Southern California Edison Company	CALC. NO. N-4080-003	ICCN NO./ PRELIM. CCN NO. C-1	PAGE 1	TOTAL NO. OF PAGES 21
INTERIM CALCULATION CHANGE NOTICE (ICCN)/ CALCULATION CHANGE NOTICE (CCN) COVER PAGE	BASE CALC. REV. 5	UNIT 2 & 3	CCN CONVERSION : CCN NO. CCN-	CALC. REV.

CALCULATION SUBJECT : CONTAINMENT SPRAY (CS) AND EMERGENCY COOLING UNIT (ECU) ACTUATION TIMES

CALCULATION CROSS-INDEX	ENGINEERING SYSTEM NUMBER / PRIMARY STATION SYSTEM DESIGNATOR	Q-CLASS
☒ New/Updated index included ☐ Existing index is complete	1206, 1500 / BKA, GNF	II

CONTROLLED PROGRAM OR DATABASE ACCORDING TO SO123-XXIV-5.1	PROGRAM / DATABASE NAME (S) ☐ ALSO, LISTED BELOW	VERSION/RELEASE NO.(S)
☐ PROGRAM ☐ DATA BASE	N/A	N/A

1. BRIEF DESCRIPTION OF ICCN / CCN:

Revise sheets 2, 3, 5, 5A, 6, 7, 8, 11, 12, 13, 14, 15, 16, 18, 21, 21A, 22, 23, and 24 (Note: the change sheets included in this ICCN include changes made to these sheets by CCN 1 on 9/20/95)

Add sheet 7A Delete sheets (NONE)

This change incorporates the resequencing of the Containment Emergency Fan Cooling Unit motors to start 5 +2.5/-0.5 seconds after the Component Cooling Water pump motors are energized.

Incorporation of this change increases the overall actuation time for the ECUs to:

a) 39 seconds following a design basis LOCA or MSLB event with No LOOP

b) 49 seconds following a design basis LOCA or MSLB event with LOOP

The revised ECU actuation times have no impact on analyses of record for Containment pressure-temperature response to design basis LOCA or MSLB events; the ECU start times actually used in the P-T AORs bound the values from this actuation timing analysis.

INITIATING DOCUMENT (DCP, FCN, OTHER) DCP 2&3 2077.00SE REV. 0

2. OTHER AFFECTED DOCUMENTS (CHECK AS APPLICABLE FOR CCN ONLY):

SEE DCP 2&3 2077.00SE FOR OTHER AFFECTED DOCUMENTS

◉ YES ○ NO OTHER AFFECTED DOCUMENTS EXIST AND ARE IDENTIFIED ON ATTACHED FORM 26-503.

3. APPROVAL : DISCIPLINE / ESC : Nuclear Safety Anal.

PAUL BARBOUR/ PTB 11/25/96	[signature] 11/26/96.	
ORIGINATOR (Print name/initial/date)	GS (Signature/date)	OTHER (Signature/date)
MARK DRUCKER/ MD, 11/26/96		
IRE (Print name/initial/date)	DM (Signature/date)	OTHER (Signature/date)

4. ASSIGNED SUPPLEMENT ALPHA DESIGNATOR : ______

CONVERSION TO CCN DATE ______

SCE CDM - SONGS

CALCULATION CROSS INDEX

ICCN NO. / PRELIM. CCN NO. C-1 | PAGE 2 OF 21

CCN CONVERSION: CCN NO. CCN-

Calculation No. N-4080-003 Sheet No. 2

Calc. rev. number and responsible supervisor initials and date	INPUTS These interfacing calculations and/or documents provide input to the subject calculation, and if revised may require revision of the subject calculation. Calc/Document No.	Rev. No.	OUTPUTS Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents. Calc/Document No.	Rev. No.	Does the output interface calc/document require revision? YES/NO	Identify output interface calc/document CCN, DCN TCN/Rev. or FIDCN
MJB 12/23/93 MJB 11/26/9x	Calculations:		UFSAR, SONGS Units 2&3, Section 6.2.2 Tables 6.2-30 & 6.2-31	~~9~~ 12	Yes	SAR23-~~2705~~ 478
	M-0014-009	0	Calculation M-0014-003	0	Yes/supersede	AJB-93-141*
	N-4080-002	1	Calculation N-4080-004	1	Yes	9030001/1 thru 9030004/1**
	N-4080-007	2				
	E4C-016	5				
	SO23-944-C50 (CE-NPSD-570-P, Rev. 03-P)	0				
	DCP 2&3 2077.00SE	0				
5	Drawings:		Calculation N-1140-020	0	No	N/A
	40383	10	Calculation N-4080-026	0	No	N/A
	40397	8	Calculation N-4080-027	0	No	N/A
	40421, sheet 1	16				
	40494	6				
	40114B	12				
	90004	55				
5	Isometric Drawings:					* NEDOTRAK Log Item
	S2-1206-ML-047, sheet 1	9				**NEDOTRAK Action Items
	S2-1206-ML-047, sheet 2	8				
	S2-1206-ML-048, sheet 1	4				
	S2-1206-ML-049, sheet 1	3				
	S2-1206-ML-050, sheet 1	4				
	S2-1206-ML-051, sheet 1	3				
	S2-1206-ML-052, sheet 1	4				
5	Vendor Prints:					
	SO23-405-9-70	1				
	SO23-410-1-158	3				

CALCULATION CROSS INDEX

CCN NO. / PRELIM. CCN NO. C-1 | PAGE 3 OF 21

CCN CONVERSION:
CCN NO. CCN-

Calculation No. N-4080-003 Sheet No. 3

Calc. rev. number and responsible supervisor initials and date	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? YES/NO	Identify output interface calc/document CCN, DCN TCN/Rev. or FIDCN
	Calc/Document No.	Rev. No.	Calc/Document No.	Rev. No.		
5 12/23/93	Specification SO23-403-12	2				
5	SONGS Unit 2 Technical Specifications	Amdt 108				
5 11/26/96	Procedures: SO23-V-3.4.6 SO23-V-3.5 SO23-3-3.30 SO23-3-3.11.2 SO23-3-3.12	 TCN10-12 TCN 7-32 TCN 7-26 TCN 0-3 TCN 11-1	△			
5	NCR 93030001 NCR 93030002 NCR 93030003 NCR 93030004 NCR960801324	1 1 1 1 0				
11/26/96	CALCULATION E4C-082 (INCL. CCN C-22)	1	△			

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
5	Paul Barbour	12/23/93	Allen Evinay	12/23/93					
	Paul Barbour	11/25/96	Mark Drucker	11/25/96					

1.0 PURPOSE

The purpose of this calculation is to determine a conservative time interval between the occurrence of the design basis loss of coolant accident (LOCA) or main steam line break (MSLB) in containment and the time at which a single train of the containment spray (CS) system or a post accident emergency cooling unit (ECU) is fully functional for containment heat removal. The containment spray and emergency cooling unit delay times are determined with and without a loss of off-site power (LOOP).

The calculation specifically includes engineered safety features (ESF) analysis set points of 5 psig for safety injection and containment emergency cooling unit actuation and 20 psig for containment spray system actuation. This revision also specifically calculates a spray piping fill time consistent with the performance of a 7.5% degraded containment spray pump identified in calculation M-0014-009 [Ref. 6.1].

The calculation also incorporates an increase in the Agastat sequencing time delay relay repeatability from the vendor specification of ±10% of the relay setting to ±2.5 seconds for sequencing the containment spray (CS) pumps and the component cooling water (CCW) pumps. The calculation also includes shorter CS pump and CCW pump acceleration times of 1.9 and 2.1 seconds, respectively.

The calculation incorporates a change in the start time for the ECU fans from the first ESF load group to five seconds following startup of the CCW pumps as provided by DCP 2&3-2077.00SE [Ref. 6.28]. The change in ECU start time assures fan operation will only occur when component cooling water pumps are operating to supply cooling water to the ECU coils, resolving a concern identified in NCR 960801324 [Ref. 6.29].

The results of this calculation are included in UFSAR Chapter 6, tables 6.2-30 and 6.2-31, which present design basis delay times for containment heat removal system operation following a design basis LOCA or MSLB in containment. For conservatism, the delay times developed in this calculation are based on the containment pressure response to the design basis MSLB (main steam line break at 102% reactor power) since this accident provides a slower rate of containment pressure rise than does the design basis LOCA.

The delay times determined in this calculation provide a basis for modeling the start of containment heat removal systems in analyses to determine the containment pressure and temperature response to the design basis LOCA and MSLB events. These delay times are applicable only to large break events with containment pressure ramps that reach the containment high and high-high pressure analysis setpoints within the times used in this calculation. In-containment high energy line break events which provide slower rates of containment pressurization should be individually evaluated for the timing of heat removal system operation using the methodology of this calculation, but based on a calculated break-specific time to reach the high and high-high containment pressure analysis setpoints.

This calculation revision is required to support closure of disposition step 2 of NCRs 93030001, 2, 3, and 4 [Ref. 6.7] by providing minimum CS and ECU start time data for use in revising the design basis LOCA and MSLB analyses of record.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
5	Paul Barbour	12/23/93	Allen Evinay	12/23/93					
	Paul Barbour	11/25/96	Mark Drucker	11/25/96					

2.0 RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

2.1 Results

The results of this calculation show that, following a design basis loss of coolant accident (DB LOCA) or a design basis main steam line break (DB MSLB), the containment emergency cooling units and containment spray system will be fully functional after the time intervals identified below. Delay times reflecting loss of offsite power (LOOP) and no loss of offsite power (no LOOP) are provided. For the LOOP case, the loss of power is assumed to occur at a point in time following the LOCA or MSLB such that the loss of voltage signal (LOVS) which starts the emergency diesel generator, occurs coincident with the generation of the safety injection actuation signal (SIAS) occurring on containment high pressure (SIAS/LOVS event). For the record, ECU and CS delay times calculated for the current plant configuration are compared with the values used to support the original licensing of SONGS Units 2 and 3.

SUMMARY OF RESULTS
Emergency Cooling Unit and Containment Spray Actuation Times

	NO LOSS OF POWER		WITH LOSS OF POWER	
	Original Licensing Basis	Current Configuration	Original Licensing Basis	Current Configuration
ECU Delay Time (seconds)	13	39	33	49
CS Delay Time (seconds)	46.6	49	55	59

As discussed in Section 2.2, current analyses of record for containment P-T response to design basis LOCA and MSLB events use ECU and CS actuations times which bound those calculated for the current configuration.

These delay times are specifically applicable to the DB LOCA (double-ended RCS suction leg slot break) or DB MSLB (steam line break at 102% power). Containment high energy line break events which provide slower rates of containment pressurization than the DBA events cited should be individually evaluated for the timing of heat removal system operation using the methodology of this calculation, but based on break-specific times to reach the high and high-high containment pressure setpoints.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
5	Paul Barbour	12/23/93	Allen Evinay	12/23/93					
	Paul Barbour	11/25/96	Mark Drucker	11/25/96					

Timelines describing the sequence of events and individual delay times associated with each component of the overall actuation time are provided in Section 8 (Calculations) as Figures 1 and 2 on pages 24 and 28 for the emergency cooling units and the containment spray, respectively.

An explanation of the principal reasons for the differences in the delay times for the current plant configuration and those used as an original plant licensing basis is provided below.

With LOOP, the ECUs are fully functional within 49 seconds, or about 16 seconds later than calculated for the original licensing basis. Delaying the start of the ECU fan motors 5 +2.5/-0.5 seconds after starting the CCW pump motors rather than starting the fans in the 1st ESF load group contributes about 15 seconds of the 16 second total increase in ECU actuation time. The 15-second increase in total response time applies equally to LOOP and No LOOP scenarios. With LOOP, an additional 1 second increase in actuation time is due to a combination of increased CCW pump motor Agastat timing delay relay uncertainty and reduced CCW pump acceleration time.

In the case of ECU operation with No LOOP, the ECUs are fully functional within 39 seconds, or about 26 seconds later than in the original licensing basis analysis. The change in ECU fan motor start to 5 seconds following the CCW pump motor start contributes about 15 seconds to the total increase in ECU actuation time. The remaining 11 second increase in delay time results from the current station operating practice of normally operating only a single CCW pump train rather than always running both train pumps with only one train performing a cooling function. In this case, a loss of voltage signal (LOVS) on the operating CCW pump train without a loss of offsite power (LOOP), or some other operating CCW train-related malfunction, will force a delay in the availability of the alternate CCW train. In this event, ESF sequencing which initiates on SIAS starts the available non-operating CCW train in the 4th load group, 15 ±2.5 seconds after initiating ESF sequencing. In addition, prior ECU startup analyses credited full functional capability at the time the CCW block valves were 10 seconds into their 12-second full open stroke time when the valves were 83% open. However, now that ECU availability is delayed until the idle CCW train is operational (with or without LOOP), the CCW block valves to the ECUs are fully open about 8 seconds prior to the CCW pump reaching full speed.

The change in containment spray system flow rate to allow for up to 7.5% spray pump degradation [Ref. 6.1] increased the spray piping/header fill time by about

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
△	Paul Barbour	11/25/96	Mark Drucker	11/25/96	△					
△					△					

3.5 seconds which is the major contributor to the changes in spray start time. Minor changes in other components of the overall delay time for the spray system actuation, including a ±2.5 second uncertainty in the repeatability of sequencing the containment spray pump and a compensating reduction in the spray pump motor acceleration time, also contributed small differences to the results.

NES&L DEPARTMENT

CALCULATION SHEET

Project or DCP/MMP N/A Calc. No. N-4080-003

CCN CONVERSION: CCN NO. CCN –

Subject Containment Spray (CS) & Emergency Cooling Unit (ECU) Actuation Times Sheet No. 8

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
5	Paul Barbour	12/23/93	Allen Evinay	12/23/93					
	Paul Barbour	11/25/96	Mark Drucker	11/25/96					

2.2 Conclusions & Recommendations

The overall delay times employ constituent response times which are consistent or conservative with respect to Station response time and operability testing success criteria. Therefore, this calculation revision does not impact Station procedures. However, DCP 2&3 2077.00SE implements a change in overall ECU response time as identified in Licensee Controlled Technical Specification Section 3.3.100. Changes to the LCS and related station procedures due to the change in start time for the ECU fans are included in the implementing DCP.

The overall and constituent delay times from the prior revisions of this calculation are included in UFSAR table 6.2-30 and 6.2-31. Therefore, a UFSAR change request has been initiated to conform these tables to the current analysis of record.

The analyses of record for containment pressure and temperature response to the design basis LOCA and MSLB events used to support containment functional design and equipment qualification are N-4080-026 (Supplement A, LOCA) and N-4080-027 (Supplements A and B, MSLB) [Refs. 6.9 and 6.8, respectively]. These calculations use emergency cooling unit and containment spray start times which conservatively envelope the values generated in this calculation. Therefore, these P/T calculations are not impacted by this revision.

The original analysis of record for the containment P/T response to the design basis MSLB event for equipment qualification [N-4080-004, Ref. 6.23] used emergency cooling unit and spray start times which do not envelope the values in this calculation. Calculation N-4080-004 has been revised by CCN to identify Supplement A to N-4080-027 [Ref. 6.8] as the current analysis of record for containment P/T response to the design basis MSLB for equipment qualification.

Calculation M-0014-003 [Ref. 6.24] is an early analysis of the fill time for containment spray piping inside containment. The current piping fill analysis contained in this revision of the emergency cooling unit and containment spray system startup delay times supersedes the analysis in Reference 6.24, and that calculation will be obsoleted as no longer applicable.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
5	Paul Barbour	12/23/93	Allen Evinay	12/23/93					
	Paul Barbour	11/25/96	Mark Drucker	11/25/96					

3.9 The filling of the spray headers will be assumed to start at the time the spray pump reaches full speed. The filling flow rate will be assumed to be 1900 gpm. This value is conservatively chosen to be less than that calculated in Case 7 of Reference 6.1 (1949 gpm; see Design Input 4.10). This flow rate is representative of the minimum value during injection mode operation with the RWST full, the containment at the design pressure of 60 psig, the spray block valves full open, but without the full nozzle pressure drop as would be the case while the headers are filling. For the case of containment spray actuation with no LOOP, the spray block valves are only 65% open at the time the spray pump reaches full speed, and about 4 seconds remain before the block valves are full open (see section 8.2.1). Based on Case 5 of Reference 6.1, the filling flow rate with the valves half open would be greater than 1650 gpm, or 87% of the valves full open flow rate (1686 gpm is shown in Ref. 6.1). Using linear interpolation, the filling flow with the block valves 65% open would be about 90% of the maximum filling flow rate. The assumption of the maximum filling flow rate from the time the block valves are 65% open, with the spray pump at full speed, is justified since no credit is taken for the substantial amount of water which will enter the assumed empty portion of the riser during the 1.9 seconds that the pump is accelerating to full speed while the block valves are moving from about 49% open to 65% open. It is estimated that over 40 gallons of water would enter the assumed empty portion of the spray riser system, which is enough to fill the 10 feet of the initial 8" diameter riser piping and about half the horizontal 6" diameter distribution pipe in the 1st ring header before the calculation assumes any water enters the dry part of the piping system.

3.10 The spray piping filling time will be calculated for the "A" spray train (header number 1) since the total length of all 3 ring headers for this train is about 19 feet longer than that for the "B" train.

3.11 The time to accelerate the CS pump to full speed following closure of the pump breaker is assumed to be 1.9 seconds per Reference 6.26.

3.12 The time to accelerate the CCW pump to full speed following closure of the pump breaker is assumed to be 2.1 seconds. This value is three times the worst case acceleration time of 0.7 seconds calculated under degraded voltage conditions in E4C-082 [Ref. 6.30]. This acceleration time is consistent with the 2.5 seconds cited in Reference 6.26, assuming the CCW pump motor breaker closing time of 0.4 seconds is included in the 2.5 second value. Finally, the 2.1 second value is conservative with respect to a vendor-supplied acceleration time of 2 seconds at 75% voltage shown in Reference 6.13.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
5	Paul Barbour	12/23/93	Allen Evinay	12/23/93						
	Paul Barbour	11/25/96	Mark Drucker	11/25/96						

4.0 DESIGN INPUT

4.1 The analysis setpoint for containment high pressure is 5 psig [Ref. 6.2]. This value is consistent with the actual containment high pressure setpoint of 3.4 psig established in Reference 6.2 and incorporated into the Station Technical Specifications [Ref. 6.15, Unit 2 as an example]. The high pressure setpoint initiates the safety injection actuation signal (SIAS) and containment cooling actuation signal (CCAS). The SIAS signal initiates startup of the high and low pressure safety injection pumps and the containment spray pumps (P-012 and P-013) through the ESF sequencer. The CCAS signal will cause the component cooling water block valves to the emergency cooling units to open (2(3)HV-6366 through 2(3)HV-6373), and enable starting of the ECU fans 5 seconds after the CCW pump motors are started.

4.2 The analysis setpoint for containment high-high pressure is 20 psig [Ref 6.2]. This value is consistent with the actual containment high-high pressure setpoint of 14.0 psig established in Reference 6.2 and incorporated into the Station Technical Specifications [Ref. 6.15, Unit 2 as an example]. The high-high pressure setpoint initiates the containment spray actuation signal (CSAS) which causes the containment spray block valves, 2(3)HV-9367 and 2(3)HV-9368, to open.

4.3 The diesel generator delay for the LOOP case is 10 seconds [Section 4.8.5.D of Ref. 6.5]. This time interval includes generator start, attainment of rated voltage and frequency, breaker closure energizing the 4160 volt ESF bus, and LOVS reset. This value is the same as the surveillance test acceptance value of 10 seconds cited in Section 7.1.16.2.2 of Reference 6.17.

4.4 The nominal delays for sequencing the first 4 ESF load groups are [Ref. 6.6]:

Group 1: 0 seconds Group 3: 10 seconds
Group 2: 5 seconds Group 4: 15 seconds

The emergency fan cooler motors are started by 5-second delay relays slaved off the power breakers feeding the CCW pump motors which load in group 4 [DCP 2&3 2077.00SE, Ref. 6.28].
The containment spray pump motors are in Group 3 [Ref. 6.6].
The component cooling water pump motors are in Group 4 [Ref. 6.6].

As identified in Assumption 3.4, the repeat accuracy of the load group delay times is ±2.5 seconds applied to the Agastat time delay relay setting.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
5	Paul Barbour	12/23/93	Allen Evinay	12/23/93					
	Paul Barbour	11/25/96	Mark Drucker	11/25/96					

4.5 The maximum stroke time for opening the containment spray block valves, 2(3)HV-9367 and 2(3)HV-9368, is 12 seconds [Refs. 6.10 and 6.11].

4.6 The maximum stroke time for opening CCW isolation valves 2(3)HV-6366 through 2(3)HV-6373, which permit cooling water to flow through the containment emergency cooling units, is 12 seconds [Refs. 6.10 and 6.11].

4.7 (Replaced by Assumption 3.11.)

4.8 (Replaced by Assumption 3.12.)

4.9 The maximum time required to accelerate an emergency cooling unit fan motor to full speed following closure of the fan motor power supply breaker is 10 seconds [Ref. 6.3]. This value is conservative with respect to a vendor-supplied acceleration time of 7.8 seconds at 80% voltage shown in Reference 6.14.

4.10 The spray pump flow rate delivered to the containment riser while filling of the spray ring headers is in progress (prior to establishment of full containment spray flow at design nozzle pressure drop) will be taken to be 1650 gpm with the spray isolation valve 2(3)HV-9367 or 2(3)HV-9368 one-half open and 1900 gpm with the spray block valves full open. These values have been conservatively selected to be less than the minimum flow rates calculated for cases 5 and 7, respectively, of Reference 6.1 for a 7.5% degraded spray pump drawing water from a full RWST and pumping into a 60 psig containment building during the time that the spray piping is filling, before the full nozzle pressure drop is developed.

4.11 The Sprayco 1713A hollow cone bottom ramp spray nozzles have a design flow rate of 15.2 gpm at a 40 psid nozzle pressure drop [Appendix 2 of Ref. 6.1]. With turbulent flow conditions, the flow rate will vary as the square root of the nozzle pressure drop.

4.12 Per Reference 6.28, the 5-second time delay relay used to start the ECU fans following start of the CCW pumps will be accurate to within + 2.5/-0.5 seconds; therefore, the maximum delay time between CCW pump start and ECU fan motor start will be 7.5 seconds.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
5	Paul Barbour	12/23/93	Allen Evinay	12/23/93					
	Paul Barbour	11/25/96	Mark Drucker	11/25/96					

5.0 METHODOLOGY

The start times for the containment sprays and emergency cooling units are determined by combining in series (and in parallel, if appropriate) the time intervals for each action which must occur to establish a functioning heat removal system. The constituents of the total delay times are identified below.

A. Emergency Cooling Unit Operation

1) Time to reach containment high pressure analysis setpoint following the design basis LOCA or MSLB

2) Sensor and instrumentation delays to generate the containment cooling actuation signal (CCAS)

3) Assuming LOOP, time to start the diesel generator, reach design voltage and frequency, energize the 4160 volt ESF bus, and LOVS reset (with No LOOP, the diesel generator delay is not applicable)

4) Time to open the component cooling water (CCW) block valves to the emergency cooling units

5) Also, with or without LOOP, ESF sequencing delay in starting the operable CCW pumps which start in the 4th load group

5a) With a loss of voltage signal (LOVS) on the operating CCW train (but with no LOOP) or another malfunction in the operating CCW train, the ESF sequencing delay will still apply to restoring CCW flow, but without the diesel generator starting delay

6) Time to accelerate the CCW pumps to full speed, restoring CCW flow, assuming a LOOP had occurred (breaker closure time plus motor acceleration time)

7) Time to energize the 5-second delay relay in preparation for starting the emergency cooling unit ECU fan motors following energizing the CCW pump motors in load group 4.

8) Time to start and accelerate the ECU fan motors to full speed.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
5	Paul Barbour	12/23/93	Allen Evinay	12/23/93					
	Paul Barbour	11/25/96	Mark Drucker	11/25/96					

B. Containment Spray System Operation

1) Time to reach containment high pressure analysis setpoint following the design basis LOCA or MSLB

2) Sensor and instrumentation delays to generate the safety injection actuation signal (SIAS) which initiates automatic sequencing of ESF equipment and starts the containment spray pump in the 3rd load group (with LOOP, sequencing is delayed until the ESF bus is energized by the emergency diesel generator)

3) Assuming LOOP, time to start the diesel generator, reach design voltage and frequency, energize the 4160 ESF bus, and LOVS reset (with No LOOP, the diesel generator delay is not applicable)

4) Time for the spray pump motors to be energized and accelerate to full speed (breaker closure time plus motor acceleration time)

5) Time to reach containment high-high-pressure analysis setpoint following design basis LOCA or MSLB

6) Sensor and instrumentation delays to generate the containment spray actuation signal (CSAS) which initiates opening of the containment spray isolation valves and allow spray water to begin filling the spray piping in containment

7) Time to open the containment spray isolation valves

8) Time to fill the spray rings and establish full containment spray flow

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
5	Paul Barbour	12/23/93	Allen Evinay	12/23/93						
	Paul Barbour	11/25/96	Mark Drucker	11/25/96						

6.0 REFERENCES

6.1 Supplement A to Mechanical Calculation M-0014-009, Rev. 0, "Containment Spray Pumps Inservice Testing Minimum Requirements", July 28, 1994

6.2 ABB-CE Calculation CE-NPSD-570-P, Rev. 03-P, "Plant Protection System Setpoint Calculation", October, 1991, SCE Document No. SO23-944-C50-0

6.3 [Reference Voided; see Reference 6.27]

6.4 Gould-Brown Bovari Switchgear Division Bulletin 8.2-1E, "ITE Type HK Stored Energy Metal-Clad Switchgear", Table 9, page 43 (copy of page 43 provided in Appendix A)

6.5 Specification SO23-403-12, Rev. 2, "Diesel Driven Electrical Generating Sets for SONGS Units 2 and 3", October 3, 1975

6.6 Electrical Calculation E4C-016, Rev. 5, "ESF Sequencing", May 4, 1984

6.7 NCRs 93030001, 2, 3, and 4; Containment Spray Pumps 1 & 2 for SONGS Units 2 & 3

6.8 Supplements A and B to Nuclear Calculation N-4080-027, Rev. 0, "Containment P/T Analysis for Design Basis MSLB", November 4, 1994 and March 14, 1995

6.9 Supplement A to Nuclear Calculation N-4080-026, Rev. 0, "Containment P/T Analysis for Design Basis LOCA", February 6, 1995

6.10 Engineering Procedure, SO23-V-3.5, TCN 7-32, "Inservice Testing of Valves Program", December 9, 1993

6.11 Surveillance Operating Instruction, SO23-3-3.30, TCN 7-26, "In-service Valve Testing, Quarterly", September 10, 1993

6.12 [Reference Deleted]

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
5	Paul Barbour	12/23/93	Allen Evinay	12/23/93					
	Paul Barbour	11/25/96	Mark Drucker	11/25/96					

6.24 Mechanical Calculation M-0014-003, Rev. 0, "Containment Spray Flow History", May 28, 1975

6.25 Amerace Corporation, Industrial Electrical Products Division, Bulletin E70-1, "Agastat Nuclear Qualified Time Delay Relays", E7000 Series Operating Characteristics from Specifications on Page 4 (copy of the table provided in Appendix B)

6.26 Memorandum, D. Stickney to A. Brough, "Analysis for Obtaining a ±2.5 Seconds of Relay Setting on Agastat Timing Relay for Load Sequence Timing Tolerance in Tech Spec 4.8.1.1.2.d.13.", July 21, 1995 (copy of the memo is provided in Appendix C)

6.27 Memorandum to File, C. E. Kramer, "Plant Protection System Response Time First Principle Documents, SONGS Units 2 & 3", July 26, 1996, including Supplement A, dated November 25, 1996

6.28 Design Change Package, DCP 2&3 2077.00SE, Revision 0

6.29 NCR 960801324; Potential Common-Mode Post-Accident Failure of Containment Emergency Cooling Units (ECUs)

6.30 Electrical Calculation E4C-082, Rev. 1, including ICCN C-22, "System Dynamic Voltages During Design Basis Accident", March 24, 1993

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
5	Paul Barbour	12/23/93	Allen Evinay	12/23/93					
	Paul Barbour	11/25/96	Mark Drucker	11/25/96					

8.0 CALCULATIONS

8.1 Emergency Cooling Units

The timing of the automatic startup of the emergency cooling units following a design basis LOCA or MSLB, with and without loss of offsite power, is developed in the following two sub-sections. The total delay time is developed using a chronology of events approach. Timelines describing the sequence of events for emergency cooling unit startup, with and without loss of offsite power, are provided in Figure 1. The delay times associated with each component of the overall delay time, which are provided in the chronologies below, have been included on the timelines in parentheses.

8.1.1 ECU Actuation With No Loss of Offsite Power (see Figure 1.A)

(A)	DB LOCA or MSLB occurs	zero seconds
(B)	Containment pressure reaches the analysis setpoint for containment high pressure (5 psig, Des. Input 4.1)	2 seconds (Assump. 3.5)
(C)	SIAS generated LOVS occurs on operating CCW train (without LOOP) or other malfunction Sequencing of ESF equipment begins CCAS generated CCW block valves to ECUs begin to open	1 second after reaching hi pressure setpoint (Assump. 3.1) (Des. Input 4.1)
(D)	CCW isolation valves to ECUs are fully open	12 seconds valve stroke time (Des. Input 4.6)
(E)	CCW pump motor breaker coils energized (CCW pump motors are in the 4th load group per Des. Input 4.4)	17.5 sec after start of ESF sequencing (Assump. 3.4)
(F)	CCW pump motors start ECU fan motor delay relay energized	0.4 sec brkr closure time (Assump. 3.2 & Des. Inp. 4.4)
(F')	CCW pump at full speed, full CCW flow to ECU established	2.1 sec after brkrs close (Assump. 3.12)

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
△	Paul Barbour	11/25/96	Mark Drucker	11/25/96	△				
△					△				

(G)	ECU fan motor breaker coils energized	7.5 sec after CCW pump motor is powered (Des. Input 4.4 & 4.12)
(H)	ECU fan motors start	0.4 sec brkr closure time (Assump. 3.2)
(I)	Emergency cooling unit motor and fan at rated speed	10 sec after brkrs close (Des. Input 4.9)

Elapsed time following DB LOCA or MSLB for CCW block valves to ECUs to be fully open = A + B + C + D
= 0 + 2 + 1 + 12 = 15 seconds

Elapsed time following DB LOCA or MSLB for full CCW flow to ECUs
= A + B + C + E + F + F'
= 0 + 2 + 1 + 17.5 + 0.4 + 2.1 = 23.0 seconds

Elapsed time following DB LOCA or MSLB for full spped emergency cooling unit fan with full CCW flow
= A + B + C + E + F + G + H + I
= 0 + 2 + 1 + 17.5 + 0.4 + 7.5 + 0.4 + 10 = 38.8 seconds
= **39 seconds, rounded**

The limiting action for establishing emergency cooling unit full operability with no loss of offsite power but with a loss of voltage signal on the operating CCW train, following a design basis LOCA or MSLB, is the delayed starting of the ECU fan motors following CCW pump restart. The total delay time for emergency cooling unit operability in this case is 39 seconds.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
5	Paul Barbour	12/23/93	Allen Evinay	12/23/93					
	Paul Barbour	11/25/96	Mark Drucker	11/25/96					

8.1.2 ECU Actuation With Loss of Offsite Power (see Figure 1.B)

(A)	DB LOCA or MSLB occurs	zero seconds
(B)	Containment pressure reaches the analysis setpoint for containment high pressure (5 psig, Des. Input 4.1)	2 seconds (Assump. 3.5)
(C)	SIAS generated CCAS generated LOVS is present and EDG starts due to LOOP	1 second after reaching hi pressure setpoint (Assump. 3.1)
(D)	EDG @ full speed and frequency and ESF bus energized Sequencing of ESF equipment begins CCW block valves to ECUs begin to open	10 seconds after EDG start (Des. Input 4.3) (Des. Input 4.1)
(E)	CCW isolation valves to ECUs are fully open	12 seconds from time valves begin to open (Des. Input 4.6)
(F)	CCW pump motor brkr coils energized (CCW pump motors are in the 4th ESF load group per Des. Input 4.4)	17.5 seconds after start of ESF sequencing (Assump 3.4)
(G)	CCW pump motor starts ECU fan motor time delay relay energized	0.4 sec brkr closure time (Assump. 3.2 & Des. Input 4.4)
(G')	CCW pump at full speed, full CCW flow to ECU established	2.1 seconds after brkrs close (Assump. 3.12)
(H)	ECU fan motor breaker coils energized	7.5 sec after CCW pump motor is powered (Des. Input 4.4 & 4.12)
(I)	ECU fan motors start	0.4 sec after brkrs close (Assump. 3.2)

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
5	Paul Barbour	12/23/93	Allen Evinay	12/23/93					
	Paul Barbour	11/25/96	Mark Drucker	11/25/96					

(J) Emergency cooling unit motor and fan at rated speed — 10 sec after brkrs close (Des. Input 4.9)

Elapsed time following DB LOCA or MSLB for CCW block valves to ECUs to be fully open
= A + B + C + D + E
= 0 + 2 + 1 + 10 + 12 = 25 seconds

Elapsed time following DB LOCA or MSLB for full CCW flow to ECUs
= A + B + C + D + F + G + G'
= 0 + 2 + 1 + 10 + 17.5 + 0.4 + 2.1 = 33.0 seconds

Elapsed time following DB LOCA or MSLB for full speed emergency cooling unit fan operation with full CCW flow
= A + B + C + D + F + G + H + I + J
= 0 + 2 + 1 + 10 + 17.5 + 0.4 + 7.5 + 0.4 + 10 = 48.8 seconds
= **49 seconds, rounded**

The limiting action for establishing emergency cooling unit full operability with loss of offsite power and the loss of voltage signal simultaneous with the safety injection actuation signal (SIAS/LOVS event) following a design basis LOCA or MSLB, is the delayed starting of the ECU fan motors following CCW pump start. The total delay time for emergency cooling unit operability in this case is 49 seconds.

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ ~~PRELIM.~~ CCN NO. C-1 | PAGE 21 OF 21

Project or DCP/MMP N/A Calc. No. N-4080-003

CCN CONVERSION:
CCN NO. CCN --

Subject Containment Spray (CS) & Emergency Cooling Unit (ECU) Actuation Times Sheet No. 24

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
5	Paul Barbour	12/23/93	Allen Evinay	12/23/93					
	Paul Barbour	11/25/96	Mark Drucker	11/25/96					

FIGURE 1 - Emergency Cooling Unit Actuation Timelines