2    3    1    4     0.0     0.015979       1.0  * FUEL PELLET
 170102     1         2    1             0.000229       0.0  * GAP
 170103     0         3    3             0.001375       0.0  * CLAD
*
 170201     2    1    4    3  0.026667   0.004583       0.0  * S/G TUBES
*
*     S/G TUBE THICKNESS = 0.004583 FT
*                        = 0.055  INCH
*
*
*
*********************** THERMAL CONDUCTIVITY DATA - 18XXYY **********************
*
*                UNIT: TEMPERATURE (F) VS. K (BTU/FT-HR-F)
*
*
*             REF.: (1) NA-82-001
*                   (2) SEE TMI-2 ACCIDENT FOR CORE HEAT-UP
*                       ANALYSIS (SUPPLEMENT), FIG. 24, P.5-18,
*                       STAINLESS STEEL THERMAL PROPERTIES.
*
*
 180101    -21          ----- UO2 -----
*
*        F      K       F      K       F      K       F      K
*
 180102      0.0  3.341   500.0  3.341   650.0  2.971   800.0  2.677
 180103    950.0  2.439  1100.0  2.242  1250.0  2.078  1400.0  1.940
 180104   1550.0  1.823  1700.0  1.724  1850.0  1.639  2000.0  1.568
 180105   2150.0  1.507  2300.0  1.457  2450.0  1.415  2600.0  1.382
 180106   3100.0  1.323  3600.0  1.333  4100.0  1.406  4600.0  1.538
 180107   5100.0  1.730
*
*
*                ----- GAP -----
 180201     -6
*
*        F      K       F      K       F      K
*
 180202    100.0  0.0937  1100.0  0.163   2100.0  0.212
 180203   3100.0  0.253   4100.0  0.289   5100.0  0.322
*
*
*             ------- STAINLESS STEEL -------
*
```

```
1259    180301      -6
1260    *
1261    *             F        K          F        K          F        K
1262    *
1263    180302      200.0     9.5       500.0    11.0      1000.0    13.1
1264    180303     1500.0    15.4      2000.0    17.6      2500.0    19.8
1265    *
1266    *
1267    *                   ----- INCONEL -----
1268    180401      -3
1269    *
1270    *             F        K          F        K          F        K
1271    *
1272    *180402     212.0    10.000     752.0    11.000    1832.0    18.000
1273    *
1274    180402      212.0     3.3139    752.0     3.4168   1832.0     3.8863
1275    *
1276    *    NOTE:  THE THERMAL CONDUCTIVITY TABLE HAS BEEN MODEIFIED TO INCLUDE
1277    *           THE EFFECT OF FOULING FACTOR ON THE OUTER TUBE SURFACE.
1278    *
1279    *
1280    ****************** VOLUME HEAT CAPACITY DATA - 19XXYY ********************
1281    *
1282    *                UNIT: TEMPERATURE (F) VS. CP (BTU/FT**3-F)
1283    *
1284    *
1285    *                REFERENCE: NA-82-001
1286    *
1287    *                ----- UO2 -----
1288    190101      -16
1289    *
1290    *             F        CP         F        CP         F        CP
1291    *
1292    190102       32.0     34.45      122.0    38.35      212.0    40.95
1293    190103      392.0     43.55      752.0    46.80     2012.0    51.35
1294    190104     2732.0     52.65     3092.0    56.55     3452.0    63.05
1295    190105     3812.0     72.80     4352.0    89.70     4532.0    94.25
1296    190106     4712.0     98.15     4892.0   100.10     5144.0   101.40
1297    190107     8000.0    101.40
1298    *
1299    *
1300    *                ----- GAP -----
1301    190201      -2
1302    *
1303    *             F        CP         F        CP
1304    *
1305    190202       32.0     0.0149    3400.0    0.0149
1306    *
1307    *                ------- STAINLESS STEEL -------
1308    190301      -6
1309    *
1310    *             F        CP         F        CP         F        CP
1311    *
1312    190302      200.0     57.6       500.0    64.1      1000.0    67.7
1313    190303     1500.0     70.2      2000.0    76.2      2500.0    79.2
1314    *
1315    *                ----- INCONEL -----
1316    190401      -8
1317    *
1318    *             F        CP         F        CP         F        CP
```

NES&L DEPARTMENT

CALCULATION SHEET

Project or DCP/MMP _____ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 56

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						

ICCN NO./ PRELIM. CCN NO. _____ PAGE ___ OF ___

CCN CONVERSION: CCN NO. CCN –

```
*
190402     200.0      57.2600      400.0     60.1409     450.0     60.6320
190403     500.0      61.1216      550.0     61.6216     600.0     62.0564
190404     800.0      64.1549     1000.0     67.2913
*
*
********* LINEAR THERMAL EXPANSION COEFFICIENT DATA - 20XXYY ***********
*
*         UNIT: TEMPERATURE (F) VS. COEF (1/F)
*
*
*                      REFERENCE: NA-82-001
*
*                      ----- UO2 -----
200101     -13
*
*           F          COEF          F          COEF          F          COEF
*
200102     440.6      3.40E-6       890.6      4.27E-6      1340.6      4.77E-6
200103    1790.6      5.19E-6      2240.6      5.71E-6      2960.6      6.02E-6
200104    3140.6      6.40E-6      3590.6      6.91E-6      4040.6      7.28E-6
200105    4490.6      7.68E-6      4940.6      8.10E-6      5390.6      1.48E-5
200106    5840.6      1.51E-5
*
*
*                      ----- GAP -----
*
200201     -2
*
*           F          COEF          F          COEF
*
200202     0.0         0.0          2000.0      0.0
*
*
*                ------- STAINLESS STEEL -------
200301     -2
*
*           F          COEF          F          COEF
*
200302    500.0      11.25E-6      2500.0     11.25E-6
*
*         FROM REF. (2):
*
*         TEMPERATURE (F)        THERMAL EXPANSION (% DELTA L/L)
*              500.0                        2.75
*             2500.0                        0.5
*
*                                        2.75 - 0.5
*         THERMAL EXPANSION COEF. = ------------ %
*                                        2500 - 500
*
*                                    = 11.25E-6 / F
*
*                      ----- INCONEL -----
200401     -5
*
*           F          COEF          F          COEF          F          COEF
*
200402    200.0      7.10E-6       600.0      7.70E-6      1000.0      8.10E-6
200403   1400.0      8.70E-6      1600.0      9.00E-6
```

NES&L DEPARTMENT

CALCULATION SHEET

Project or DCP/MMP _____ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 57

ICCN NO./ PRELIM. CCN NO. _____ PAGE ___ OF ___

CCN CONVERSION: CCN NO. CCN –

REV	ORIGINATOR	DATE	IRE	DATE
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91

REV	ORIGINATOR	DATE	IRE	DATE	REV

```
*
*
********** NON-CONDUCTION HEAT EXCHANGER DATA CARDS - 21XXYY ***********
*
*
* XXYY   IHTX  IDTRP   JVOL  IHTYPE   W5(KW)  W6(SEC)
*
*210101        1000     99      7       0.0     0.0  * HEAT SINK LOSS
*
*
*
********** LOCAL CONDITION HEAT TRANSFER STACK CARDS - 2200YX **********
*
*
*   YX    ISHD   LENS    DZ     TQNCH    NCON1    NCON2
*
*220011    -1      2     0.0     0.0       4        5
*220021    -1      2     0.0     0.0       7        6
*220031    -1      2     0.0     0.0       8        9
*220041    -1      2     0.0     0.0      11       10
*
*
******* STEADY-STATE INITIALIZATION CONVERGENCE CRITERIA - 230000 ******
*
*
*          LCOUNT      ACEPSI        HEPSE        EPSIM       VSEPSI
*                      (PRES)     (ENTHALPY)     (MASS)    (SLIP VEL)
*
230000       25        1.0E-5        1.0E-5       1.0E-5       1.0E-5
*
*
*
************ STEADY-STATE POWER REMOVAL SYSTEM DATA - 230XXY ***********
*
*
*  XXY        ISGNUM      JBIAS       JBAL       POWF
*
230011           1          60          81        0.333
230021           2          70          91        0.667
*
*
******************** CONTROL SYSTEM MODELING - 70YXXX ********************
*
*
*           NO. OF CNTL       NO. OF CNTL      MAX. TIME
*          INPUT BLOCKS         BLOCKS           STEP
*
701000          13               25             0.01
*
*
*          --------- CONTROL INPUT BLOCKS ----------
*
*   $$$  VFN CHANGES  $$$
*   INLET AND OUTLET TEMPERATURES CORRECTED
*     -- INLET TEMP 527 F (WAS 528 F)
*     -- OUTLET TEMP 576 F (WAS 575 F)
*   SG LEVEL CHANGED TO GET INITIAL LEVEL AT 30% NR
*     -- LEVEL 22.2938 FT (WAS 22.3838)
*     -- GAIN (IN BLOCK -20) 0.1044 (WAS 0.1012)
*   RCS FLOW RATE GAIN ADJUSTED TO RESULT IN STEADY STATE
```

NES&L DEPARTMENT

CALCULATION SHEET

Project or DCP/MMP _____ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 58

REV	ORIGINATOR	DATE	IRE	DATE
	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91

ICCN NO./ PRELIM. CCN NO.

PAGE ___ OF ___

CCN CONVERSION: CCN NO. CCN -

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE___ OF___
CCN CONVERSION: CCN NO. CCN –	

Project or DCP/MMP________________ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 59

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
△	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91	△					
△					△					

```
*      LIZED FLOW RATE OF 1.0
*    $$$  VFN CHANGES  $$$
*
*  XXX    IDC   SYMBOL    IREG    CGAIN       CIC
*
  702001    1    MIXL,     25 2.6882E-2     0.375 * PZR LEVEL (FRACTION)
  702002    2    TIMX,      0       1.0     0.0   * SYSTEM TIME
  702003    3    WP**,     21 4.6882E-5     1.0   * NORM. RCS FLOWRATE
  702003    3    WP**,     21 4.9315E-5     1.0   * NORM. RCS FLOWRATE          *** THIS CARD IS A REPLACEMENT CARD.
  702004    4    CONS,      0      -1.0    -1.0   *
  702005    5    CONS,      0     535.0   535.0   * NO LOAD T(REF)
  702006    6    TRPT,      2       1.0     0.0   * TRIP TIME FOR TRIP 2.
  702007    7    TEMP,      9       1.0   575.01  * HOT  LEG TEMP.
  702008    8    TEMP,     20       1.0   528.02  * COLD LEG TEMP.
  702009    9    LIQL,     50       1.0   22.3838 * S/G LIQUID LEVEL
  702007    7    TEMP,      9       1.0   576.0   * HOT  LEG TEMP.              *** THIS CARD IS A REPLACEMENT CARD.
  702008    8    TEMP,     20       1.0   527.0   * COLD LEG TEMP.              *** THIS CARD IS A REPLACEMENT CARD.
  702009    9    LIQL,     50       1.0   22.2938 * S/G LIQUID LEVEL            *** THIS CARD IS A REPLACEMENT CARD.
  702010   10    CONS,      0     19.42    19.42  * LOWER NR LEVEL TAP
  702011   11    TRIP,      3       1.0     0.0
  702012   12    PRES,     50       1.0   547.0
  702013   13    TEMP,     50       1.0   476.053
*
*
*      ---------- CONTROL BLOCK DEFINITIONS ----------
*
*
*          1      2      3     4       5      6      7      8       9     10
*  XXX    IDC  ITYPE   INC1  INC2    GAIN    CP1    CP2    CIC     MIN   MAX
*
  703001   -1   SUM,     7     8     0.5    1.0    1.0   551.5
  703002   -2   LLG,    -1     0     1.0   10.0    3.0   551.5
  703003   -3   SUM,     5    -2     1.0   -1.0    1.0    16.5  * DELTA T
  703004   -4   FNG,    -3     2     1.0    0.0    0.0     1.0
  703005   -5   FNG,    -4     3     0.0    0.0    0.0     0.0  * BYPASS
  703006   -6   FNG,    -4     4     1.0    0.0    0.0     1.0
  703007   -7   SUM,    -6    -9     1.0    1.0   -1.0     1.0
  703008   -8   FNG,    -7     6     1.0    0.0    0.0     0.1
  703009   -9   INT,    -8     0     1.0    0.0    0.0     0.0    0.0   1.0
  703010  -10   SUM,     2     6     1.0    1.0   -1.0 -1.0E+6
  703011  -11   FNG,   -10     5     1.0    0.0    0.0     0.0    0.0   1.0
  703012  -12   MAX,    -9   -11     1.0    0.0    0.0     0.0    0.0   1.0
  703013  -13   FNG,   -10     7     1.0    0.0    0.0     1.0    0.0   1.0
  703014  -14   MUL,   -12   -13     1.0    0.0    0.0     0.0    0.0   1.0
  703015  -15   MUL,   -10     8     1.0    0.0    0.0     0.0    0.0   1.0
  703016  -16   SUM,     5    13     1.0   -1.0    1.0 -58.947
  703017  -17   FNG,   -16     9     1.0    0.0    0.0     0.0    0.0   1.0
  703018  -18   MUL,   -15   -17     1.0    0.0    0.0     0.0    0.0   1.0
  703019  -19   SUM,   -14   -18 -407.77    1.0    1.0     0.0
*
*     SEE P.14 OF SD-SO1-190 FOR THE ADV RELIEVING CAPACITY.
*
*     --------------------  AUXFW CNTL  -----------------------
*
  703020  -20   SUM,     9    10  0.1012    1.0   -1.0     0.3    0.0   1.0
  703020  -20   SUM,     9    10  0.1044    1.0   -1.0     0.3    0.0   1.0   *** THIS CARD IS A REPLACEMENT CARD.
  703021  -21   FNG,   -20    10     1.0    0.0    0.0     1.0    0.0   1.0
  703022  -22   MUL,    11   -21     1.0    0.0    0.0     0.0    0.0   1.0
  703023  -23   FNG,    12    11     1.0    0.0    0.0   123.3
  703024  -24   MUL,   -22   -23     1.0    0.0    0.0     0.0  * TO J 69
```

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./
PRELIM. CCN NO.

PAGE___ OF___

Project or DCP/MMP_____ Calc. No. **DC - 3601**

CCN CONVERSION:
CCN NO. CCN --

Subject **SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT** Sheet No. 60

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
1	V. F. Nazareth	6/21/91	W. Alhassani	6/21/91						↓
2										

```
99  703025  MUL,  -22   -23    2.0    0.0    0.0    0.0   * TO J 79
00  *
01  *
02  ********** END OF DATA **********
03
```

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE___ OF___
CCN CONVERSION: CCN NO. CCN --	

Project or DCP/MMP_____ Calc. No. **DC - 3601**

Subject **SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT** Sheet No. 61

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth VFN	6/21/91	W. Alhassani WA	6/21/91						

APPENDIX B

PRESSURIZER PROGRAM LEVEL

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE__ OF__
CCN CONVERSION: CCN NO. CCN --	

oject or DCP/MMP_____ Calc. No. DC - 3601

Subject SONGS 1 RCS INVENTORY ANALYSIS FOR STATION BLACKOUT Sheet No. 62

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	V. F. Nazareth VFN	6/21/91	W. Alhassani WA	6/21/91						

[205] From: JOHN CUSTER at WEST3 6/20/91 1:41PM (859 bytes: 14 ln)
To: MIKE MCDEVITT at NESL3
Subject: Pressurizer Program level
---------- Message Contents ----------

Mike -

Although Pressurizer program level is not specifically addressed in Operations procedures, this information is common operator required knowledge. It is addressed in our training and system description and is set by I&C as required by engineering. Presently the program level for our lower Tave program (level is prgrammed to Tave) is 25% level from 0 to 15% power and ramps linearly from 25% to 37.5% level from 15% power to 100% power.

At our present normal full Rx power level of 92% PZR program level is approximately 36.5%.

John Custer 89271 6/20/91

ENCLOSURE 2

125V DC Battery No.1 Sizing

Calculation No. DC-1604, Supplement V

(For ICCNs Only)
DCP/MMP NO. REV.

Southern California Edison Company

INTERIM CALCULATION CHANGE NOTICE (ICCN)/ CALCULATION CHANGE NOTICE (CCN)

ICCN NO./PRELIMINARY CCN NO. N-1	CCN CONVERSION : CCN NO. CCN-		CALC. REV.
CALCULATION NO. DC-1604	REV. 10	UNIT. 1	Q-CLASS SR
CALCULATION TITLE : 125V DC BATTERY NO. 1 SIZING			
ORIGINATOR A.S. MATIONG		SYS. NO./STAT. SYS. DESIGNATOR ELE DCB 1	
PAX 5144	DATE 6/21/91	PAGE 1 OF 29	

1.

ADD SUPPLEMENT "V"

INITIATING DOCUMENT (NCR, SPR, OTHER) _____

2. OTHER AFFECTED DOCUMENTS (CHECK AS APPLICABLE):

☐ YES ☑ NO OTHER AFFECTED DOCUMENTS EXIST AND ARE IDENTIFIED ON ATTACHED183/184 FORMS.
THE APPLICABLE SOURCE DOCUMENT IS IDENTIFIED AS FOLLOWS:
☐ THIS CCN OR ☐ THE FOLLOWING DOCUMENT: _____

3. SCE DESIGN APPROVALS :

NUCLEAR GENERATION SITE DEPARTMENT		NES&L DEPARTMENT	
ORIGINATOR	DATE	ORIGINATOR A.S. Mationg	DATE 6/21/91
INDEPENDENT REVIEW ENGR.	DATE	INDEPENDENT REVIEW ENGR. S.K. Ramakrishnan	DATE 6/21/91
GROUP SUPERVISING ENGINEER	DATE	GROUP SUPERVISOR A.S. Mationg	DATE 6/21/91
DISCIPLINE MANAGER	DATE	DISCIPLINE MANAGER A.T. Ramello	DATE 6/21/91

4.

CONVERSION TO CCN DATE _____ _____
SCE CDM-SONGS

CALCULATION TITLE PAGE SUPPLEMENT V Sheet 1 OF 28

SONGS Unit 1 DCP/MMP No. & Rev. _____ Calc. No. DC-1604 REV. 10

Subject 125V DC BATTERY NO. 1 SIZING

Engineering System Number _____ Primary Station System Designator _____ Q-Class _____

Tech Spec Effecting ☐ YES ☑ NO Section No. _____ Equipment Tag No. _____

Computer Program	STANDARD COMPUTER PROGRAM	PROGRAM NO.(S)	VERSION/RELEASE NO.
	☑ YES ☐ NO	LOTUS 123	2.01

RECORD OF ISSUES

SCE DISC. or ESC	REV.	DESCRIPTION	TOTAL NO. of SHEETS	LAST SHEET NO.	ORIG.	IRE	GS	DM	DATE
E	0	EVALUATION OF BATTERY NO.1 SYSTEM ADEQUACY DURING SBO	28	28	[signature]	SCK	[signature]	ATK 6/21/91	

Space for RPE Stamp, reference alternate calc., and notes as applicable.

This calc. was prepared for the identified DCP/MMP. DCP completion and turnover acceptance to be verified by receipt of a memorandum directing DCN Conversion. Upon receipt, this calc. represents the as-built condition. Memo date _____ by _____.

CALCULATION CROSS-INDEX

Subject Calculation No. DC-1604 REV. 10

SUPPLEMENT V
SHEET 2 OF 28

Subject Calculation Revision No.	Superseded By Calc. No.	INPUTS: These interfacing calculations and /or documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		OUTPUTS: Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents.		Does the output interface calc/document require revision?	Identify output interface calc/document CCN or DCN TCN/Rev.	Group Supervisor or Station Technical Group Supervising Engineer Signature/Date
		Calc/ Document No.	Rev. No.	Calc/ Document No.	Rev. No.	YES / NO		
10	N/A	90050	0	EOI 501-1.0-60	8	YES	N/A	Actuating 6/21/89

SUPPLEMENT V

Sheet V3 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SCK	6/24/91					

TABLE OF CONTENTS

SUPPLEMENT V

Sheet V4 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SCK	6/21/91					

TABLE OF CONTENTS (CONTINUATION)

SUPPLEMENT V

Sheet V5 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SEK	6/21/91					

1.0 PURPOSE

The purpose of this calculation supplement is:

- To demonstrate that Battery No. 1 (D04) has the capacity and the capability to continue to supply power to the required components identified in Station Blackout Analysis Document No. 90050 during a 4-hour station blackout (SBO) duration, as well as support Emergency Diesel Generator (EDG) No.1 manual random restart attempts throughout the SBO duration.

- To demonstrate the capability of each battery charger, per Technical Specification 4.4.D.2.c(4) requirement, to restore the battery to a fully charged state within 8 hours following SBO recovery.

Acceptance Criteria:

- The battery, operating at 80% capacity and 61^0F electrolyte temperature, shall be able to satisfy the SBO duty cycle requirements. In addition, the battery terminal voltage shall be at least 106.91 volts to ensure at least 105 volts is maintained at the inverter terminals throughout the 4-hour SBO duration.

- Each battery charger shall have adequate ampere capacity to restore the battery to a fully charged condition within 8 hours following ac recovery from a station blackout event.

Since no design basis accidents or other events are assumed to occur immediately prior to or during station blackout, this calculation supplement is limited only to the verification of battery capability to provide for the SBO load requirements as well as the charger's ability to restore the battery in its fully charged state within the specified recharging time.

Credit is taken for manual dc load shedding operations during the SBO duration.

SUPPLEMENT V

Sheet V6 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SCE	6/21/91					

2.0 RESULTS/CONCLUSIONS and RECOMMENDATIONS

2.1 RESULTS/CONCLUSIONS

2.1.1 Battery Capacity

The results of the calculations shown in Table 8.1 indicate the battery can cope with the 4-hour station blackout, as well as support Emergency Diesel Generator (EDG) No.1 manual random restart attempts throughout the 4-hour SBO duration, provided manual shedding of dc loads are performed in the sequence of operations identified in Sections 2.2.1 and 4.8.

2.1.2 Battery Terminal Voltage

The results of the calculations shown in Table 8.2 indicate a minimum battery voltage of 107.59 volts, thereby ensuring at least 105 volts at the inverter input terminals during the SBO duration.

2.1.3 Battery Charger Capacity

The results of the battery charger sizing calculation in Section 8.3 indicate a required charger ampacity of 555.35 amperes.

Each battery charger is rated 1000 amperes. Therefore, each charger has the capacity and capability to restore the battery to a fully charged state within 8 hours following ac power restoration.

SUPPLEMENT V

Sheet V7 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SCE	6/21/91					

2.1.4 Battery System Surveillance Requirements

- Battery Service Test

  The new SBO-based load profile is more severe than the SISLOP-based accident load profile. However, there is no present requirement for battery service testing to the SBO profile.

  Should a service test to the SBO load profile be required in the future, station maintenance procedures, which presently use a service test profile based on the accident load profile shown in calculation Supplement T, shall be revised accordingly as recommended in Section 2.2.2.

- Battery Charger Capability Verification

  The 555.35 amperes charger ampacity required to recharge the battery following SBO recovery is well within the surveillance requirements of Technical Specification 4.4.D.2.c(4) and Station Maintenance Procedures SO123-I-2.5 and SO123-I-2.6, which specify verification of battery charger capability to supply at least 800 amperes for at least 8 hours.

  Therefore, no change to Technical Specification 4.4.D.2.c(4) or Station Maintenance Procedures SO123-I-2.5 and SO123-I-2.6 is required.

2.2 RECOMMENDATIONS

Based on the above results and conclusions, the following actions are recommended:

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO. N-1
PRELIM. CCN NO.

CCN CONVERSION
CCN NO.

Project or DCP/MMP Station Blackout Calc No. DC-1604 Rev. 10

Subject SONGS 1 125V DC BATTERY NO. 1 SIZING Sheet No.

SUPPLEMENT V

Sheet V8 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SCE	6/21/91					

2.2.1 When the new SBO requirements are implementd, revise Emergency Operating Instruction SO1-1.0-60 to include the following manual dc load shedding operations during SBO:

DC Bkr. No.	Trip After	Load Description
See Note	30 minutes	Emergency RCP Thermal Barrier Pump
72-139	45 minutes	Emergency Bearing Oil Pump
72-102	90 minutes	Turbine Plant Annunciator
72-104	90 minutes	Reactor Plant Annunciator
72-109	90 minutes	Hydrogen Control Panel
72-110	90 minutes	Digital Fault Recorder
72-111	90 minutes	Turbine Controls
72-121	90 minutes	Chemical Control Board
72-122	90 minutes	Containment Spray System
72-123	90 minutes	Sphere Isolation Valves
72-124	90 minutes	Sequencer No. 1
72-127	90 minutes	HVAC Control Board Annunciator
72-129	90 minutes	Radwaste Control Board Annunciator
72-131	90 minutes	Inverter No. 4
72-134	90 minutes	NIS Coincidentor Cabinets A and B
72-136	90 minutes	Inverter No. 2
72-140	90 minutes	Emergency Lighting Switchboard
72-141	90 minutes	Control Rods
72-138	180 minutes	Emergency Hydrogen Seal Oil Pump

NOTE: Turn off pump at the Control Room.

SUPPLEMENT V

Sheet V9 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG Ashn	6/21/91	SCE	6/21/91					

2.2.2 Should a surveillance test based on the SBO load profile be required, revise Station Maintenance Procedures SO123-I-2.5 and SO123-I-9.301 to reflect the new surveillance service test profile shown in Table 2.2.2, which envelops the accident load profile.

TABLE 2.2.2
BATTERY SURVEILLANCE SERVICE TEST PROFILE

Period in Mins.	0-1	1-30	30-45	45-90	90-180	180-239	239-240
DC Amps	1195	741	646	434	256	140	283

The minimum battery terminal voltage is 106.91 volts for Station Maintenance Procedure SO123-I-2.5 and 1.845 volts per cell for Station Maintenance Procedure SO123-I-9.301.

SUPPLEMENT V

Sheet V10 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SCE	6/24/91					

3.0 ASSUMPTIONS

3.1 Based on SONGS 1 Station Blackout Analysis Document No. 90050, Rev. 0, no credit can be taken for manual dc load shedding operations prior to 30 minutes into the station blackout.

3.2 After failure of the Emergency Diesel Generator to automatically start during the first minute, depending on starting air supply capability, multiple manual start attempts are assumed to occur randomly as follows:

- During the 1-30 minute period of the duty cycle.
- During the 30-45 minute period following manual tripping at the Control Room of the RCP Thermal Barrier Pump at the 30th minute. Credit is taken for DSD operation and Charging Pump operation within one hour.
- During the 45-90 minute period of the duty cycle following manual tripping of the dc breaker for the Emergency Bearing Oil Pump at the 45th minute.
- During the 90-180 minute period following tripping of additional dc load breakers at the 90th minute. These load breakers are listed in Table 4.8.
- During the 180-240 minute period following tripping of the dc breaker for the Emergency Hydrogen Seal Oil Pump at the 180th minute.

SUPPLEMENT V

Sheet V11 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SCE	6/24/91					

4.0 DESIGN INPUT

4.1 IEEE Stds 485-1983 and 450-1980 recommendation that a battery be replaced when its actual capacity drops to 80% of its rated capacity and SONGS 1 Technical Specifications 4.4.D.2.e requirement that battery capacity is at least 80% of the manufacturer's rating when subjected to a performance discharge test.

4.2 Technical Specification 4.4.D.2.b.(3) which specifies 61^{0}F minimum battery electrolyte temperature.

4.3 SONGS 1 SBO Analysis Document No. 90050, Rev. 0, which identifies the 4-hour coping duration for SONGS 1, designates the Dedicated Safe Shutdown (DSD) system as the alternate AC (AAC) power source, and analyzes AAC availability within one hour of SBO event and capability to power the required DSD equipment and instrumentation throughout the SBO duration.

4.4 Emergency Operating Instruction SO1-1.0-60, Rev. 8, Loss of All AC Power identifying the non-vital dc loads to be shed. This includes the Emergency Bearing Oil Pump which, based on Westinghouse's estimated 30-40 minutes time for the turbine to come to rest following SBO initiation, can then be manually tripped after 45 minutes (Reference 6.6 of this calculation supplement).

4.5 Minimum 105 volts required at the inverter terminals based on inverter input low voltage shutdown setting of 104±1 volts dc (Reference 6.11).

4.6 Battery Charger walkdown information (360 amperes normal continuous dc output current on 5/28/91) from A. B. Samanta of Station Technical.

SUPPLEMENT V

Sheet V12 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SCE	6/21/91					

4.7 The proposed replacement for the Train B battery bank (Battery No. 2) will be adequate to support the station blackout requirements.

Control Room instrumentation and controls supplied from Train A Inverters 1 and 3, and Train B Inverter 5 will be sufficient to satisfy the minimum control room instrumentation during station blackout (Reference 6.12). As such, loads noted in Table 4.8, including Train A Inverters 2 and 4, can then be manually tripped in order to reduce loading on Battery No. 1.

4.8 The resultant load profile shown in Table 4.8 developed based on:

- The SISLOP-based loading tables of Table 5.1.142 of Supplement T, Revision 3 (DC-1604 Revision 9), considering those loads associated with a LOP only. The random load (EDG restart) value for this calculation (Supplement V) is developed from the 0-1 minute loading of Supplement T Table 5.1.142.

- Cycle XI load changes (the 10 amperes contingency load is used instead of the actual net load added since the service test was performed based on the load profile which included this 10 amperes contingency load).

- Cycle XII contingencies (10 amperes).

- Manual load stripping of selected dc loads to reduce battery loading.

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO. N-1
PRELIM. CCN NO.

CCN CONVERSION
CCN NO.

oject or DCP/MMP Station Blackout Calc No. DC-1604 Rev. 10

Subject SONGS 1 125V DC BATTERY NO. 1 SIZING Sheet No.

SUPPLEMENT V

Sheet V13 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SCH	6/21/91					

TABLE 4.8
SBO Event Detailed Load Profile

Breaker No. & Load ID	0 to 1 min	1 to 30 min	30 to 45 min	45 to 90 min	90 to 180 min	180 to 240 min	Random Load	Manual Actions Required
72-101 Reheater Stm Dump Control	9.1	0.0	0.0	0.0	0.0	0.0		None
72-102 Turbine Plant Ann	15.9	15.9	15.9	15.9	0.0	0.0		Open DC breaker @ 90 minutes
72-103 4160V Swgr 1A and 1C	77.3	4.4	4.4	4.4	4.4	4.4		None
72-104 Reactor Plant Ann	17.4	17.4	17.4	17.4	0.0	0.0		Open DC breaker @ 90 minutes
72-105 Emerg DG1 Exc Control	0.0	0.0	0.0	0.0	0.0	0.0	90.0	None
72-106 Area Load Freq Cont	0.0	0.0	0.0	0.0	0.0	0.0		None
72-107 480V/4160V ACB Test Panel	0.0	0.0	0.0	0.0	0.0	0.0		None
72-108 Gen & Xfmr Relay Bus	56.1	0.1	0.1	0.1	0.1	0.1		None

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO. N-1
PRELIM. CCN NO.

CCN CONVERSION
CCN NO.

Project or DCP/MMP Station Blackout Calc No. DC-1604 Rev. 10

Subject SONGS 1 125V DC BATTERY NO. 1 SIZING Sheet No.

SUPPLEMENT V

Sheet V14 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
-	A. S. MATIONG Adm	6/21/91	SCK	6/21/91					

Table 4.8 Continuation

Breaker No. & Load ID	0 to 1 min	1 to 30 min	30 to 45 min	45 to 90 min	90 to 180 min	180 to 240 min	Random Load	Manual Actions Required
72-109 Hydrogen Cont Pnl	2.7	2.7	2.7	2.7	0.0	0.0		Open DC breaker @ 90 minutes
72-110 Digital Fault Rec	3.8	3.8	3.8	3.8	0.0	0.0		Open DC breaker @ 90 minutes
72-111 Turb Cont	7.6	4.3	4.3	4.3	0.0	0.0		Open DC breaker @ 90 minutes
72-112 480V Swgr No. 1	2.7	1.0	1.0	1.0	1.0	1.0		None
72-113 Turb Prot	0.0	0.0	0.0	0.0	0.0	0.0		None
72-114 Emerg DG1 Fuel Oil Pp	31.5	0.0	0.0	0.0	0.0	0.0	21.0	None
72-115 Generator Field Cont	36.0	0.0	0.0	0.0	0.0	0.0		None
72-116 480V Swgr No. 3	1.5	0.6	0.6	0.6	0.6	0.6		None
72-117 DG Bldg Emerg Ltg	27.4	27.4	27.4	27.4	27.4	27.4		None
72-118 SIS/LOP Lockout Rly	0.0	0.0	0.0	0.0	0.0	0.0		None

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO. N-1 PRELIM. CCN NO.	PAGE 16 OF 29
CCN CONVERSION CCN NO.	

Project or DCP/MMP Station Blackout Calc No. DC-1604 Rev. 10

Subject SONGS 1 125V DC BATTERY NO. 1 SIZING Sheet No.

SUPPLEMENT V

Sheet V15 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SCK	6/21/91					

Table 4.8 Continuation

Breaker No. & Load ID	0 to 1 min	1 to 30 min	30 to 45 min	45 to 90 min	90 to 180 min	180 to 240 min	Random Load	Manual Actions Required
72-119 ELP-1 Right Feed	23.9	23.5	8.3	8.3	8.3	8.3	15.6	None
72-120 Emerg RCP Thermal Barrier Pp	94.6	63.2	0.0	0.0	0.0	0.0		Turn off pump from Control Room @ 30 minutes
72-121 Chemical Cont Board	4.6	4.6	4.6	4.6	0.0	0.0		Open breaker @ 90 minutes
72-122 Containment Spray Sys	2.1	2.1	2.1	2.1	0.0	0.0		Open breaker @ 90 minutes
72-123 Sphere Iso Valve	5.5	5.5	5.5	5.5	0.0	0.0		Open breaker @ 90 minutes
72-124 Sequencer 1	8.0	0.0	0.0	0.0	0.0	0.0		Open DC breaker @ 90 minutes
72-125 Portable Exc Control	0.0	0.0	0.0	0.0	0.0	0.0		None
72-126 ELP-1 Left Feed	19.1	17.3	2.8	2.8	2.8	2.8	16.3	None
72-127 HVAC Cont Board Ann	0.9	0.9	0.9	0.9	0.0	0.0		Open DC breaker @ 90 minutes

SUPPLEMENT V

Sheet V16 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SCK	6/21/91					

Table 4.8 Continuation

Breaker No. & Load ID	0 to 1 min	1 to 30 min	30 to 45 min	45 to 90 min	90 to 180 min	180 to 240 min	Random Load	Manual Actions Required
72-128 Cond Steam Dump Cont	2.2	0.1	0.1	0.1	0.1	0.1		None
72-129 Radwaste Cont Bd Ann	1.9	1.9	1.9	1.9	0.0	0.0		Open DC breaker @ 90 minutes
72-130 SI Valves	12.7	2.9	0.1	0.1	0.1	0.1		None
72-131 Inverter 4	54.7	54.7	54.7	54.7	0.0	0.0		Open DC breaker @ 90 minutes
72-132 Gen Bus Disc Switch	24.9	0.0	0.0	0.0	0.0	0.0		None
72-133 Spare	0.0	0.0	0.0	0.0	0.0	0.0		None
72-134 NIS Coinc Cabs A&B	4.0	4.0	4.0	4.0	0.0	0.0		Open DC breaker @ 90 minutes
72-135 Inverter 1	37.5	37.5	37.5	37.5	37.5	37.5		None
72-136 Inverter 2	50.2	50.2	50.2	50.2	0.0	0.0		Open DC breaker @ 90 minutes
72-137 Inverter 3	37.1	37.2	37.2	37.2	37.2	37.2		None

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO. N-1
PRELIM. CCN NO.

CCN CONVERSION
CCN NO.

Project or DCP/MMP Station Blackout Calc No. DC-1604 Rev. 10

Subject SONGS 1 125V DC BATTERY NO. 1 SIZING Sheet No.

SUPPLEMENT V

Sheet V17 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SCK	6/21/91					

Table 4.8 Continuation

Breaker No. & Load ID	0 to 1 min	1 to 30 min	30 to 45 min	45 to 90 min	90 to 180 min	180 to 240 min	Random Load	Manual Actions Required
72-138 Emergency Hydrogen Seal Oil Pp	174.0	116.0	116.0	116.0	116.0	0.0		Open breaker @ 180 minutes
72-139 Emerg Brg Oil Pump	318.0	212.0	212.0	0.0	0.0	0.0		Open DC breaker @ 45 minutes
72-140 Emerg Ltg Switchboard	6.0	6.0	6.0	6.0	0.0	0.0		Open DC breaker @ 90 minutes
72-141 Cont Rods	3.8	3.8	3.8	3.8	0.0	0.0		Open DC breaker @ 90 minutes
Cycle XI Contingency	10.0	10.0	10.0	10.0	10.0	10.0		None
Cycle XII Contingency	10.0	10.0	10.0	10.0	10.0	10.0		None
TOTAL	1194.7	741.0	645.3	433.3	255.5	139.5	142.9	

NOTE:

Applicable for the 0-1 Minute and the Random Load columns, the load shown for each breaker column represents the load on that breaker coincident with the peak loading during that particular minute of the duty cycle.

SUPPLEMENT V

Sheet V18 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SCK	6/21/91					

5.0 METHODOLOGY

Using the resultant load profile shown in Table 4.6, battery capacity and terminal voltages, as well as battery charger capacity are calculated as follows:

5.1 Battery Capacity Calculation

The end-of-discharge voltage is first determined by adding the worst case battery-bus and bus-inverter voltage drops to the minimum inverter terminal input voltage. The voltage drops are calculated using the following formula:

$$VD = 2 \times I \times R \times L$$

where: I = load in amperes
R = conductor resistance in ohms/1000 ft at 75^0C
L = circuit length in feet

With the end-of-discharge voltage established, the required battery capacity is then calculated using the GNB NCX-2550 discharge characteristics curves per IEEE Std 485 guidelines.

5.2 Battery Terminal Voltage Calculation

The battery terminal voltages calculated for each period of the battery duty cycle are calculated as follows:

- Load Amps is the load amperes for the period.
- Adjusted Load Amps is the Load Amperes multiplied by the Aging Factor and the Temperature Correction Factor.
- Adjusted Load Amps per Positive Plate is the Adjusted Load Amperes divided by the number of positive plates.

SUPPLEMENT V

Sheet V19 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SCK	6/21/91					

- Expended Amp-Hours per Positive Plate is the Adjusted Load Amperes per positive plate multiplied by the period duration.

  For succeeding periods, it is the Expended Amp-Hours per Positive Plate of the period plus the Expended Amp-Hours per Positive Plate of the preceding period.

- Cell Volts is the cell voltage read directly from the battery discharge characteristics curves corresponding to the specific Amps per Positive Plate and Expended Amp-Hours per Positive Plate. The Begin voltage corresponds to the specific period Amps per Positive Plate and Expended Amp-Hours at the beginning of the period. The End voltage corresponds to the specific period Amps per Positive Plate and Expended Amp-Hours at the end of the period.

- Battery Volts is the Cell Volts multiplied by the number of cells.

5.3 Battery Charger Capacity

The ampere capacity of the charger is calculated using the following formula:

$$A = L + 1.1\ (C/H)$$

where: A = required capacity charger in amperes
L = continuous load amperes
H = number of hours for recharging
C = ampere hours removed from the battery

SUPPLEMENT V

Sheet V20 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91		6/21/91					

6.0 REFERENCES

6.1 IEEE Standard 485-1983, Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations.

6.2 IEEE Standard 450-1987, Recommended Practice for Maintenance, Testing and Replacement of Large Lead Storage Batteries for Generating Stations and Substations.

6.3 Lotus 123 Computer Application Program, Release 2.01.

6.4 NUMARC 87-00, Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors.

6.5 SONGS 1 Station Blackout Analysis Document No. 90050, Rev. 0.

6.6 Letter from R.G. Perez to R. Radakovic, dated 3/27/84 - Westinghouse Site Input to Preliminary Battery Sizing Calculations.

6.7 One Line Diagram Dwg. 5102173, Revision 27.

6.8 Circuit Schedules M-30415-32 and M-30419-50.

6.9 SCE Electrical Engineering Guide, Section E9.2.

6.10 Emergency Operating Instruction SO1-1.0-60, Rev. 8.

6.11 Repetitive Maintenance Order Nos. 96810000001, 96810000002, 96810000003 and 96810000057.

6.12 Letter from Bernie Carlisle to A.T. Kaneko, dated 6/21/91, Minimum Instrumentation and Controls Required in the Control Room During a Station Blackout, San Onofre Nuclear generating Station, Unit 1.

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO. N-1
PRELIM. CCN NO.

CCN CONVERSION
CCN NO.

Project or DCP/MMP Station Blackout Calc No. DC-1604 Rev. 10

Subject SONGS 1 125V DC BATTERY NO. 1 SIZING Sheet No.

SUPPLEMENT V

Sheet V21 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/4/91	SCK	6/21/91					

7.0 NOMENCLATURE

D02 is the equipment designator for Battery Charger Set A

D03 is the equipment designator for Battery Charger Set B

D04 is the equipment designator for Battery No. 1

SUPPLEMENT V

Sheet V22 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SCK	6/21/91					

8.0 COMPUTATIONS

8.1 Battery Capacity

The minimum end-of-discharge voltage for the 58-cell battery bank ($V_{battery}$) is the sum of the minimum inverter input voltage ($V_{inverter}$), the worst case battery-bus voltage drop ($VD_{battery-bus}$) and bus-inverter voltage drop ($VD_{bus-inverter}$).

From References 6.7, 6.8 and 6.9:

Battery-Bus feeder : 3-1/C#500 MCM per pole
47.5 ft circuit length
0.0265 ohm/1000 ft @ 75^0C

Bus-Inverter feeder: 1/C#4/0 MCM per pole
132 ft circuit length
0.0626 ohm/1000 ft @ 75^0C

The worst case voltage drop on the battery-bus feeder occurs during the initial minute of the duty cycle when battery load is at maximum (1195 amperes).

$$VD_{battery-bus} = 2(1195)(0.0265/3)(47.5/1000)$$
$$= 1.0028 \text{ volts}$$

The Inverter 4 supply feeder voltage drop represents the worst case bus-inverter voltage drop. Inverter 4 draws the most current (54.7 amperes) and is located farthest from the dc bus. Inverter 4 is located at the 4KV Switchgear Room while Inverters 1, 2 and 3 as well as the dc bus are all located in the DC Switchgear Room.

$$VD_{bus-inverter} = 2(54.7)(0.0626)(132/1000)$$
$$= 0.9040 \text{ volt}$$

The minimum required inverter input voltage is:

$$V_{inverter} = 105 \text{ volts}$$

SUPPLEMENT V

Sheet V23 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SCK	6/21/91					

Therefore, the minimum battery end-of-discharge voltage is:

$$V_{battery} = 105 + 1.0028 + 0.9040$$
$$= 106.91 \text{ volts or } 1.845 \text{ volts per cell}$$

Using the methodology described in Section 5.1, in conjunction with the battery discharge characteristics curves of Figure 8.1, battery capacity is calculated as shown in Table 8.1 below.

TABLE 8.1
Battery Sizing Calculations
SBO Event Loading Conditions

Lowest Expected Electrolyte Temp: 61 F | Minimum Cell Voltage: 1.845 | Cell Mfr: GNB | Cell Type: NCX-2550 | Pos. Plates: 17

(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T Min Rate ----Amps/Pos. Pl.	(7) Required Section Size (3)/(6) = Positive Plates Pos. Values	Neg. Values
Section 1 - First Period Only - If A2 is greater than A1, go to Section 2							
1	A1 = 1195.00	A1 - 0 = 1195.00	M1 = 1	T = M1 = 1	104	11.49	
				Section 1:	Total	11.49	
Section 2 - First Two Periods Only - If A3 is greater than A2, go to Section 3							
1	A1 = 1195.00	A1 - 0 = 1195.00	M1 = 1	T = M1+M2 = 30	74	16.15	
2	A2 = 741.00	A2 - A1 = -454.00	M2 = 29	T = M2 = 29	74		-6.14
				Section 2:	Sub-Total	16.15	-6.14
					Total	10.01	

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO. N-1
PRELIM. CCN NO.

CCN CONVERSION
CCN NO.

Project or DCP/MMP Station Blackout Calc No. DC-1604 Rev. 10

Subject SONGS 1 125V DC BATTERY NO. 1 SIZING Sheet No.

SUPPLEMENT V

Sheet V24 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG Ashm	6/21/91	SEK	6/21/91					

TABLE 8.1 Continuation

Section 3 - First Three Periods Only - If A4 is greater than A3, go to Section 4

1	A1 = 1195.00	A1 - 0 = 1195.00	M1 = 1	T = M1+M2+M3 = 45	65	18.38	
2	A2 = 741.00	A2 - A1 = -454.00	M2 = 29	T = M2+M3 = 44	65		-6.98
3	A3 = 646.00	A3 - A2 = -95.00	M3 = 15	T = M3 = 15	85		-1.12
				Section 3:	Sub-Total	18.38	-8.10
					Total	10.28	

Section 4 - First Four Periods Only - If A5 is greater than A4, go to Section 5

1	A1 = 1195.00	A1 - 0 = 1195.00	M1 = 1	T = M1+M2+M3+M4 = 90	48	24.90	
2	A2 = 741.00	A2 - A1 = -454.00	M2 = 29	T = M2+M3+M4 = 89	48		-9.46
3	A3 = 646.00	A3 - A2 = -95.00	M3 = 15	T = M3+M4 = 60	58		-1.64
4	A4 = 434.00	A4 - A3 = -212.00	M4 = 45	T = M4 = 45	65		-3.26
				Section 4:	Sub-Total	24.90	-14.36
					Total	10.54	

Section 5 - First Five Periods Only - If A6 is greater than A5, go to Section 5

1	A1 = 1195.00	A1 - 0 = 1195.00	M1 = 1	T = M1+M2+M3+M4+M5 = 180	33	36.21	
2	A2 = 741.00	A2 - A1 = -454.00	M2 = 29	T = M2+M3+M4+M5 = 179	33		-13.76
3	A3 = 646.00	A3 - A2 = -95.00	M3 = 15	T = M3+M4+M5 = 150	36		-2.64
4	A4 = 434.00	A4 - A3 = -212.00	M4 = 45	T = M4+M5 = 135	39		-5.44
5	A5 = 256.00	A5 - A4 = -178.00	M5 = 90	T = M5 = 90	48		-3.71
				Section 5:	Sub-Total	36.21	-25.54
					Total	10.67	

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO. N-1 PRELIM. CCN NO.	PAGE 26 OF 29
	CCN CONVERSION CCN NO.

Project or DCP/MMP Station Blackout Calc No. DC-1604 Rev. 10

Subject SONGS 1 125V DC BATTERY NO. 1 SIZING Sheet No. _____

SUPPLEMENT V

Sheet V25 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SCK	6/21/91					

TABLE 8.1 Continuation

Section 6 - First Six Periods Only - If A7 is greater than A6, go to Section 7

1	A1 = 1195.00	A1 - 0 = 1195.00	M1 = 1	T = M1+M2+.....M6 = 240	27	44.26	
2	A2 = 741.00	A2 - A1 = -454.00	M2 = 29	T = M2+M3+M4+M5+M6 = 239	27		-16.81
3	A3 = 646.00	A3 - A2 = -95.00	M3 = 15	T = M3+M4+M5+M6 = 210	29		-3.28
4	A4 = 434.00	A4 - A3 = -212.00	M4 = 45	T = M4+M5+M6 = 195	31		-6.84
5	A5 = 256.00	A5 - A4 = -178.00	M5 = 90	T = M5+M6 = 150	36		-4.94
6	A6 = 140.00	A6 - A5 = -116.00	M6 = 60	T = M6 = 60	58		-2.00
				Section 6:	Sub-Total	44.26	-33.87
					Total	10.39	

Random Load Only (Emergency Diesel Generator Restart)

R	AR =	AR - 0 =	MR =	T = MR			
	143.00	143.00	1	1	104	1.38	

Maximum Section Size		Random Section Size		Uncorrected Size
10.67	+	1.38	=	12.05

Unc. Size		Temp. Correction Factor		Aging Factor		Required Size
12.05	x	1.11	x	1.25	=	16.71

Margin = (Actual Size - Required Size) x 100% / Actual Size = 1.68 %

NOTE:

The random load represents the EDG manual restart loads which could occur anytime between 1-240 minutes. The load associated with EDG auto-start is already included in the peak loading for the 0-1 minute period.

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO. N-1 PRELIM. CCN NO.	PAGE 27 OF 29
CCN CONVERSION CCN NO.	

Project or DCP/MMP Station Blackout Calc No. DC-1604 Rev. 10

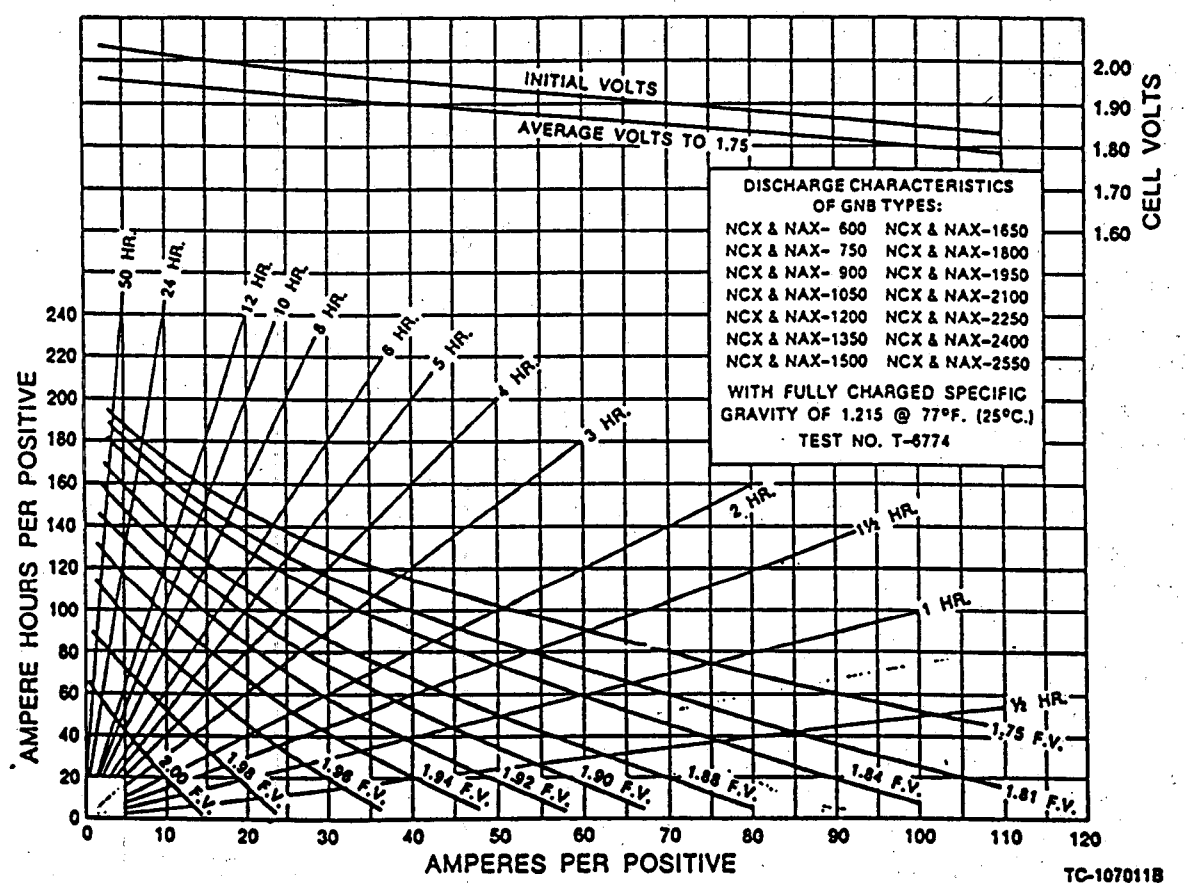
Subject SONGS 1 125V DC BATTERY NO. 1 SIZING Sheet No. _____

SUPPLEMENT V

Sheet V26 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SCE	6/21/91					

FIGURE 8.1
Battery Discharge Characteristics Curves
GNB Type NCX-2550



TC-107011B

SUPPLEMENT V

Sheet V27 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SCK	6/21/91					

8.2 Battery Terminal Voltage

Using the methodology described in Section 5.2, in conjunction with the battery discharge characteristics curves of Figure 8.1, battery terminal voltages during the discharge duration are calculated as shown in Table 8.2.

TABLE 8.2
Battery Terminal Voltage Calculations
SBO Event Loading Conditions

		Time Period in Minutes						
		0-1	1-30	30-31	31-45	45-90	90-180	180-240
Load Amps		1195.00	741.00	789.00	646.00	434.00	256.00	140.00
Adjusted Load Amps		1658.06	1028.14	1094.74	896.33	602.18	355.20	194.25
Adjusted Load Amps per Positive Plate		97.53	60.48	64.40	52.73	35.42	20.89	11.43
Expended Amp-Hours per Positive Plate		1.63	30.86	1.07	13.93	57.42	88.76	100.19
Cell Volts	Begin	1.855	1.915	1.880	1.930	1.955	1.945	1.945
	End	1.855	1.885	1.910	1.915	1.905	1.910	1.935
Battery Volts	Begin	107.59	111.07	109.04	111.94	113.39	112.81	112.81
	End	107.59	109.33	110.78	111.07	110.49	110.78	112.23

NOTE:

The EDG manual restart random load is imposed on the 30-31 minute because the lowest battery terminal voltage is calculated to be at the 30th minute. The initial minute end voltage which is lower is not considered to be the conservative voltage because the battery voltage recovers immediately following a load reduction and that diesel generator restart is not likely to occur immediately following a failed auto-start.

SUPPLEMENT V

Sheet V28 of V28

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	A. S. MATIONG	6/21/91	SLK	6/21/91					

8.3 Battery Charger Capacity

Using the methodology described in Section 5.3, the required battery charger capacity is calculated below.

From the resultant load profile, the amperes removed from the battery (C) and the maximum continuous load (L) are:

$$C = 1195(1/60) + 741(29/60) + 709(15/60) + 434(45/60) + 256(90/60) + 140(59/60 + 283(1/60)$$
$$= 1407.95 \text{ ampere hours}$$

From Design Input 4.6:

$$L = 360 \text{ amperes}$$

The required recharging time (H) is:

$$H = 8 \text{ hours}$$

The required charger ampere capacity (A) is:

$$A = L + 1.1(C/H)$$
$$= 360 + 1.1(1407.95/8) = 555.35 \text{ amperes}$$

Battery chargers A and B, each rated 1000 amperes, therefore, have the capability of restoring the battery to a fully charged state within 8 hours after ac power restoration.

ENCLOSURE 3

Justification for Removal of Loads From Battery No. 1 During a Station Blackout

Justification For Removal of Loads
From Battery No. 1 During a Station Blackout

The Control Room must remain functional for the four hour coping duration of the SBO. Plant coping during the SBO is performed utilizing the DSD diesel. The DC loads on battery No. 1 listed below are removed during the station blackout and are not required for the Control Room to remain functional. The justification for removing loads at the indicated times during a blackout are provided. It should be noted that the plant configuration after removing the DC loads listed below is no different than the plant configuration when using the DSD diesel for plant shutdown after an Appendix R fire.

1) DC Breaker No. 72-120 - Emergency RCP Thermal Barrier Pump

The Emergency RCP Thermal Barrier Pump can provide alternate cooling to the RCP seals. However, during an SBO event, the thermal barrier pump is not credited. Seal cooling is provided along with RCS inventory makeup by the North Charging pump powered by the DSD diesel.

The SBO RCS inventory calculation assumes seal leakage consistent with NUMARC 87-00 guidelines for RCS inventory loss until charging is established utilizing the DSD diesel. This load can be shed at any time.

2) DC Breaker No. 72-139 - Emergency Bearing Seal Oil Pump.

The Turbine Bearing Emergency Oil Pump can be shed after the turbine comes to rest. Westinghouse estimates that the standard time frame for the turbine to come to rest is 30 to 40 minutes. The pump can be manually tripped after this occurs which can be assumed to be 45 minutes.

3) DC Breaker No. 72-138 - Emergency Hydrogen Seal Oil Pump.

The Emergency Seal Oil Pump is used to prevent hydrogen leakage from the generator. After the DSD diesel has been started and loaded, operators will be available to remove hydrogen from the generator. This process includes depressurizing, degassing and CO_2 flushing. Assuming one hour to start and load the DSD diesel and two hours to degas and partially flush the generator, this pump can be manually tripped after three hours.

4) DC Breaker No. 72-102 - Turbine Plant Annunciator
DC Breaker No. 72-104 - Reactor Plant Annunciator
DC Breaker No. 72-109 - Hydrogen Control Panel Annunciator
DC Breaker No. 72-127 - HVAC Control Board Annunciator
DC Breaker No. 72-129 - Radwaste Control Board Annunciator

These annunciators do not provide an instrument or control function and can be removed at any time.

5) DC Breaker No. 72-110 - Digital Fault Recorder

This provides a diagnostic tool to monitor pre-fault and post fault conditions in breakers and power supplies. This is not required to cope with a SBO and can be removed at any time.

6) DC Breaker No. 72-111 - Turbine Controls

After the turbine has tripped, these controls are no longer required and can be removed at any time.

7) DC Breaker No. 72-121 - Chemical Control Board

This provides the capability to obtain a Steam Generator Blowdown sample. This load is not required to cope with a SBO and can be removed at any time.

8) DC Breaker No. 72-124 - Sequencer No. 1

The EDG has failed to start as part of the SBO scenerio and auto sequencing of the EDG is not required. This load can be removed at any time.

9) DC Breaker No. 72-140 - Emergency Lighting Switchboard

This provides DC control power to the incoming normal and standby supply breakers for the AC lighting switchboard. This load can be removed at any time.

10) DC Breaker No. 72-141 - Control Rods

Once the reactor has tripped this load is no longer required to cope with a SBO and can be removed at any time.

11) DC Breaker No. 72-122 - Containment Spray System
DC Breaker No. 72-134 - NIS Coincidentor Cabinets A and B

Accidents are not assumed to occur concurrent with the SBO event. Therefore these loads are not required to cope with an SBO and can be removed at any time.

12) DC Breaker No. 72-123 - Sphere Isolation Valves

This breaker powers the isolation valves for the sphere sample, sump discharge, and RCS drain tank discharge lines. They all fail closed on loss of DC power. Closure of these valves meets the SBO position on establishing containment integrity. This load can be removed at any time.

13) DC Breaker No. 72-131 - Inverter No. 4
DC Breaker No. 72-136 - Inverter No. 2

Inverters 1 and 3 will provide the minimum instrumentation required for the Control Room to remain functional during a SBO. Inverters 2 and 4 provide instrumentation that is redundant to that provided by Inverters 1 and 3.

Additionally, with the shedding of these breakers, the control valves powered by Inverters 2 and 4 are left in the same configuration as when the breakers are shed during a plant shutdown after an Appendix R fire which utilizes the DSD diesel.